



Research on the blocking mechanism of vocational education industry-education interface under the structural mismatch between supply and demand side

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SUMMARY: *Facing the structural mismatch between school training and enterprise demand in vocational education, the study reveals the deep-seated blocking mechanism of industry-education docking in the context of supply-demand mismatch and explores its cracking path. Starting from institutional analysis, the study clarifies the multi-stakeholder interactions among the government, schools and enterprises. Then, through extensive research for institutions, enterprises and graduates, 18 specific influencing factors are measured under the four dimensions of supply-side, demand-side, mutual coupling and government environment. On this basis, a progressive analysis strategy of structural analysis-multiple regression-structural equation modeling was designed to test the mechanism of the influencing factors of industry-education docking. Factors such as benefit distribution (centrality degree 5.245), policy support (influence degree 3.045), and technical talent demand (cause degree 1.517) reside in the key position of the network. Multiple regression further confirms that benefit distribution, enterprise participation willingness and policy support are the most significant influence variables on docking effectiveness, with standard regression coefficients β of 0.201, 0.174 and 0.190, respectively. Through the full path analysis of structural equation modeling, the coupling mechanism between two parties has the strongest direct effect on the effectiveness of industry-teaching docking, with a path coefficient = 0.657, and it acts as a key intermediary bridge, and the policy environment then by influencing the coupling mechanism, path coefficient = 0.688.*

KEYWORDS: *supply-demand mismatch; vocational education; industry-education interface; blocking mechanism; multiple regression; structural equation*

1 Introduction

Docking between industry and education is an effective way to effectively connect vocational education and enterprise demand, and to promote the synergistic development of “industry” and “education” [1]. The explicit function of industry-education docking is that it helps vocational education to improve the quality of talent training, meets the requirements of the times of the innovation-driven development strategy, is the inevitable requirement of local economic development for vocational education, and is a powerful support for the connotative development of vocational education and the progress of industry and technology [2-5]. Industry and education can be seamlessly docked at the root of the supply and demand side of the balance, from the supply and demand side of the point of view, the comprehensive quality of vocational education students to match the industrial development of the demand for talent is crucial, in the docking of industry and education in the enterprise to provide students with

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productive practical activities is the root cause and motivation of the students' technical skills, vocational qualities and sense of responsibility development [6-9]. Currently, academics have explored extensively about industry-education docking. Kayyali emphasizes the importance of industry-education docking in vocational education, analyzes the necessity of cooperation between institutions and enterprises in designing curricula, and discusses best practices in successful cases and their effects on students' employment and industrial satisfaction, emphasizing the positive impact of strengthening docking with innovative technologies on regional economic development [10]. Hu and Li explain the connotation of new quality productivity, analyze its internal logic with the development of vocational education and the mechanism of talent supply and demand, construct the industry-teaching docking and talent training system on this basis, and emphasize that vocational colleges and universities should improve the precision of talent supply and the quality of cultivation, and promote the high-quality construction of the industry-teaching docking community, in order to enhance the impetus of empowering new quality productivity [11].

In addition, Wang explored the content, mode and mechanism of industry-teaching docking, analyzed the status quo of talent demand in the information industry and the relationship between industry-teaching docking and its practice teaching system, and examined the correlation between the practice teaching system and students' satisfaction through a questionnaire survey and SPSS statistical analysis, with the aim of providing a reference basis for the optimization of the practice teaching system of the information majors of vocational colleges and universities and the public industry-teaching docking training bases [12]. Zhao discusses the innovation and practice of higher education talent cultivation mode under the perspective of industry-education docking, and through case study and empirical research, points out that industry-education docking can effectively narrow the gap between educational output and industrial demand, while emphasizing challenges such as coordination and management, and providing suggestions for educational leaders to strengthen industry-education docking with the aim of cultivating talents adapted to the needs of the modern economy through the combination of theory and practice [13]. Xu et al. from the perspective of industry-teaching docking, in-depth discussion of higher vocational colleges and universities professional talent cultivation path, through multi-college research and case study analysis, pointing out its problems in the curriculum system, faculty construction, practical teaching and so on, and put forward to optimize the docking of industry-teaching and strengthen the cooperation between schools and enterprises, and other improvement measures, in order to improve the quality of talent cultivation, to meet the demand for high-quality technical and skilled personnel in the new era [14]. Wang and Zhang emphasized that in the context of industrial transformation and upgrading, the cultivation of skilled innovative talents has become the key to the sustainable development of regional economies. Based on the alignment between industry and education, they examined the connotation characteristics and the interaction mechanism between the educational structure and the industrial structure, proposed multiple-dimensional paths such as curriculum system optimization and expansion of multi-disciplinary capabilities, and analyzed the matching relationship between talents and the industrial structure. They pointed out that establishing a deep coupling mechanism between education and economy holds significant value [15].

Supply and demand side is the basic concept of economics, "equilibrium" from the phenomenon level, is the balance of supply and demand. Between the supply of talents in vocational education and the industry's "labor demand", there are the following two situations: first, the focus of professional settings is based on the demand for specialists for the development of the local and regional economy [16]; second, the professional settings should also pay attention to the degree of supply of educational resources in vocational colleges and

universities themselves [17]. However, in the context of the new industrial revolution trend and China's manufacturing strategy, the pace of industrial upgrading and transformation has accelerated, and the supply side of talent training and the industrial demand side in the structure, quality, and level can not be fully adapted to the shortage of intelligent manufacturing high-skilled personnel has always been a difficult problem plaguing social production [18-21]. This has caused the docking to appear structural, institutional as well as innovative blockage. In the face of these problems, it is necessary for vocational education to promote vocational education from supply-oriented to demand-oriented through mechanism innovation, so as to realize the balance between supply and demand.

The study understands the pattern of interests involved in the industry-education docking from the institutional level, and breaks down the abstract mismatch phenomenon into observable influencing factors, revealing the interaction of the factors leading to docking blockage through empirical methods. The article cuts through the perspective of historical institutionalism and establishes that the industry-education docking is the result of the game and collaboration among multiple stakeholders, including the government, industry, enterprises, schools, and students. It then turns to the specific structural mismatch phenomenon, which is quantified as specific influencing factors under the four dimensions of supply side (institutions), demand side (enterprises), coupling between the two sides, and government environment, and collects data from frontline teachers, enterprise experts, and graduates through a questionnaire survey. At the methodological level, multivariate linear regression and structural equation modeling are used, the former measuring the magnitude and direction of the influence of a particular factor of efficacy mismatch on the effectiveness of the industry-teacher dyad, and the latter testing the path of causality among multiple potential variables.

2 Analysis of the Impact of Industry-Education Docking under Supply and Demand Mismatch and Research Methods

2.1 Analysis of factors affecting the system of matching industry and education in vocational education

Historical institutionalism pays particular attention to the distribution of power by the system among different members of society or social organizations, and to the different choices of action made by different stakeholders and different social organizations. In the evolution and change of the system of industry-education interface, it is influenced by stakeholders including government, employers and employers' organizations, trade unions, schools and apprentices, guilds, enterprises and other factors. Of course, the stakeholders may vary from country to country, but the main stakeholders will not be absent, including the government and related departments, employers, schools and apprentices, and thus they become the influencing factors of the system of industry-education interface.

It can also be seen that the construction of vocational education industry-education docking system is a systematic project, and its formation process is shown in Figure 1. The formation of vocational education industry-education docking system needs to be centered on the docking content of the system design, system implementation and system evaluation, while the system design, implementation and evaluation need to be supported by government laws and regulations, industry-education docking stakeholders (tax department, labor security department, Economic and Information Technology Commission, industry associations), etc., and will also be affected by the environment of the system construction. The elements at each

level of the system are interconnected, mutually constrained and related to each other.

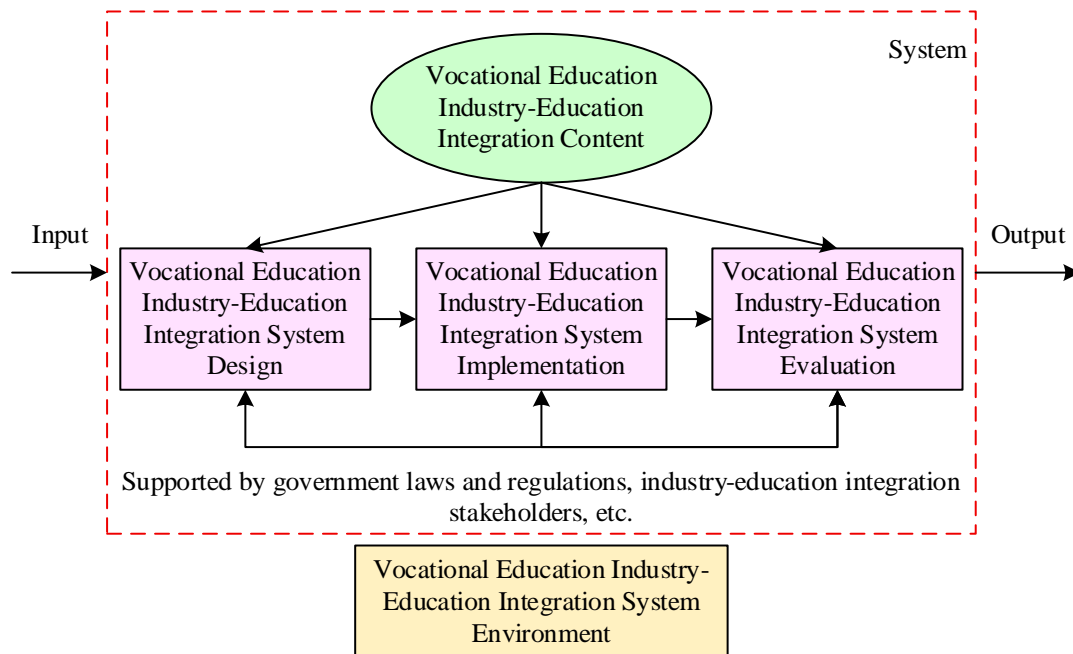


Figure 1: Formation process of the vocational education-industry connection system

2.2 Impact of structural mismatch on the supply and demand side on the interface between education and production

2.2.1 Influencing factors

The structural mismatch between the supply and demand side refers to the systematic mismatch between the supply side (vocational colleges and universities) and the demand side (enterprises) in terms of the structure, quality, scale and supply rhythm of talent cultivation during the process of industry-education docking of vocational education. This mismatch not only leads to the difficulty of the talents cultivated by institutions to meet the actual job requirements of enterprises, but also affects the willingness and effect of enterprises to participate in the integration of industry and education, which in turn restricts the ability of vocational education to serve the development of industry. In addition to the supply and demand sides and their coupling performance, vocational education industry-education docking is also affected by the government environment. The influencing factors of vocational education industry-education docking under the structural mismatch between the supply and demand sides are shown in Table 1.

Table 1: Influencing factors of supply-demand imbalance to education and industry

Dimension	Influencing factors
Supply side (School)	S1: Technical talent cultivation
	S2: Awareness of industry-academia integration
	S3: Course content
	S4: Teacher allocation
	S5: School resource investment
Demand side (Enterprise)	E1: Demand for technical talents
	E2: Enterprise participation intention
	E3: Enterprise basic conditions
	E4: Cultural characteristics
	E5: Enterprise resource investment
Coupling of Supply and demand	C1: Cooperation experience
	C2: Profit distribution
	C3: Information communication
	C4: Organizational coordination
Government Environment	G1: Government attention level
	G2: Financial support
	G3: Policy support
	G4: Market environment

The influencing factors of vocational colleges mainly include the supply capacity in terms of technical personnel training, curriculum content, and faculty allocation; the enterprise side includes the actual demand for technical personnel, willingness to participate, basic conditions, and other configuration capabilities. At the same time, the coupling factors of both sides include the degree of cooperation experience, distribution of benefits, communication and coordination, etc.; the government environment factors are the degree of government attention, financial and policy support, market environment and other external conditions, the factors together cast the contradiction between the mismatch of supply and demand, and further impact on the docking of education industry and education.

2.2.2 Data sources and collection

This study focuses on collecting information and practical research to analyze the relationship between government, schools and enterprises and their respective positioning in the integration of industry and education, to innovate the mode of integration of industry and education, and to explore the mechanism of the impact of structural mismatch on the supply and demand side on the interface between industry and education.

In terms of research methodology, according to the needs of the research, using questionnaires, symposiums and other ways and means, using the Likert five-level scale from “very consistent” to “very inconsistent” for evaluation, scoring from 5 to 1, and organizing the backbone of professional teachers and students to investigate the current situation of the development of the integration of industry and education and the factors affecting it. The organization of professional backbone teachers, students to investigate the current status of the development of the integration of industry and education and the factors affecting the research target for some of the colleges and universities of applied specialties of the graduates, enterprises and experts and scholars in related fields. A total of 800 questionnaires were issued, and 773 were actually recovered, with 728 valid questionnaires, a recovery rate of 96.63% and an effective rate of 94.18%. Factor analysis was applied to analyze the influence factors of

structural mismatch on the supply and demand side on the industry-education docking.

2.3 Research methodology

Multiple linear regression and structural equation modeling are introduced to deepen the understanding of the mechanism of the impact of supply-demand mismatch at the levels of direct effects among variables and structural relationships among latent variables, respectively.

2.3.1 Principles of Multiple Linear Regression Analysis

The advantage of regression analysis is that it quantitatively describes the correlation between the variables, and the use of factor analysis also yields the strength of the relationship between the explanatory variables and the explained variables as well as the overall level of explanatory significance, and the general form of the multiple linear regression model is:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \cdots + b_pX_p \quad (1)$$

b_0 represents the regression constant and $b_1, b_2, b_3, \cdots, b_p$ is the partial regression coefficient. The dependent variable Y consists of its estimated value and residuals, the estimated value is related to the independent variable, and the residuals, although not related to the independent variable, are important for the ability to build a multiple regression model. Multiple linear regression analysis requires that there is no multivariate covariate relationship between the explanatory variables, so multiple covariate diagnosis should be used for the model, and in order to achieve the expected effect of the model, it is also necessary to ensure that the independent variable and the dependent variable have a significant effect while the correlation is close.

2.3.2 Structural equation modeling

In structural equation modeling, variables that cannot be directly observed are potential variables, and variables that can be directly observed are apparent variables. The model consists of two parts, the structural model and the measurement model, the first part is the structural model, which mainly describes the relationship between latent variables with the path relationship diagram [Equation (2)]; and the second part is the measurement model, which mainly describes the relationship between the measurement indexes and latent variables [Equation (3)-(4)].

$$\eta = B_\eta + \Gamma \xi + \zeta \quad (2)$$

$$X = \Lambda_X \xi + \delta \quad (3)$$

$$Y = \Lambda_Y \eta + \varepsilon \quad (4)$$

where: η, ξ is the endogenous and exogenous latent variables, respectively; B, Γ is the path coefficient; ζ is the residual term; X, Y is the observed variable for the exogenous latent variable and the endogenous latent η variable, respectively; Λ_X, Λ_Y denotes the relationship between the observed variable to the latent variables ξ and η , respectively; and δ, ε is the error term for X and Y , respectively.

3 Empirical Analysis of the Influence Mechanism of Industry-Education Docking under Supply-Demand Mismatch

Various quantitative methods such as structural analysis, multiple regression, path modeling and hypothesis testing are used to test the theoretical hypotheses proposed in the previous paper.

(1) Based on expert evaluation and questionnaire data, structural analysis and correlation interpretation of influencing factors are conducted;

(2) Further identifying the independent effects of key variables through multiple regression;

(3) Finally, with the help of structural equation modeling, we explore the complex paths of action between the four core variables: supply-side, demand-side, two-side coupling and government environment.

3.1 Analysis of factors affecting the matching of production and education under the mismatch of supply and demand

3.1.1 Structural analysis of influencing factors

Adopting the expert survey method, 20 experts from general colleges and universities, vocational colleges and universities, enterprises and government departments are invited to assign values to the influence relationships among 18 influencing factors in 4 dimensions based on Table 1 according to the rule of assignment of the factors' influence intensity {no influence, weak influence, average influence, strong influence, stronger influence}={0,1,2,3,4}, and the averaging method is taken to process the experts' data, to get the The direct influence matrix between the influencing factors of industry-education docking under the mismatch of supply and demand, and calculate the degree of influence and the degree of being influenced by each factor on other factors, as well as the center degree and the cause degree of each factor. Among them, the center degree is the sum of the influence degree and the influenced degree, and its size is positively correlated with the importance of the factor. The cause degree is the difference between the degree of influence and the degree of influence, and its value has positive and negative points, the cause degree of positive influencing factors known as cause-type factors, and the cause degree of negative influencing factors known as result-type factors.

The obtained influence, influenced, center and cause degrees of each factor are shown in Table 2.

Table 2: Degree of influence, being affected, centrality and causality

	Degree of influence	Degree of being influenced	Centrality	Reasoning degree
S1	1.234	1.789	3.023	-0.555
S2	1.568	2.105	3.673	-0.537
S3	1.892	1.745	3.637	0.147
S4	2.117	1.963	4.08	0.154
S5	1.672	2.389	4.061	-0.717
E1	2.845	1.328	4.173	1.517
E2	2.117	1.894	4.011	0.223
E3	1.989	0.956	2.945	1.033
E4	1.456	1.231	2.687	0.225
E5	2.334	2.017	4.351	0.317
C1	1.978	2.245	4.223	-0.267
C2	2.456	2.789	5.245	-0.333
C3	2.123	2.567	4.69	-0.444
C4	2.345	2.112	4.457	0.233
G1	3.112	1.894	5.006	1.218
G2	2.889	2.234	5.123	0.655
G3	3.045	1.678	4.723	1.367
G4	2.456	1.345	3.801	1.111

Meanwhile, in order to more clearly show the relationship between the influence degree and the influenced degree values among the factors, the 3D scatter of influence degree - influenced degree - centrality degree is also plotted as shown in Figure 2. Where the bubble size represents the centrality size, the color mapping represents the cause size, the YZ projection point size represents the factor influence size, the XZ projection represents the influenced size, and the XY projection represents the centrality size.

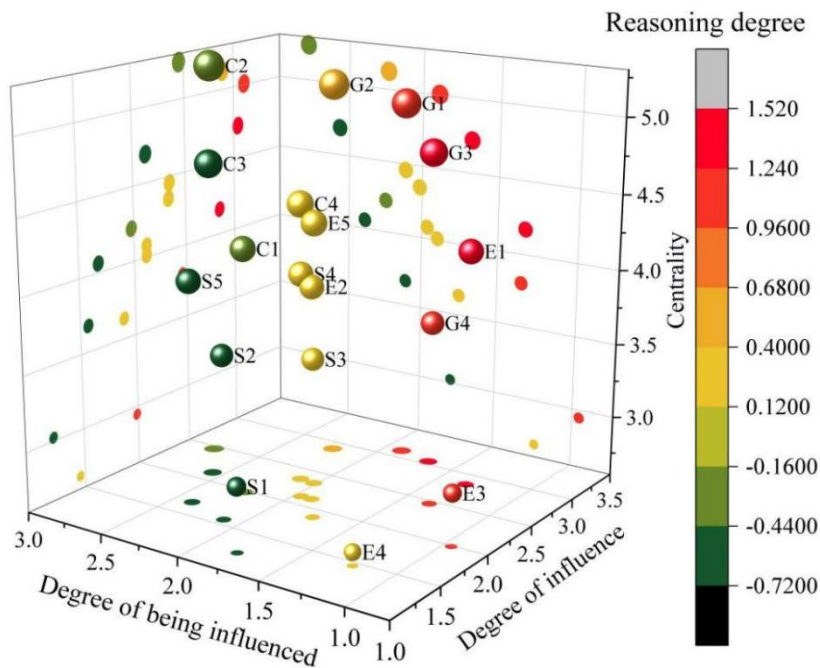


Figure 2: 3D scatter plot of factor influence degree - influenced degree - centrality

According to the calculation results of the degree of influence, it can be seen that the factors with high degree of influence include G1 the degree of governmental emphasis (3.112), G2 financial support (2.889), G3 policy support (3.045) and E1 the demand for technical talents (2.845). It shows that in the industry-education docking, the guidance and regulation at the government level is the most prominent, and its policy, funding and emphasis have a strong influence on other factors. Meanwhile, the technical talent demand of enterprises also has a greater impact on vocational education industry-education docking under the mismatch of supply and demand.

In terms of the degree of being influenced, factors such as C1 cooperation experience (2.245), C2 benefit distribution (2.789), C3 information communication (2.567), and S5 school resource input (2.389) are more highly influenced by other factors, which by themselves play a more direct role in industry-education docking under the mismatch of supply and demand. It indicates that factors at the coupling level of both parties as well as school resource inputs are more likely to be constrained and driven by other external factors, such as government policies and enterprise demand, and exhibit stronger outcome characteristics.

The centrality degree can be said to be the direct indicator of the importance mapping of factors, and the more important influencing factors are C2 benefit distribution (5.245), G2 financial support (5.123), G1 governmental importance (5.006) and C4 organizational coordination (4.457). Among them, benefit distribution has the highest centrality, which is the most critical influence factor of industry-education docking under the mismatch of talent cultivation and demand. Among the top 10 influencing factors in the centrality degree, 4 influencing factors at the level of coupling between two parties, 2 influencing factors of enterprises, 1 influencing factor of schools, and 3 influencing factors of governmental environment.

There are 6 outcome-type factors among the 18 influencing factors, and the other 12 are cause-type factors, which are planned into 3 categories based on the point distribution and color mapping in Figure 2. One is the 6 outcome-type factors with the color green, including S1: technical talent cultivation, S2: awareness of industry-education integration, S5: school resource input, C1: cooperation experience, C2: benefit distribution and C3: information communication. The data points are located on the left side of the 3D graph, are generally high in the degree of being influenced, relatively low in the degree of influence, are influenced by other factors in the system, and are the landing point for the role of various types of policies, needs and conditions.

The second category of yellow data points, including G2, C4, E5, S4, E2, S3, E4 and other 7 factors, the cause of the degree of value between 0-0.65, for the weak cause of the type of factors, this type of factors influence and the degree of influence is more balanced, located in the middle of the figure, with a certain degree of active influence and other factors regulated by other factors.

The third category is the five strong causal factors with reddish color, including G1 governmental importance, G3 policy support, E1 technical talent demand, G4 market environment and E3 enterprise basic conditions, whose influence degree is generally high, and the degree of being influenced is low, and is located on the right side of the graph. These types of factors have a significant impact on the industry-education docking and also have a greater impact on other outcome-based factors.

3.1.2 Factor correlation analysis

Based on 728 questionnaires from students, teachers and experts, the correlation analysis between the 18 factors was obtained based on the subjects' evaluation scores for each factor as shown in Figure 3.

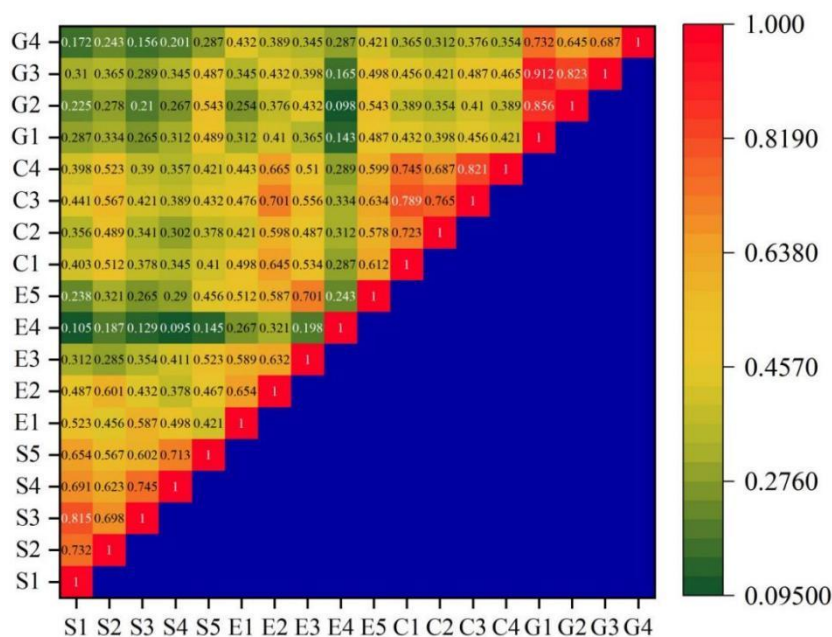


Figure 3: Correlation analysis among 18 factors

As can be seen from Figure 3, the data gradually turn red from the lower left to the upper right, indicating that the correlation among factors within the same dimension is generally high. In the supply side of S1-S5, the correlation coefficients between factors range from 0.567 to 0.815. On the demand side of E1-E5, the correlation among various factors is also strong. Except for the cultural characteristic of E4 (whose correlation coefficients with other factors range from 0.098 to 0.334, and the correlation is relatively weak, corresponding to the lowest centrality of 2.687 in the previous factor structural analysis), the internal factors of both coupling dimensions and the government environment dimension are also strongly correlated, with correlation coefficients generally above 0.7. There are also multiple significant correlation paths between different dimensions, such as the correlation coefficient between S2 and E2, which represents the awareness of industry-academia integration, is 0.601, and the correlation coefficient between E2 and C3, which represents the enterprise participation intention, is 0.701. The analysis of the correlation of factors influencing the industry-academia integration is verified through testing and can be used for subsequent regression analysis.

3.2 Multiple regression analysis

In order to further identify the intensity of the influence of each influential factor on the effectiveness of industry-education docking, on the basis of correlation analysis, a multiple linear regression model was constructed to analyze the comprehensive effectiveness of industry-education docking as the dependent variable, and representative factors from four dimensions: the supply side, the demand side, the coupling of both sides and the government environment were selected as independent variables.

Eight key variables, including S3 curriculum content, S5 school resource input, E1 demand for skilled personnel, E2 willingness of enterprises to participate, C2 benefit distribution, C3 information communication, G1 government attention and G3 policy support, were selected to be included in the model in order to circumvent multiple covariance and focus on the core explanatory power. School type (vocational college = 1) and enterprise size (medium and large = 1) were introduced as control variables. SPSS 26.0 was used to regression analyze the data from 728 questionnaires and stepwise regression was used to screen the variables, and the final

model results are shown in Table 3.

Table 3: The results of the multiple linear regression analysis of influencing factors

	B	Std.Error	Beta	t	p	
Constant	1.204	0.238	—	5.059	0.000***	
Enterprise size (Large and medium-sized enterprises = 1)	0.088	0.036	0.075	2.444	0.015*	
School type (Vocational Colleges = 1)	0.072	0.033	0.068	2.182	0.029*	
Course content	0.157	0.048	0.132	3.271	0.002**	
School resource investment	0.142	0.052	0.121	2.731	0.006**	
Technical talent demand	0.231	0.041	0.218	5.634	0.000***	
Enterprise participation intention	0.189	0.045	0.174	4.202	0.000***	
Benefit distribution	0.276	0.055	0.201	5.018	0.000***	
Information communication	0.203	0.049	0.168	4.143	0.000***	
Government attention level	0.182	0.043	0.165	4.233	0.000***	
Policy support	0.214	0.046	0.190	4.652	0.000***	
Model	R	R ²	Adjusted R ²	D-W	F	p
	0.687	0.472	0.465	2.018	63.352	0.000***

The regression model introducing eight variables can explain 46.5% of the variation in the effectiveness of industry-education docking, while the model as a whole is significant, $F = 63.352$, $p < 0.001$, with good explanatory power. Considering the standardized coefficient Beta as the influence weight, the enterprise's E1 technical talent demand has the largest influence weight, $Beta = 0.218$. At the same time, the intensity of both sides' coupling influences is also larger, C2 benefit distribution and C3 information communication, with the standardized coefficient $Beta = 0.201/0.168$, and the ability to establish a mutually satisfactory benefit mechanism between schools and enterprises and effective communication of information is an important operational factors. Meanwhile, the governmental environment G3 policy support $Beta=0.190$, in contrast, the school level influence weight is not so big in contrast, curriculum content and resource input $Beta=0.132$ and 0.121 , but $p=0.002$ and 0.006 , the influence effect is significant at the 0.01 level.

3.3 Path Analysis of Influential Factors of Industry-Education Docking Based on Structural Equation Modeling

3.3.1 Theoretical assumptions on the relationship between the role of influencing factors

Based on the results of the structural analysis of the factors influencing the industry-education docking under the 3.1 supply-demand mismatch, structural equation modeling is introduced to continue exploring the mechanism of the influence of the industry-education docking of vocational education in terms of the dimensions of four variables: the supply side (schools), the demand side (enterprises), the coupling mechanism of both sides, and the governmental environment. The study quantifies the effect of vocational education industry-education docking into three dimensions: talent matching fit, achievement transformation level and sustainability of industry-education docking. The theoretical model of the relationship between

the influencing factors of vocational education-industry-education docking under the mismatch of supply and demand proposed by the study is shown in Figure 3.

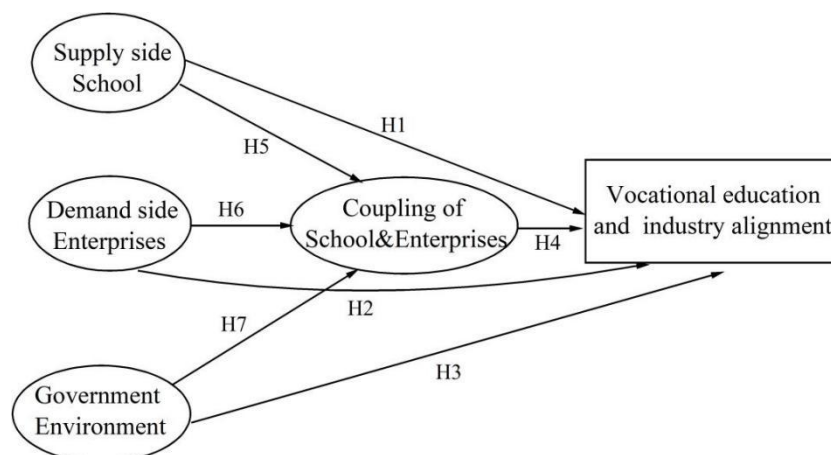


Figure 3: Theoretical model for analyzing the interaction of influencing factors

The theoretical hypotheses of the role relationship between the factors influencing the vocational education industry-teaching docking under the supply-demand mismatch are as follows:

H1: the supply side (school) has a significant impact on the industry-teaching docking under the supply-demand mismatch, with the sub-hypothesis

H1a: The supply side has a significant impact on the talent matching fit of the industry-teaching docking;

H1b: the supply side has a significant impact on the level of outcome transformation of the industry-teaching docking;

H1c: the supply side has a significant impact on the sustainability of industry-teaching docking;

H2: the demand side (enterprises) has a significant impact on the industry-teaching docking under the mismatch of supply and demand, with the subhypotheses

H2a: the demand side has a significant impact on the talent matching fit of the industry-teaching docking;

H2b: the demand side has a significant impact on the level of outcome transformation of the industry-teaching docking;

H2c: the demand side has a significant impact on the sustainability of industry-teaching docking;

H3: the two-party coupling has a significant impact on the industry-education docking under the supply-demand mismatch, with the sub-hypotheses

H3a: two-party coupling has a significant effect on the talent matching fit of industry-education docking;

H3b: the two-party coupling has a significant impact on the level of transformation of the results of the industry-education docking;

H3c: two-party coupling has a significant effect on the sustainability of industry-education docking;

H4: the government environment has a significant effect on the industry-education docking under the mismatch of supply and demand, with the subhypotheses

H4a: the government environment has a significant effect on the talent matching fit of industry-education docking;

H4b: the government environment has a significant effect on the level of outcome transformation of the industry-education docking;

H4c: the government environment has a significant effect on the sustainability of the industry-education docking;

At the same time, it can be found that the two sides coupling plays a mediating role in it, so there are hypotheses

H5: The supply side (school) affects the industry-teaching docking by acting on the coupling of both sides

H6: The demand side (enterprises) influences the education-industry docking by acting on the coupling between the two sides.

H7: The policy environment affects the education-industry docking by acting on both sides of the coupling Complementary

3.3.2 Analysis of exogenous latent variable estimates

In structural equation modeling analysis, the estimation of variance of exogenous latent variables is the basis of model identification and fitting, and its significance reflects the stability and explanatory power of each latent variable in the model. Based on the theoretical model constructed in the previous section, the exogenous latent variables in this study include the four core constructs of supply-side (schools), demand-side (enterprises), the coupling mechanism between the two sides, and the governmental environment, as well as their subordinate 18 observed variables. The variance estimates of these four latent variables and their observational variables are first examined, and the statistics of their variance estimates are shown in Table 4.

Table 4: Analysis of 22 extrinsic latent variable estimates

Variable	Estimate	Standard Error	C.R	P
Supply side (School)	0.727	0.042	17.167	0.000
Demand side (Enterprise)	0.741	0.038	20.447	0.000
Coupling of Supply and demand	0.826	0.032	25.938	0.000
Government Environment	0.753	0.035	22.801	0.000
S1	0.633	0.051	12.353	0.000
S2	0.522	0.062	7.839	0.000
S3	0.665	0.048	13.979	0.000
S4	0.595	0.055	10.545	0.000
S5	0.548	0.059	8.831	0.000
E1	0.704	0.041	17.829	0.000
E2	0.662	0.029	13.571	0.000
E3	0.618	0.053	11.491	0.000
E4	0.473	0.068	6.1602	0.000
E5	0.645	0.052	12.910	0.000
C1	0.606	0.054	11.372	0.000
C2	0.737	0.037	20.973	0.000
C3	0.721	0.039	19.333	0.000
C4	0.682	0.045	15.489	0.000
G1	0.755	0.034	23.618	0.000
G2	0.711	0.042	18.502	0.000
G3	0.768	0.023	24.818	0.000
G4	0.641	0.051	12.512	0.000

The four major dimension estimates are 0.727, 0.741, 0.826 and 0.753, with all $P = 0.000$, and their statistical explanatory power is very strong. This paper constructs the analytical framework from four perspectives: supply-demand-coupling-environment is theoretically accurate and reliable. Meanwhile, the estimated values of each observed variable are also between 0.473 and 0.768, all the measurements are significantly valid, and the standard error estimates are all very small, with values between 0.023 and 0.059, and the model is basically well adapted.

3.3.3 Analysis of regression coefficients for each pathway

The estimates of the regression coefficients for each path, estimated by the great likelihood method, are shown in Table 5.

Table 5: The estimated values of the regression coefficients for each path

Variable	Estimate	Standard Error	C.R	P
Supply side (school) → Industry-education integration	0.335	0.052	5.096	0.000
Demand side (enterprise) → Industry-education integration	0.502	0.048	9.428	0.000
Coupling of Supply and demand → Industry-education integration	0.657	0.045	13.044	0.000
Policy environment → Industry-education integration	0.454	0.042	9.143	0.000
Supply side (school) → Coupling of Supply and demand	0.415	0.054	6.389	0.000
Demand side (enterprise) → Coupling of Supply and demand	0.583	0.049	10.469	0.000
Policy environment → Coupling of Supply and demand	0.688	0.044	14.045	0.000
Supply side (school) → Talent matching compatibility	0.493	0.061	6.934	0.000
Supply side (school) → Transformation of achievements	0.357	0.058	4.948	0.000
Supply side (school) → Sustainability of industry-education integration	0.268	0.06	3.345	0.000
Demand side (enterprise) → Talent matching compatibility	0.451	0.056	6.804	0.000
Demand side (enterprise) → Transformation of achievements	0.526	0.053	8.604	0.000
Demand side (enterprise) → Sustainability of industry-education integration	0.464	0.055	7.164	0.000
Coupling of Supply and demand → Talent matching compatibility	0.582	0.05	10.24	0.000
Coupling of Supply and demand → Transformation of achievements	0.759	0.047	14.66	0.000
Coupling of Supply and demand → Sustainability of industry-education integration	0.801	0.046	15.891	0.000
Government environment → Talent matching compatibility	0.326	0.059	4.339	0.000
Government environment → Transformation of achievements	0.482	0.055	7.491	0.000
Government environment → Sustainability of industry-education integration	0.559	0.053	9.226	0.000

All the 19 paths listed in Table 5 are significant, supporting all the hypotheses (H1-H7) put forward in this paper, while revealing that the coupling of both sides as the biggest pusher of vocational education industry-education docking has a path coefficient of 0.657, confirming the H3 hypothesis. The path coefficient of the direct comprehensive influence of enterprises as the demand side on the industry-education docking of factors such as the demand for technical talents and the willingness to participate under them is 0.502.

Meanwhile, the mediating role of the coupling between the two sides was found, and the direct effect of the policy environment on the coupling between the two sides amounted to 0.688, which exceeded its direct effect on the industry-education docking of 0.454, suggesting that the policy environment affects the effect of the industry-education docking mainly by acting on the coupling mechanism of the supply and demand sides, which supports the hypothesis H7.

Gathering again on the different impacts of each factor on the three specific objectives, the supply side (school) is dominant in training people, so its impact on talent matching fit is the most prominent, with a path coefficient = 0.493, supporting hypothesis H1a, while the demand side (enterprise) shows stronger influence on outcome transformation and sustainability, with path coefficients = 0.526 and 0.464, supporting H2b, H2c. The two sides of the coupling has an extremely strong positive impact on all three outcomes, especially on sustainability (0.801) and outcome transformation (0.759), again confirming the H3 series of hypotheses. The direct effect of policy environment on sustainability (0.559) and outcome transformation (0.482) is greater than the effect on talent matching (0.326). Hypotheses H4a, H4b and H4c are tested.

4 Conclusions and recommendations

4.1 Conclusion

This study centers on the question of how the mismatch between supply and demand hinders the matching of industry and education in vocational education, and explores from theoretical deduction to data validation.

The industry-education docking system is a dynamic network centered on coupling mechanisms and driven by policies and markets. Among the 18 influencing factors, the coupling mechanism factors of benefit distribution (5.245) and organizational coordination (4.457) have the highest centrality of 5.245 and 4.457, respectively, followed by financial support at the government level (5.123), and the degree of governmental attention (5.006). Regression analysis further confirms that among the coupling mechanisms, equity of benefit distribution and smoothness of communication are the most powerful predictors of docking effectiveness, with standardized regression coefficients of 0.201 and 0.168, respectively.

Structural equation modeling unveils the deeper logic of transmission. The policy environment has the strongest shaping power on the formation of the coupling mechanism between the two parties, with a path coefficient of 0.688, even exceeding the direct effects of enterprise demand (0.583) and school supply (0.345). Meanwhile, the path coefficient of the coupling mechanism on the sustainability of the industry-education dyad amounts to 0.801, → the level of outcome transformation = 0.759. Verifying the core mediating hypotheses H5, H6 and H7, the power of the policy and the market and the school, to a large extent, ultimately acts on the industry-education dyad through the empowering cooperation mechanism.

4.2 Recommendations

Based on the above research conclusions, the study proposes in this regard a demand-oriented, coordinated two-party coupling method for improving the integration of industry and education in vocational education majors.

(1) Establishing an adjustment mechanism centered on demand-capability dynamic matching

The demand side strengthens the professional setting, relying on the industry steering committee and enterprise research data, and establishes the professional setting and dynamic early warning model. When the demand for jobs corresponding to a specialty declines continuously or the employment rate of graduates' counterparts falls below the threshold, the program of specialty reduction or transformation should be triggered to ensure that the supply structure follows the industrial changes.

The supply side strengthens key competencies, and curriculum development needs to be based on real job task analysis to ensure the synchronization and update rate of core curriculum content with mainstream technology and process standards in the industry. Focus on investing in the construction of shared practical training bases, whose equipment and technology iteration cycle should maintain synergy with the main production line of cooperative enterprises.

(2) Constructing a synergistic operation mechanism with project-interest as the linkage

Promote university-enterprise joint construction of industrial colleges, technology research and development centers and other entities, with specific technology research, product development or training projects as the carrier. Clarify the attribution of intellectual property rights and benefit distribution scheme in the projects, so that the cooperation can be shifted to the symbiosis of interests. And establish an institutionalized mechanism of mutual employment and two-way flow of school and enterprise personnel. The modularized teaching tasks undertaken by enterprise technical backbones should be counted in their performance appraisal; school teachers' experience of enterprise practice is linked to the promotion of their titles. At the same time, build school-enterprise information sharing platform, real-time transmission of technological change, curriculum update and talent supply and demand data.

(3) Create an integration ecology guaranteed by policies and culture.

Local governments should introduce and implement policies for the certification and combined incentives of industry-education integration enterprises, and compensate the actual costs of enterprises participating in deep cooperation. At the same time, improve the rights and responsibilities insurance system for students' internships and teachers' practices to reduce the risk of cooperation.

Within schools and enterprises, the values of joint education are shaped through the joint establishment of scholarships and fellowships, and the joint organization of skills competitions and cultural activities. The effectiveness of cooperation will be included in the quality report of the school and the social responsibility report of the enterprise, so as to enhance the social recognition and internal driving force of integrated development.

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