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Research on Linear Programming Optimization Strategies for Constructing a New Ecosystem of Industry-Education Integration in Higher Vocational Colleges in Hunan Province under the Strategy of Rejuvenating the Country through Science and Education

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ABSTRACT
This study aims to explore how Hunan higher vocational colleges and universities can build a new ecosystem of industry-education integration through linear programming optimization strategies under the guidance of the strategy of developing the country through science and technology. The article evaluates and analyzes the ecosystem of industry-teaching integration in Hunan higher vocational colleges under the strategy of developing the country through science and education using linear programming method, and proposes relevant optimization strategies using the dyadic model of linear programming. The main factors affecting the efficiency of industry-teaching integration are identified through multiple regression analysis, including industry-teaching resources, incentive mechanism and management system. According to the linear programming model for maximizing the efficiency of industry-teaching integration in higher vocational colleges and universities, it is calculated that the efficiency of industry-teaching integration is maximized when Hunan higher vocational colleges and universities invest 3.6 million yuan, 0.3 million yuan and 0.5 million yuan in the resource consumption of industry-teaching resources, incentive mechanism and management system respectively. And it is proposed to build a new ecology of industry-education integration from three aspects of platform construction, cooperation docking and parenting path, respectively.

Keywords: Linear Programming, Pairwise Modeling, Multiple Regression, Industry-Education Integration

1. Introduction

The strategy of revitalizing the country through science and education is a cross-century strategic decision, which is of great significance to the steady development of China's education [1-2]. The proposal of the strategy of developing the country through science and education helps China to fully implement the idea that science and technology is the first productive force and adhere to the principle of education-oriented, and shift the center of gravity of economic construction to the level of scientific

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and technological progress and improvement of the quality of workers [3-5]. Vocational education belongs to the universal, basic and bottom-up livelihood project, which is the fundamental work to realize the reform of Chinese-style modernization [6-7]. However, in the process of modernization of Chinese vocational education driven by the development of science and education, there still exists the imperfect professional structure of vocational education and unsound cooperation mechanism, which leads to the poor match between vocational education and industrial development of supply and demand, and hinders the modernization of Chinese vocational education [8-10].

On the one hand, the professional structure does not match the industrial structure. In the process of modernization of Chinese-style vocational education boosted by science and education, there are problems such as imperfections in the internal governance structure and organization of vocational colleges and universities, which make the professional settings of vocational education obviously lag behind the requirements of industrial development and the regional economic structure, and lead to a mismatch between vocational education curricula and the industrial structure, which affects the modernization and development of Chinese-style vocational education [11-15]. On the other hand, there is a fixed interest barrier between universities and enterprises. In the process of rejuvenating the country through science and education to promote the modernization of Chinese-style vocational education, the cooperation between vocational education and industry enterprises still exists in the form of separate policies and interests, which derails schools and enterprises, theory and practice, and leads to the phenomenon of "two skins" in the integration of industry and education in vocational education, which hinders the modernization of Chinese-style vocational education [16-19]. Therefore, Hunan higher vocational colleges and universities should take the strategic goal of enhancing the national scientific and technological strength, guiding vocational education to innovate the way of educating people in accordance with the industrial chain division of labor, and establishing a “new ecology” for the development of vocational education, so as to consolidate the foundation of human resources for the modernization of Chinese-style vocational education.

The ecosystem operation mechanism of industry-teaching integration in higher vocational colleges in Hunan constructed in this paper includes the construction of policy research and institutional guarantee mechanism, incentive mechanism of the main body of industry-teaching integration, self-organization mechanism of higher vocational colleges and evaluation and assessment mechanism of industry-teaching integration. In order to optimize the operation mechanism of the ecosystem of industry-teaching integration, this paper uses the linear programming method to construct a linear programming model for maximizing the efficiency of industry-teaching integration and uses the pairwise theorem of the model to optimize the strategy. The constructed model is simulated and analyzed to find out the conditions for maximizing the efficiency of the integration of production and education, and put forward specific optimization strategies.

2. Construction of an ecosystem operation mechanism for industry-teaching integration in Hunan higher vocational colleges and universities

The strategy of developing the country through science and education is a major strategic decision across the century, which is of great significance to the steady development of China's education [20]. The report of the 20th Party Congress points out that “promote the integration of general education and vocational education, the integration of industry and education, and the integration of science and education, and optimize the positioning of the type of vocational education”. Therefore, in the new era, vocational education should fully recognize the new mission in the context of the strategy of developing the country through science and education, and strive for new achievements in the new journey of comprehensively building a socialist modernized country. Under the strategy of developing the country through science and education, building a new ecology of industry-education integration is an important support for promoting student employment.

In order to guarantee the win-win interests of multiple participants in the integration of industry and education and to carry out the work in an orderly manner, it is necessary to build an operational mechanism for the integration of industry and education based on coordination, implementation, evaluation and incentives to ensure its good development.

1) Policy research and construction of institutional guarantee mechanism. In the work of integration of education and industry, schools, industry enterprises, government and other parties have different interests, relationships and responsibilities are not straightened out, higher vocational colleges and enterprises must deeply understand the spirit of national laws, regulations, policies and other relevant documents, within the framework of legal compliance policies, focus on researching on new modes of integration of education and industry and institutional safeguard mechanisms that are conducive to the development of the work, signing of the cooperation agreement, clarifying the rights of all parties, clarifying responsibilities, listing the operational details, and ensuring the effective implementation of the work of integration of education and industry from the mechanism level. The cooperation agreement should be signed to clarify the rights and responsibilities of all parties, and the operation rules should be listed to ensure the effective implementation of the integration of industry and education from the mechanism level.

2) Construction of incentive mechanism for the main body of industry-education integration. In the work of integration of industry and education, schools and enterprises need to establish corresponding incentive mechanisms. For example, students who get excellent results in enterprise, provincial and national skill competitions can get special rewards, students who have excellent performance but have family difficulties can sign relevant agreements to fund rewards, and units, higher vocational colleges and universities and employees who have made outstanding achievements in their work can be honored. At the same time, enterprises that play an active role in the integration of industry and education are given preferential treatment in all aspects to ensure the enthusiasm of the main bodies to participate.

3) Construction of self-organization mechanism of higher vocational colleges and universities. Self-organizing mechanism of higher vocational colleges and universities refers to their ability to adjust their internal structure, professional settings, practical training base construction, and faculty construction, etc., to better adapt to the market development needs in the process of industry-teaching integration. The integration of industry and education reduces the mismatch between talent training and the market to a certain extent, but the continuous development of the industry inevitably leads to the continuous adjustment of the demand for talents, which requires higher vocational colleges and universities to build a corresponding mechanism for the construction of specialties, and representatives from schools and enterprises to set up a steering committee of specialties and experts, to develop a talent training program and curriculum system that is docked to the needs of the industry and to cultivate the vocational abilities of the students in a more targeted way. Ability. The working mechanism of practical training base construction is the guarantee of effective cultivation of students' practical skills. The main body of industry-teaching integration follows the principle of resource sharing and school-enterprise co-construction, and utilizes the advantages of each party to realize the diversification of on- and off-campus practical training base construction. By utilizing the advantages of enterprises through “factory in school” and “implantation workstation”, we can effectively solve the practical training and employment work of the professional practice teaching system in off-campus practical training bases. Fully utilize the site and human resources of the college, through the self-built “production training studio”, the introduction of enterprises, the formation of “factory in the school”, the school training base will not only satisfy the practical training of students, but also become a base for enterprise production and staff training.

4) Construction of evaluation and assessment mechanism for the integration of industry and education. As there is no affiliation between the main parties, the construction of the evaluation and assessment mechanism for the integration of industry and education is an effective guarantee to ensure that the

work is carried out, and the evaluation system is infiltrated into the various aspects of the integration of industry and education. For example, the evaluation of enterprise instructors on students' practical training in the process of work skills records, students' skills level progression and the integration of enterprise participation, the degree of existing school resources for the enterprise staff training services, students and enterprises, such as satisfaction with the choice of employment.

3. Evaluation and optimization of the ecosystem for industry-education integration based on linear programming

3.1. Linear Programming Models

Let the evaluation index system consist of $x_1, x_2, \cdots\cdots, x_m$, where, $x_i \in [0, B_i]$, B_i are constants $(i = 1, 2, \cdots\cdots, m)$ and the index synthesis method is:

$$E = E(x_1, x_2, \cdots\cdots, x_m) = a_1 x_1 + a_2 x_2 + \cdots\cdots + a_m x_m \tag{1}$$

where $a_1, a_2, \cdots\cdots, a_m$ is a constant (called the weighting constant). If there is a n linear constraint relationship between these indicators:

$$f_{1j} x_1 + f_{2j} x_2 + \cdots\cdots + f_{mj} x_m = f_j \tag{2}$$

where f_{ij}, $f_j (i = 1, 2, \cdots\cdots, m, j = 1, 2, \cdots\cdots, n)$ are constants. The former are called constraint coefficients, and the totality of the constraint coefficients can form a matrix $F = (f_{ij})_{n \times m}$, which is called matrix F as the matrix of constraint coefficients. The latter is called the constraint constant. In this way the following linear programming model can be established:

$$(LP) \begin{cases} \max E = a_1 x_1 + a_2 x_2 + \cdots\cdots + a_m x_m \\ f_{1j} x_1 + f_{2j} x_2 + \cdots + f_{mj} x_m = f_j (j = 1, 2, \cdots\cdots, n) \\ x_i \in [0, B_i] (i = 1, 2, \cdots\cdots, m) \end{cases} \tag{3}$$

and call the solution of the model LP a feasible solution.

3.2. Evaluation Method of Industry-Education Integration Based on Linear Programming

Applying a linear programming model involves the key steps of establishing the range of variation of the metrics $x_i \in [0, B_i] (i = 1, 2, \cdots\cdots, m)$, establishing the value synthesis algorithm $E = a_1 x_1 + a_2 x_2 + \cdots\cdots + a_m x_m$, and establishing the constraints for value synthesis $f_{1j} x_1 + f_{2j} x_2 + \cdots\cdots + f_{mj} x_m = f_j (j = 1, 2, \cdots\cdots, n)$. The criteria for its evaluation include the following four.

Criterion 1: If the model LP has a feasible solution, the value object's metrics take values that are also feasible solutions to the model LP:

$$x_1 = e_1, x_2 = e_2, \cdots\cdots, x_m = e_m \tag{4}$$

Then the value object realizes its satisfactory value and has a value of $E(e_1, e_2, \cdots\cdots, e_m)$.

Criterion 2: If the model LP has feasible solutions and the value object's metrics take values that are not feasible solutions, then the value object does not realize its maximum value.

Criterion 3: If the model LP has more than one feasible solution, there must be an optimal solution:

$$x_1 = v_1, x_2 = v_2, \cdots\cdots, x_m = v_m \tag{5}$$

Then the value object realizes its satisfactory value and has a value of $E(v_1, v_2, \cdots\cdots, v_m)$.

Criterion 4: If the model LP has no feasible solution, there is no upper bound on the value of the value synthesis function $E = a_1x_1 + a_2x_2 + \cdots\cdots + a_mx_m$, and the value can be infinitely large. That is, there is room for improvement in any current value state.

The model LP reveals the specific values of each evaluation indicator, and the amount of value at this time, when the evaluation object reaches the state of maximum value, given the method of synthesizing the indicators, given the constraints between the indicators, and given the range of variation of the indicators [21].

Despite the fact that the mathematical method of synthesizing the indicators $E(x_1, x_2, \cdots\cdots, x_m)$ is unchanged in the evaluation process, the constraint relations between the indicators may be different for different manifestations of the value object. Therefore, the LP model is able to derive different solutions for specific forms of value objects.

Using the solutions derived from the LP model (mathematically called feasible solutions), the following general conclusions can be obtained:

Conclusion 1: If the value object's metrics take values that are feasible solutions for the model LP:

$$x_1 = e_1, x_2 = e_2, \cdots\cdots, x_m = e_m \tag{6}$$

Then the value object realizes its satisfactory value and is worth $E(e_1, e_2, \cdots\cdots, e_m)$.

Conclusion 2: If the value object's metrics take values that are not feasible solutions to the model LP, the value object does not realize its maximum value.

Conclusion 1 provides the possibility of value comparisons between different manifestations of the value object. The value comparisons made using Conclusion 1 are comparisons of the ideal value of each value object in its current situation, through which the optimal way of constraining between indicators within the value object can be found. The so-called optimal constraints are the constraints between indicators corresponding to the feasible solutions that maximize the amount of value among the constraints corresponding to the feasible solutions of the value objects. The optimal constraints provide a way for value objects to break through the original value-seeking model and realize greater value.

Conclusion 2 provides specific solutions for specific value objects to improve their current state of value and maximize value. Among the value objects that do not achieve the maximum value, a consistency comparison between the current index value and the feasible solution of the model LP can be used to derive a solution to achieve the maximum value.

Therefore, when comparing the amount of value, the specific form of the value object should first be divided into two categories: reaching the current maximum value and not reaching the current maximum value state. Then, a comparison of the amount of value is made in the category of reaching the current maximum value, and a comparison of the difference is made in the category of not reaching the current maximum value. The simplest way to make a difference comparison is to use as a criterion the quotient of the absolute value of the difference between the current value and the ideal (maximum) value divided by its ideal value; the larger the quotient, the more wasteful it is, the more costly it is to obtain the current value, and the lower the value of this type of object.

3.3. Optimization method of industry-education integration based on linear programming

Another important function of the model LP is that it simultaneously determines another mathematical model. It is conventionally called its dyadic model (denoted DLP). For the model LP, let the evaluation index involved in the model DLP be $y_1, y_2, \cdots\cdots, y_n$, where $y_j \in [0, A_j]\,(j = 1, 2, \cdots\cdots, n)$, retaining the same value of the same number as the notation in the model LP, the corresponding objective function (equivalent to the synthetic index function) can be obtained as:

$$\min D = f_1 y_1 + f_2 y_2 + \cdots\cdots + f_n y_n \tag{7}$$

The corresponding constraints are:

$$f_{i1} y_1 + f_{i2} y_2 + \cdots\cdots + f_{in} y_n = e_j (i = 1, 2, \cdots\cdots, m) \tag{8}$$

The resulting structure of the model DLP is obtained as:

$$(DLP)\begin{cases} \min D == f_1 y_1 + f_2 y_2 + \cdots\cdots + f_n y_n \\ f_{i1} y_1 + f_i y_2 + \cdots\cdots + f_{in} y_n = e_j (i = 1, 2, \cdots\cdots, m) \\ y_j \in \left[0, A_j\right]\left(j = 1, 2, \cdots\cdots, n\right) \end{cases} \tag{9}$$

Obviously, the model DLP is a linear programming model built with the number of constraints of the model LP as the number of indicators, the constraint constants as the weight constants, and the transpose matrix of the matrix formed by the constraint coefficients as the constraint coefficient matrix. Model DLP and model LP are each other's dyadic model. The dyadic model provides a new way of evaluating changes in the value of objects.

In economics, the feasible solution of model DLP has a clear economic meaning, and its optimal feasible solution is called the shadow price under the constraints of the original model LP, which indicates the economic value of an additional unit of resource. For the model LP, the shadow price reflects the increased value of the optimal value of the model LP objective function when a certain constraint constant (corresponding to the current total amount of a certain resource) is increased by one unit, provided that the constraint approach is unchanged (i.e., the matrix of constraint coefficients is unchanged) [22].

In mathematics, the range of values of variables that change but the shadow price does not change is called the shadow price domain. In the shadow price domain, the way in which the variables are constrained to each other is not changed, and the way in which the inputs of the variables corresponding to the additional shadow price return benefits is unchanged. The shadow price domain is sought using the dyadic model developed in evaluating the value of the university to perform the evaluation. The dyadic model for evaluating the ecosystem of the integration of industry and education in higher education institutions points the way to the optimization of the system.

4. Analysis of simulation cases based on linear programming models

The study uses linear planning model to evaluate the ecosystem of industry-education integration, including several steps such as establishing the range of variation of evaluation indexes, establishing the creation function, establishing the constraint function, and analyzing and discussing the solution. The following paper uses linear programming to simulate and evaluate the ecosystem of industry-teaching integration in Hunan higher vocational colleges.

4.1. Analysis of factors influencing the ecosystem of industry-teaching integration

4.1.1. Survey methodology and modeling.The target of this paper is 200 teachers and students of a higher vocational college in Hunan Province, who were surveyed with questionnaires respectively. Teachers are the main force to promote the development of the cause of industry-teaching integration, and are the direct participants and managers of the industry-teaching integration program, which is the most important participant in industry-teaching integration. Higher vocational teachers in this paper mainly refer to higher vocational teachers officially on staff, including experimenters, technicians, etc., and also include higher vocational administrators. The student group in this paper mainly refers to the full-time students in school. Students are a mirror reflecting the development of the industry-teaching integration program, and they are individuals with mobility, creativity and autonomy. By investigating them, the actual process can be better grasped from the process dimension, thus corroborating with the survey of senior teachers, and more conducive to improving the credibility and validity of the results of the survey and research.

The study selected three perspectives of resources (R), incentives (M) and management system (In) to construct a multiple linear regression model to explore the influence of resources, incentives, management system and other variables on the integration of production and education. The initial model is set as follows:

$$InS = a_1 InR + a_2 InM + a_3 InIn + u \tag{10}$$

Where S represents the dependent variable of the effectiveness of the integration of production and education, u represents the constant, and a_1, a_2, and a_3 all represent the coefficients.

4.1.2. Descriptive statistical analysis. In SPSS 25 software, the average of the questionnaire data under each dimension of production and education resources, incentive mechanism and management system was first taken for descriptive statistics. In the value labels of the questionnaire design, 1 represents "very good", 2 represents "relatively good", 3 represents "fair", 4 represents "relatively poor", and 5 represents "very poor". The main variables are described in Figure 1. According to the results, the mean values of the variables of industry-education resources, incentive mechanism and management system were 1.622, 3.066 and 3.015, respectively. It indicated that the respondents tended to think that the school's production and education resources were "relatively good", and the incentive mechanism and management system were "average".

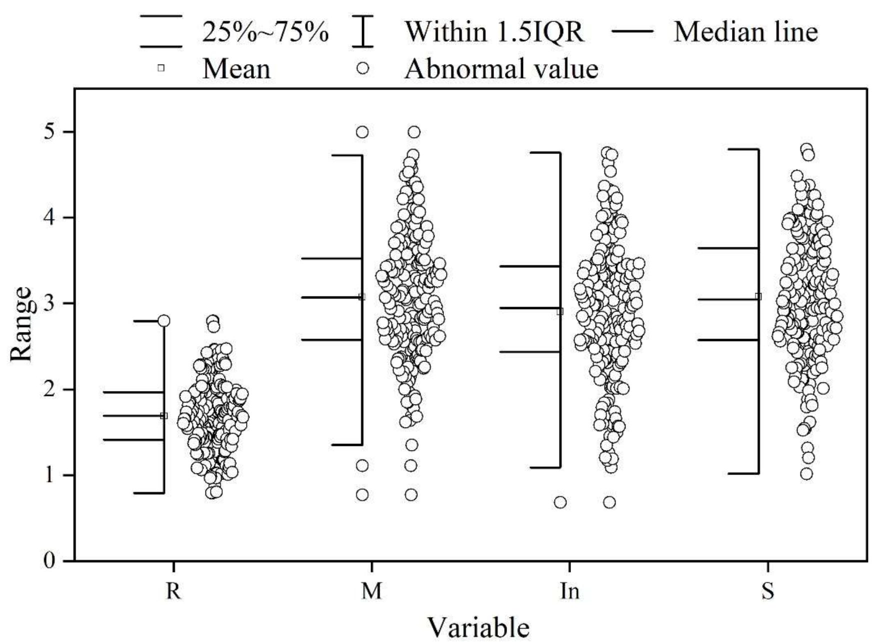

Fig. 1. Descriptive statistics of major variables

4.1.3. Correlation analysis. The correlation analysis is shown in Figure 2. According to the results of the correlation analysis, the resources of production and education, incentive mechanism and management system are positively correlated with the effectiveness of production and education integration at the level of 0.01, and the correlation is significant.

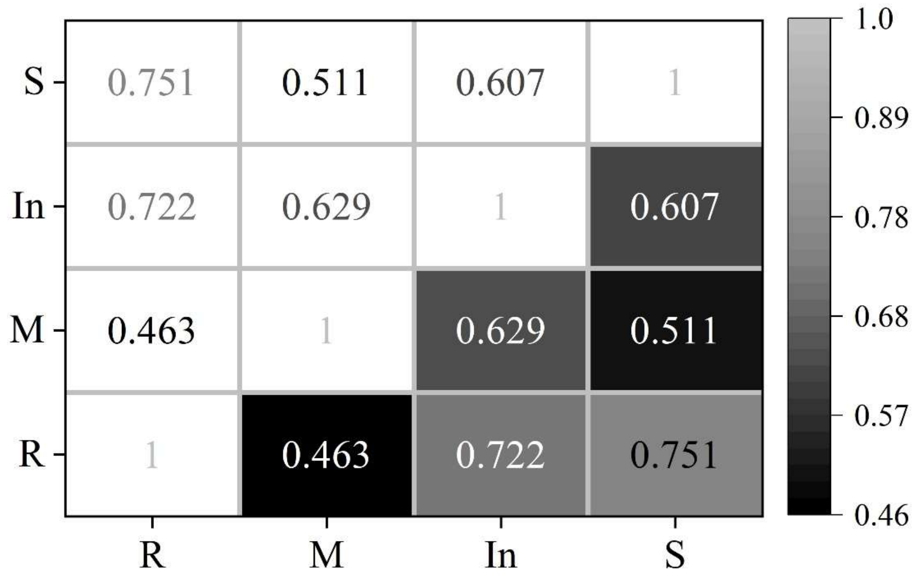

Fig. 2. The main variable correlation analysis

4.1.4. Analysis of multiple regression results. The model interpretation is shown in Table 1, with a denoting the predictor variables (industry-education resources, incentive mechanism, and management system). The adjusted R^2 is 0.428 > 0.3, indicating that the degree to which the three independent variables of production and education resources, incentives, and management system are able to explain the dependent variable (the effectiveness of integration of production and education) is 42.8%, and the model fit is 0.446, which is an acceptable level of explanation. The Durbin-Watson value is 2.066, which is between 1.5 and 2.5, indicating good independence between the respective variables.

Table 1. Model interpretation

Model	R	R^2	ΔR^2	Standard error	Texbin Watson
1	0.699a	0.428	0.446	0.705	2.066

The model coefficients are shown in Table 2, with b denoting the predictor variable. The significance 0.000b<0.05 in the regression model indicates that there is a significant effect of the independent variable on the dependent variable.

Table 2. Model coefficient

Model		Sum of squares	F	Mean square	F	Sig.
1	Regression	212.475	6	71.694	135.22	0.000b
	Residual error	136.952	255	0.533	-	-
	Total	337.809	261	-	-	-

The regression results are analyzed as shown in Table 3. The influence coefficients of production and education resources, incentive mechanism and management system are 1.769, 0.355 and 0.041 respectively.In the covariance statistics, the VIF values of production and education resources, incentive mechanism and management system are all <5, which indicates that there is no multicollinearity among the three independent variables and the statistical results are credible.

Table 3. Regression analysis

Variable	B	SE	Beta	t	P	VIF

u	-0.772	0.247	-	-3.755	0.001	-
R	1.769	0.166	0.523	9.806	0.000	3.242
M	0.355	0.132	0.177	2.771	0.005	2.564
In	0.041	0.074	0.036	0.564	0.001	2.785

Based on the above table, the regression model equation can be derived:

$$InS = -0.722 + 1.769 InR + 0.355 InM + 0.041 InIn \tag{11}$$

From the regression equation, it can be seen that the independent variables such as production and education resources, incentive mechanism and management system all have a positive correlation with the dependent variable, the effectiveness of production and education integration.

4.2. *Construction and calculation of the planning model*

The previous section analyzed the Hunan higher vocational colleges and universities to create the value of this organization with the resources of production and education, incentives and management system. This chapter uses a linear programming model to analyze whether these elements are effective in the actual value creation activities. Generally speaking, when evaluating the efficiency of the integration of industry and education, the value creation function (algorithm of synthetic indicators) and the range of the value of each indicator can be accomplished by methods such as expert establishment method and empirical determination method. While the constraints are generally ready and specific, the resources consumed by the ecosystems of industry-education integration of the three Hunan higher vocational colleges and universities selected in this paper and their resource limits are shown in Table 4. The linear planning model for maximizing the efficiency of industry-teaching integration in higher vocational colleges is constructed according to the resource consumption of industry-teaching resources (x1), incentive mechanism (x2) and management system (x3):

$$P_1 \begin{cases} \max \quad E = 62x_1 + 25x_2 + 13x_3 \\ s.t. \quad 80x_1 + 1300x_2 + 300x_3 \le 485400 \\ 16x_1 + 7x_2 \le 3000 \\ 44x_1 + 23x_2 \le 1100 \\ x_1 \ge 0, x_2 \ge 0, x_3 \ge 0 \end{cases} \tag{12}$$

Table 4. The resources and resources consumed by the integrated ecosystem

School	R	M	In	Satisfaction
x_1	80	16	44	62
x_2	1300	7	23	25
x_3	300	0	0	13
Resource limit	485400	3000	1100	-

The original linear programming model for the evaluation of industry-teaching integration in higher vocational colleges is transformed into the standard form by adding slack variables, and its initial simplex type is listed as shown in Table 5. Using the simplex method, the basic solutions $x_1 = 360$, $x_2 = 30$, $x_3 = 50$ and $E = 8715200$ are obtained after iterative solving.

Table 5. Initial simplex

-	C_j	-	62	25	13	0	0	0
C_b	x_b	-	x_1	x_2	x_3	x_4	x_5	x_6
0	x_4	485400	80	1300	300	1	0	0
0	x_5	3000	16	7	0	0	1	0

0	x_6	1100	44	23	0	0	0	1
Inspection line	$C_j - C_i a_{ij}$	0	-62	-25	-13	0	0	0

4.2.1. Analysis of evaluation results. The linear programming model reveals the specific values of each evaluation indicator when the evaluation object reaches the state of maximum value and the amount of value at that time, given the method of synthesizing indicators, the constraints between indicators and the range of variation of indicators. The organization's Soka Gakkai function remains unchanged, according to the above solution can be made in the following several cases of conclusions:

Scenario Ⅰ: under the existing resource constraints, when the Hunan higher vocational college invests 3.6 million yuan, 300,000 yuan and 500,000 yuan in the resource consumption of production and education resources, incentives and management system respectively, the output of the efficiency of production and education integration of this higher vocational college is maximum. It means that the resource structure of this Hunan higher vocational college is reasonably configured, making the best use of the resources, which is the best choice under the existing conditions, and the maximum efficiency value is 8,715,200 value units.

Scenario Ⅱ: Under the existing resource constraints, when the Hunan higher vocational college invests more than 3.6 million yuan, 300,000 yuan and 500,000 yuan in the resource consumption of production and education resources, incentive mechanism and management system in the ecosystem of industry-teaching integration, then there is a waste of resources and lethargy of personnel in the ecosystem of industry-teaching integration of that Hunan higher vocational college, and thus there is insufficient output of organizational efficiency, and the working style of the higher vocational college should be improved, and the personnel streamlined to Improve work efficiency.

Scenario III: Under the existing resource constraints, the actual input indicators are larger than the solution of linear programming, i.e., the ideal inputs, which means that the available resources of the industry-teaching integration ecosystem of this Hunan higher vocational college are insufficient, and it is necessary to increase the available resources. If under the existing resource constraints, the number of actual inputs is inconsistent with the ideal inputs, then it indicates that the role of the existing resources has not been utilized, the internal resources have not been reasonably allocated, and the input program should be re-determined.

Scenario Ⅳ: Under the existing resource constraints, the actual inputs are all less than the ideal inputs, then the Hunan higher vocational college has not fully utilized the existing resources, resulting in idle resources and indiscriminate expenses. If the resources continue to be utilized effectively, the efficiency of the work can be continuously increased.

4.2.2. Strategies for optimizing the ecosystem of industry-education integration. Optimize platform construction and provide whole-chain innovation services. Higher vocational colleges and universities dock with industries, collaborate with enterprises, gather scientific research institutes, innovation platforms, scientific and technological achievements transformation platforms, etc., to build an integrated intelligent platform with multiple synergies for the in-depth fusion of industry and education, focusing on the basic positioning of talent training and social services, key technology research and development of small and medium-sized enterprises, transformation of intellectual property rights, incubation of scientific and technological achievements, and training services for talents. It focuses on key technology research and development of small and medium-sized enterprises, intellectual property transformation, incubation of scientific and technological achievements, talent training services, etc., forming an “industry-teaching-science-creation-transfer-use” whole-chain university-enterprise cooperation and innovation system, and a synergistic development system that matches the supply and demand of talent cultivation, and promoting the innovation and solidification of the mechanism of integration of industry and education.

Optimize the cooperation and docking to solve the problems of industry-education integration. First, optimize the mixed faculty team. Taking team building as an entry point, we have established a “dual-teacher, dual-capability” teacher team consisting of engineers from enterprises and teachers from professional groups, and established a teacher team and guarantee system of full-time and part-time mutual employment and mixing of teachers from schools and enterprises. Secondly, do product technology development. Dig deeper into the demand of schools and enterprises, produce results in technical cooperation, and cultivate talents in integration and collaboration.

Broaden the path of educating people to serve the high-quality development of society. First, value-added diversified social training. Formulate a social training service system, optimize the training function of the platform, develop training resources on the platform in combination with specialization and multiple synergies, and carry out social training to serve economic development. Second, cultivate high-quality skilled personnel. Strengthen the synergistic interaction of multiple educators, facilitate the implementation of the “1+X” certificate system, improve the quality of talent cultivation in vocational colleges and universities, and promote the connotative development of vocational education. Third, promote student employment and entrepreneurship. Relying on the platform, we strive to build an ecosystem of enterprises in the middle and lower reaches of the industrial chain that serves the head enterprises, provide in-depth guidance on employment services, and realize the enhancement of the quality of students' employment and entrepreneurship.

5. Conclusion

The study constructed an ecosystem for the integration of industry and education in Hunan higher vocational colleges under the strategy of revitalizing the country through science and education, and evaluated and optimized the system using a linear programming model. According to the multiple regression model $InS = -0.722 + 1.769InR + 0.355InM + 0.041InIn$, it is determined that the resources, incentive mechanism and management system are the main factors affecting the efficiency of industry-teaching integration. The linear planning model for maximizing the efficiency of industry-teaching integration in higher vocational colleges and universities is constructed using the three factors as follows: $P_1\begin{cases} \max & E = 62x_1 + 25x_2 + 13x_3 \\ s.t. & 80x_1 + 1300x_2 + 300x_3 \le 485400 \\ & 16x_1 + 7x_2 \le 3000 \\ & 44x_1 + 23x_2 \le 1100 \\ & x_1 \ge 0, x_2 \ge 0, x_3 \ge 0 \end{cases}$. According to the model, it is calculated that the efficiency of industry-teaching integration is maximized when the resource consumption of industry-teaching resources, incentives and management system is 3.6 million yuan, 0.3 million yuan and 0.5 million yuan, respectively. According to the resource consumption of industry-education integration, specific optimization strategies for building a new ecology of industry-education integration are proposed from three aspects: platform construction, cooperation docking and parenting path.

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