

Study on Multi-Agent School Running in Higher Vocational Colleges from the Perspective of Resource Optimization Allocation*

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Abstract—Under the model of taking the government as the main body and the vocational college as the main body, China's vocational education has made great progress. But from the perspective of resource allocation, the single input mechanism relying on the government has restricted the development speed and quality of vocational education. The use efficiency of educational resources is not at its best. Under this circumstance, multi-agent school running becomes a feasible way to achieve Pareto Optimality in vocational education. On the basis of theoretical analysis, this paper summarizes five typical multi-agent school running models, and proposes some optimization strategies to further explore the multi-agent school running.

Keywords—multiple agent; school running patterns; higher vocational colleges; resource optimization allocation

I. INTRODUCTION

With the advancement of the socialist market economic system reform, "Decision on the Reform of the Education System" issued in 1985 and "Outline of China's Education Reform and Development" issued in 1993, indicates that China's education reform has officially entered a new stage with the focus on the reform of the education system and the establishment of an education system that is compatible with the socialist market economic system. The reform of the education system involves all aspects of education. The most important of these is the reform of the school-running system and the management system. The reform of the school-running system originates from the reform of educational system and the reform of economic system. With the successful operation of the market economy, the economic situation is getting better, the people's living standards are constantly improving, the people's cultural level is further developed, and the public's educational needs are also increasing year by year. In this case, the operation of

nationalized school-running system only relying on government investment appears to be "willing but unable", and the limitation of national economic power has become the bottleneck restricting the development of education in China. At this time, scholars have begun to call for the transformation of "big education supported by poor countries" to "big education supported by all social subjects". The importance of school-running system reform gradually became prominent. It has become the call of the times to mobilize all sectors of society to participate in school-running, and to change the nationalized school-running into multi-agent school running system [1]. After more than 20 years of reform practice, China's school-running system reform has made remarkable progress. Whether in the field of general education or vocational education, the situation in which public education dominates the world has been broken, and the situation of multi-agent education has taken initial shape. In this process, many regions and colleges have the courage to try, explore and innovate. In a certain flexible space, combining with the existing resource, institutional, and policy conditions, they innovate the vocational education running mode suitable for local economic and social development, and achieved a lot of remarkable results [2]. Therefore, based on the perspective of resource optimization allocation, this paper proposes to use multi-subjects as a solution to solve the shortcomings of the traditional school-running model in higher vocational colleges, and summarizes five typical models of multi-subject education. Finally, the optimization strategies of multi-agents school running are further explored from three aspects: concept recognition and development characteristics positioning, financial aid management system, property rights and qualitative classification management.

II. THE DISADVANTAGES OF THE TRADITIONAL SCHOOL RUNNING MODEL

Taking government as the main investment body and vocational colleges as the main training body has always

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been the mainstream development model of vocational education in China. Under this model, China's vocational education has made considerable progress. However, from the perspective of resource allocation and utilization efficiency, this model has the following obvious drawbacks.

First of all, the single input mechanism relying on the government restricts the development speed and quality of vocational education. Regardless of the government's talent service supply capacity and the limitation of resource endowment on government supply capacity, the traditional model assumes an ideal premise. However, the fact is that the vast central and western regions are backward in economic development level, lack of financial resources and the pre-determined resource endowment conditions are not available. Under the condition of limited resource endowment, the government has to decide the priority of public service supply according to urgency and difficulty [3]. The investment in vocational education talents is huge and the rewards are long-term and unpredictable, which may lead vocational education to the embarrassing situation of school resources shortage.

Secondly, the phenomenon of low-level redundant allocation of resources in the vocational education system is serious. Since the launch of the "National Model Higher Vocational College Construction Plan" in 2006, China has formed 100 national demonstration higher vocational colleges and 100 backbone higher vocational colleges. In terms of effect, the quality of talent training in various demonstration and backbone higher vocational colleges has been significantly improved and played a certain role of demonstration and guidance [4]. However, due to the unclear orientation and development direction of various regions and schools, the rush to hot majors, repeated construction of hardware and software resources, the promotion role of higher vocational education as a whole is very limited and unable to meet the diversified needs of talent training in today's society.

Finally, vocational education resources are mainly limited to the operation within the system, the exchange and utilization of external resources is far from sufficient, and the efficiency of resource use is not at its best. Controlled by the administrative authority of the early "big government, small market", China's vocational education resource allocation is like a pool of stagnant water in a closed pond, which is isolated from the rapidly changing society, market and industry. It is limited to the internal vocational education system and fails to exchange and share resources with external subjects.

III. THE INNOVATION PATH OF RUNNING SCHOOL — MULTI-AGENT EDUCATION

The innovation of vocational education system is essentially a problem of social resource allocation, that is, the reasonable and effective distribution of limited resources among different demands, including the distribution of total social resources to education and the distribution of total educational resources among various types of education [5]. In order to improve the efficiency of vocational education,

alleviate the contradiction between the shortage of educational resources and demand for educational resources, realizing the optimal allocation of vocational education resources becomes the key to solve this problem. The generalized resource optimization configuration refers to the resources allocation through the automatic adjustment of the market mechanism according to the general rule of equality, competition, legality and openness in the market economy, not by the subjective will of the human being. That is, by carrying out free competition and free choice of "rational economic man", the market automatically adjusts the distribution resources between supply and demand by the law of value, and eliminates the fittest with the "invisible hand", thus automatically realizing the optimal allocation of resources of the whole society [6]. From the perspective of social system, the resource allocation of the current vocational education development model does not reach the Pareto Optimality, and there is room for further improvement. The reform of the vocational education system is actually a process of re-allocating resources within and outside the vocational education system. Multi-agent education is a desirable path to achieve Pareto Optimality in vocational education.

Therefore, in the development of vocational education, we should also follow the law of resource allocation, actively encourage multi-subjects to participate in running schools, and pay attention to prevent problems that may occur under the participation of multiple stakeholders. First, the optimal allocation of resources should be explored from different levels. The resource allocation model within the vocational education system, between vocational education and industry, and for the coordinated development of vocational education and socioeconomic system should all be considered. Secondly, the role of the market mechanism should be given full play. Market mechanism is an indispensable subject for the innovation of school-running mode in vocational education. Giving full play to the role of the market mechanism can benefit all participants and build a multi-win pattern. Finally, government departments should play an important role in promoting the integration of vocational education resources. Whether it is resource integration within the vocational education system, resource integration between vocational education and industry, or resource integration from the perspective of the entire economic system, the success of each type of development model should not rely solely on a single subject, but multiple main body participation will inevitably produce conflict of interest. Therefore, their cooperation must rely on external coordination, government departments become an indispensable important force.

IV. ANALYSIS OF THE THEORY OF MULTI-AGENT EDUCATION

A. Stakeholders of Multi-agent Running in Higher Vocational Colleges

As one of the trends of educational system reform, "multi-agent school running" has frequently appeared in public view since the reform of the education system was put

into practice in the 1990s. Although there is a unanimous call from the academic and political circles that the school-running agent should be diversified in the reform of school-running system, there are different opinions on how to define this subject. Some scholars believe that the school-running subject is the school "sponsor". For example, Ma Shuping, dean of the Beijing Academy of Education, pointed out that "the mobilization of social forces to run schools should adhere to the path of multi-form education. Under the premise of standardizing operations, clarifying the main body of the school (sponsor), clarifying the attributes of assets and the source of funds for running schools, we should actively explore various forms of practice such as private, private office assistance, public assistance, state-owned private work, and Sino-foreign cooperative education to cumulative experience" [7]. There also scholars interpret the school-running subject as the specific running scholar of colleges and universities, that is, the President. "The essence of the school-running system is who runs the school. There are two concepts to be distinguished: one is that whoever invests is the host of the school; another concept is that whoever owns the right to run the school is the owner of the school...We support the latter concept, which is to separate the investor from the right to run a school. Instead of the investor, the right to run a school should be taken as the main basis to decide who the school-running subject is." [8] Others believe that the main body of running a school is the

university itself. For example, Professor Deng Xiaochun of Liaoning education research institute proposed that "after the macro-system reform of higher education, the initiative of running schools has expanded from only one department in charge of central higher education in the past to all aspects including provincial governments and school-running bodies. This has laid a good foundation for further managing higher education and truly realizing the system and mechanism of macro-control and micro-liberalization [9]".

The differences focus of the above three interpretation lies in the different understanding of "running school", either as "creating a school" or as "managing a school". To open a school, not only need fixed assets such as infrastructure and teaching equipment, but also staffs employment like teachers and administrators. All of these require a lot of money, so investors are undoubtedly an important subject of running a school. However, the main subject cannot be confined to investors. In some cases, other organizations or individuals, although not funded, may have invested in software facilities or intangible assets such as social prestige, advanced textbooks, and management models in the process of school running. Therefore, as an important way of the connotative development of vocational colleges, the essence of multi-agent education subjects includes two dimensions: diversification of investment subjects and diversification of management subjects.

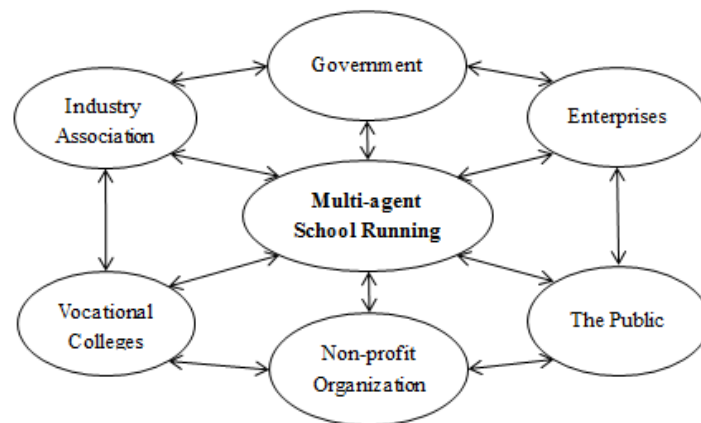


Fig. 1. Multi-dimensional relationship network of stakeholders in Multi-agent running of vocational education.

If we can jump out of the thinker circle of the organizer or the manager, we may be able to explore the "subject" of the multi-agents of vocational education from the perspective of stakeholders. As a generalized corporate governance theory, stakeholder theory is a theoretical claim put forward by Joseph Stieglitz (1999), which is widely applied in the study of enterprise performance evaluation and management [10]. As enterprises, schools are also a typical stakeholder organization, and even have a much larger interest network than the average company. So stakeholder theory is equally applicable in schools. As shown in "Fig. 1", from the perspective of stakeholder network, multi-subject school-running of vocational education requires the construction of a partnership-based and diversified school-running model with the participation of stakeholders such as government departments, industry associations, enterprises, vocational

colleges, non-profit organizations and the public. Its ultimate goal is to establish a governance mechanism that is not controlled but autonomous and cooperative, not centralized but decentralized, not governed by the government but cooperated with stakeholders, not pursuing consistency but diversification, and conforms to the common interests of the society.

B. Aggregate-elements of Multi-agent Running in Higher Vocational Colleges

Multi-agent education can be seen as a process in which the above stakeholders cooperate to build a vocational education system. As a subsystem of the social system, vocational education presents different forms in different historical stages based on different aggregation elements or

linkages. The composition of the social system mainly includes the following aspects: the collection of relevant actors, the interrelationship of actors, social activities and processes, and the consequences and effects, shaping and reshaping actors, cultural structures, endogenous constraints of social institutions and structuring process [11]. The actor-system-dynamics Theory holds that the social system can be divided into three levels, the first level points to the actor, that is, the role and status of the actor; the second level is the scene and process of social action and interaction; the third level refers to endogenous constraints, including material factors, institutional factors and cultural factors. Taking the actor-system-dynamics Theory as the analysis framework and analyzing from the dynamic perspective, it can be seen that the vocational education system is a group or organization formed by the organic combination of vocational education actors (public, non-profit organizations, government, industrial enterprises, etc.) through cooperation based on a certain consensus. It exists as a form or entity, and is not only a community of interests, but also an ethical community.

"Aggregate elements" is an abstract expression of the relationship between professional education actors. The nature of aggregate elements can determine and reflect the nature of the community. The Apprenticeship in the Agricultural Society is mainly based on the connection of natural factors such as blood and geography. In essence, the relationship between teachers and apprentices is an extension of the blood community. "Teachers and apprentices are like father and son." It belongs to the category of "ethical" vocational education system. After entering the Industrial Society, along with the organization of the society, the school has become the main form of vocational education at this stage. Industry has become the center of society, and the vocational education of the school form is on the edge of industry and become a tool of industrialization. Vocational education is a "for him" or "instrumental" vocational education system here.

In modern industrial society, factors such as globalization, technological innovation and modernity make social relations more complicated. The competition for talents makes the subjectivity of vocational education more prominent. The structure of the past industry-centered and vocational education-edged has obviously not adapted to the needs of social development. The establishment of cooperative interaction between industry (enterprise), vocational colleges and government has become a trend of development. Based on school capital, school venues, technical standards, curriculum plans, research platform, social service function and other resources, the actors mainly strengthen the relationship according to the contract. The vocational education system centering on the cooperation between schools and industries (enterprises) and the cooperation between governments has become the main paradigm of the development of vocational education in this era. At the micro level, the current aggregation elements of multi-subject school running mainly include school capital (capital), school site (environment) and other hard school infrastructure resources; standards, technology, programs,

courses, teachers and other soft resources for talent training; research and development, social services, practical training and other Shared platform resources.

C. Targets of Multi-agent Running in Higher Vocational Colleges

In the vocational education, the government is not only the manager of the entire vocational education, but also the organizer of some universities [12]. As a manager, the government's focus is on how to make the "cake" of the public interest bigger, so that individuals and country can benefit more from it. For example, vocational education benefits more people, and the beneficiaries becomes broader, frequency of benefiting citizens' production and life gets higher, which makes the connection between higher education and personal life quality, national strength and human well-being closer. As a university organizer, the government aims to distribute the existing welfare or public interest "cake" of vocational education fairly to the citizens, so that every citizen can equally enjoy the social public welfare. In the process of improving the service ability of the government, the public trust and influence of the government are enhanced.

At the level of vocational colleges, the idea of multi-subjects is based on many considerations. The first is financing. The lack of funds for running schools is the biggest problem facing vocational education in China. Advocating multi-subject education and encouraging each subject to invest in education will help reduce the financial pressure of vocational colleges. The second is to optimize the allocation of educational and teaching resources, break through the limitation of narrow schools to run education independently, change the isolated and closed development mode of vocational colleges, explore and grasp various factors conducive to the development of vocational education, and fully mobilize, integrate and utilize various educational resources and social resources. We should make full use of government, industry, enterprises and other social resources, establish and improve the school-running mechanism of government-led, industry-guided, and enterprise-participated, and introduce advanced technology, management, experience and models. The third is to create the government-enterprise-industry-school cooperative school-running model, constantly improve the construction of modern vocational education system, and strive to realize the new development of vocational education school-running model.

Enterprises and other market players participate in running vocational education mostly to "seek private benefits by volunteering". Whether it is for the consideration of exporting products, services, management and channel construction, or for the motivation of introducing temporary labor force, potential excellent employees and potential customers, it is always inseparable from its profit. Of course, although education is a public welfare undertaking and not for profit, as an industry, it can indeed make profits if it is operated properly. In other words, the public welfare and profitability of education are not two sides of the same coin. Acknowledging that education is profitable does not change

the fundamental nature of education. To encourage enterprises and other market entities to participate in vocational education and allow them to get a certain return from the market is not only conducive to the prosperity of vocational education, but also conducive to balancing the relationship between educational fairness and educational efficiency.

V. MODELS OF MULTI-AGENT RUNNING IN HIGHER VOCATIONAL COLLEGES

According to the status and role of different interest subjects in running a school, from the perspective of theoretical logic deduction and practical experience observation, vocational education has the following five typical types of multi-subject running.

A. *Government Driven Model*

In this model, the government is in the leading position. The government funded the construction of vocational colleges and acted as administrators with complete control over the operation and development of the schools. Under this traditional mode, the vocational education system is subordinate to the government system, and the space for independent management and innovation integration is extremely limited. The administrative system determines the characteristics of institutionalized management and compulsory planning of vocational colleges. The government has considerable power and ability to allocate resources. It regulates and controls the connotation, principle, mode and scope of running a vocational college, and transmits a specific vocational education idea and behavior to the society through a vertical system management, and enforces the implementation. This model is mandatory, planned and effective. It is often seen in the early stage of the development of vocational education.

B. *Market Driven Model*

In this mode of running a school, market entities such as enterprises, industries, and for-profit educational institutions play a major role. To a certain extent, vocational education is regarded as an industry, which believes in "market omnipotence" and "efficiency model", emphasizes the allocation of resources by market competition, and competes for students, teachers, and public and private sources of funds in a broad market. The existence of the education market and its hidden profits attract more and more private organizations to enter the field of higher education. They provide education services to meet the needs of society, and realize the transformation of education costs and benefits through the market. Under this mode, the free market provides innovative supply for vocational education in the social system, so as to stimulate and create the consciousness and mechanism of self-development optimization of vocational education. Of course, this mode must be based on the perfect market mechanism.

C. *Industry Driven Model*

In this mode of education, industry or industry associations will take advantage of their information integration, grasp the trend of industrial development and the demand trend of post groups, dynamically adjust the school policy and talent output level and structure, mobilize the enthusiasm of industry groups to participate in vocational education, and make full use of the industry's capital, equipment, technology, internship, manpower, corporate culture and other resources, to achieve a close combination of theoretical teaching and production practice, on-campus training and on-site practice, c teaching and research and technology development in higher vocational education, and cultivate the higher vocational talents that the society really needs. Industry or industry associations are an important part of vocational education, and have unique and significant advantages in in running vocational education and training applied high skilled personnel.

D. *Non-profit Organization Driven Model*

In this model, vocational education is funded by non-governmental forces, and non-profit organizations play a leading role in it, with the mission of developing education and serving the society instead of making profits. It has the characteristics of public welfare, service, civil, non-profit and voluntary, etc. The accumulation and surplus of running a school are all used for the development of the school with the ultimate purpose of cultivating talents. Public welfare is the core value pursuit and fundamental characteristic of China's non-profit organizations in running schools. Schools run by non-profit organizations need to be registered in relevant departments according to regulations and laws. They belong to the third department, perform the functions of public organizations of the government, and provide vocational education, which is a quasi-public product. They play an important and positive role in the development and progress of the whole society.

E. *Cooperation Driven Model*

In this model, government departments, education departments and market departments corresponding to government, school, bank and enterprise not only interact with each other, but also overlap the functions of the four parties in running a school, giving birth to four mixed living organizations. They have taken on new functions in addition to their traditional ones. Among them, the government is in the overall position. Through the construction of education policies and systems, the government improves the public service environment to support vocational education. Through the concept of coordination and autonomy, this model focuses on the discussion of how vocational education forms a relationship of mutual influence and promotion of four forces around the theme of resource production and transformation with the help of the link of market demand. It is the evolution of the school-running mode of vocational education, and the interaction of government, school, administration and enterprise produces a new overlapping social state, so as to stimulate the creativity and innovative vitality of vocational education.

VI. CONCLUSION

Rising only 20 years, multi-subject education of vocational education is a new thing in our country. The period of its rise is only 20 years. There are many problems in its development, such as school orientation and development characteristics, public welfare and profit-making contradictions, property rights orientation and financial support, etc. Although we can't find a solution once and for all, the problems and contradictions in multi-subject education can be gradually resolved through sober understanding, rational analysis and scientific design. In this process, the most important thing is to grasp such a principle: as long as it is beneficial to developing education, optimizing education resources configuration, meeting people's growing education needs, improving national quality and promoting social progress, any solution should be bold to try to apply.

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