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Intelligent Manufacturing Major Construction Based on the Integration of Production and Education

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Abstract. Intelligent manufacturing is an integrated concept that covers multiple disciplines, including automation, information technology, mechanical engineering, artificial intelligence, etc. This interdisciplinary nature means that colleges and universities need to promote cooperation between different disciplines. Interdisciplinary professional teaching has high requirements for institution and teachers, while enterprises are users of intelligent manufacturing, and their production lines naturally have interdisciplinary characteristics. There is a huge demand for engineers in intelligent manufacturing. It is very meaningful to build a teaching system for intelligent manufacturing major through cooperation between education and production. However, there are many shortcomings in the current production-education integration. Therefore, education institutions need to innovate training models to improve students' practical ability and innovation spirit, while the government should strengthen supporting policies to enhance the enthusiasm of both education and production.

Keywords. Intelligent manufacturing; Major Construction; Integration of Production and Education

1. Introduction

Intelligent manufacturing is a new manufacturing model that integrates information technology, Internet of Things, big data, artificial intelligence, and other technologies. It achieves automated, digitalized and intelligent production through highly integrated production processes, equipment and systems, greatly improving production efficiency and flexibility. The goal of intelligent manufacturing is to build an adaptive and self-learning production system to adapt to constantly changing market demands while improving production efficiency and product quality [1-4].

Intelligent manufacturing is a global trend, and governments around the world are actively promoting the development of intelligent manufacturing. The German government has invested a lot of funds and resources to support the development of relevant enterprises and research institutions [5]. The U.S. government has proposed the "Advanced Manufacturing" plan, which aims to revitalize the U.S. manufacturing industry through technological innovation and digital transformation. The plan includes policies and measures to strengthen research and development and talent cultivation, promote digital transformation, encourage innovation and entrepreneurship, etc [6]. The

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Chinese government has proposed the "Made in China 2025" plan, which aims to promote the transformation and upgrading of the manufacturing industry through digitalization, intelligence, and green technology. The plan includes policies and measures to strengthen technological innovation, build intelligent manufacturing demonstration bases, and promote the application of intelligent manufacturing[7]. The future of intelligent manufacturing requires a large number of professional talents, and the demand for and cultivation of talents also pose new challenges.

At present, the talent cultivation system in the field of intelligent manufacturing has the following deficiencies [8-10]:

One, curriculum offering is not comprehensive enough: Intelligent manufacturing is a cross-disciplinary field that requires knowledge in mechanical engineering, information technology, automation, and other aspects. However, many universities currently have deficiencies in the course offerings related to intelligent manufacturing majors, lacking systematization and comprehensiveness, making it difficult to cultivate compound talents that meet the needs of enterprises.

Two, practical teaching is insufficient: The technology in the intelligent manufacturing field is updated rapidly, and practical teaching is an important part of talent cultivation. However, many universities currently have insufficient practical teaching conditions and insufficient cooperation with enterprises, which makes it difficult for students to gain practical experience and innovation experience, making it difficult to adapt to enterprise needs.

Three, lack of comprehensive talent cultivation: Intelligent manufacturing requires compound talents with multidisciplinary knowledge. However, many universities currently lack comprehensiveness in talent cultivation in the field of intelligent manufacturing, making it difficult for students to integrate multiple disciplines of knowledge together, limiting their development potential.

In view of the deficiencies in the above talent cultivation, it is necessary to adopt the cooperation between schools and enterprises to build a professional practical teaching system that can manufacture. Through cooperation between schools and enterprises, they can jointly develop talent training programs, carry out practical teaching, and share resources to improve the pertinence and practicality of talent training. At the same time, school-enterprise cooperation can also promote technological innovation and product upgrading of enterprises, and enhance their competitiveness and development potential.

2. Current Situation of Enterprise Intelligent Manufacturing and Talent Demand

In the current era of Industry 4.0, intelligent manufacturing has become the mainstream trend of manufacturing development. Intelligent manufacturing refers to the continuous integration of advanced technologies such as information technology, the Internet of Things, big data, and artificial intelligence, and the transformation of traditional manufacturing processes into a new digital, automated, and intelligent manufacturing model shown in Figure 1. The emergence of this model has greatly improved the efficiency and quality of manufacturing, while also posed new challenges and demanded for talent cultivation in universities [11-15].

Highly Information-based: Enterprise intelligent manufacturing systems center on information technology [16,17], utilizing digital technology and big data analysis to collect [18-20], transmit, process, and store various information in the production process for full information management.

Automation and Intelligence: With advanced robotics technology, automation equipment, and artificial intelligence, enterprise intelligent manufacturing systems can achieve automated and intelligent production, significantly improving production efficiency and reducing labor costs.

2.1. Characteristics of Enterprise Intelligent Manufacturing System

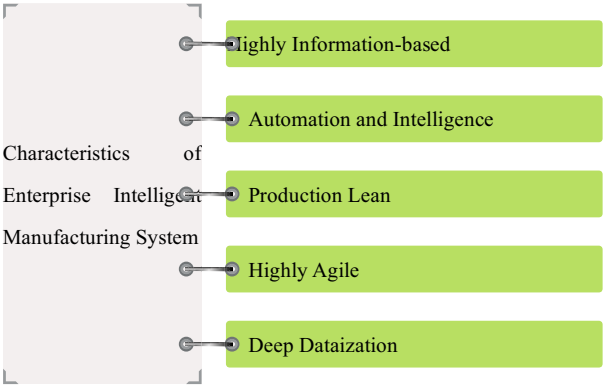

Figure 1. Characteristics of Enterprise Intelligent Manufacturing System

Production Lean: Through digital simulation technology, enterprise intelligent manufacturing systems can predict and address potential issues before production, optimize production processes, and reduce waste to achieve lean production.

Highly Agile: Enterprise intelligent manufacturing systems can quickly adjust production mode according to market demand to meet personalized customized needs and enhance enterprise market response capabilities.

Deep Dataization: Through technologies such as the Internet of Things and sensors, enterprise intelligent manufacturing systems can achieve data interaction between devices and data collection during the production process, providing more reliable data support for enterprise decision-making.

In summary, high information, automation and intelligence, lean manufacturing, high agility, and deep digitization have close logical relationships in intelligent production lines. Only by fully understanding and mastering these aspects can we better apply and develop intelligent production line technology to achieve high-efficiency and high-quality production.

2.2. Cooperation Demand of Enterprise Intelligent Manufacturing System for Universities

The construction and operation of enterprise intelligent manufacturing systems require a large number of talent support. Intelligent manufacturing involves multiple disciplines, such as mechanical engineering, information technology, automation, and other fields, so enterprises need interdisciplinary talents that have a grasp of multiple professional knowledge and skills, as well as innovative thinking and problem-solving capabilities. However, the current talent cultivation mode in universities often focuses too much on the imparting of knowledge in a single discipline, lacks the cultivation of cross-disciplinary comprehensive qualities, and is difficult to meet the talent needs of enterprise intelligent manufacturing systems.

The construction and operation of enterprise intelligent manufacturing systems require universities to provide strong technical support. The development and operation of intelligent manufacturing systems involve the use of various advanced technologies, such as big data analysis, artificial intelligence, the Internet of Things, and other fields. These technologies have been deeply studied and developed in universities, and many teachers and students also possess corresponding technical abilities. However, transforming technology into actual productivity requires close cooperation between universities and enterprises. Therefore, universities and enterprises need to strengthen technical communication and cooperation, transform the advanced technology of universities into enterprise productivity, and promote the further development of intelligent manufacturing systems.

The construction and operation of enterprise intelligent manufacturing systems require universities to provide rich teaching resources. The development and operation of intelligent manufacturing systems require a large number of human, material, and financial resources. As an important talent cultivation institution, universities possess rich teaching resources and facilities that can provide powerful support for the construction and operation of enterprise intelligent manufacturing systems. At the same time, universities can also transform enterprise resources into teaching resources through cooperation with enterprises to improve teaching quality and levels

3. Principles for the Construction of Intelligent Manufacturing Professional Courses Based on School-enterprise Cooperation

The construction of the intelligent manufacturing system curriculum is to cultivate professional talents with intelligent manufacturing technology, improve the technological level and market competitiveness of enterprises, and promote the sustainable development of the national economy. The construction of the intelligent manufacturing major curriculum system based on school-enterprise cooperation should follow the following principles:

Principles	**Enterprise demand-oriented**
	Cross-disciplinary integration
	Emphasis on practical teaching
	International perspective
	Student-centered
	Innovation spirit and innovation ability
	Professional ethics and social responsibility consciousness

Figure 2. Principles for the construction of intelligent manufacturing

3.1. Enterprise Demand-oriented

Intelligent manufacturing is a rapidly developing and constantly innovating field, and the demand for talents in enterprises is also constantly changing. Therefore, the intelligent manufacturing professional curriculum system based on school-enterprise cooperation should be enterprise demand-oriented, deeply understand the requirements for talents' knowledge, skills, and qualities of enterprises, and adjust course offerings and teaching content in a timely manner according to changes in demand. Through cooperation with enterprises, universities can more accurately grasp the direction and goal of talent cultivation, and improve the pertinence and practicality of talent cultivation.

3.2. Cross-disciplinary Integration

Intelligent manufacturing involves multiple disciplines such as mechanical engineering, information technology, automation, and other fields. Therefore, the intelligent manufacturing professional curriculum system based on school-enterprise cooperation should focus on cross-disciplinary integration. Through the intersection and fusion of multiple disciplines, students can grasp more comprehensive knowledge and skills, cultivate their comprehensive quality and innovation ability. In terms of course settings, the restriction of traditional single discipline can be broken to strengthen the connection and linkage between different disciplines, and encourage students to conduct interdisciplinary studies and research.

3.3. Emphasis on Practical Teaching

Intelligent manufacturing is a highly technical and practical field. Therefore, the intelligent manufacturing professional curriculum system based on school-enterprise cooperation should focus on practical teaching. Through cooperation with enterprises, universities can introduce advanced production equipment and teaching resources to build a practical teaching base, providing students with real production environments and opportunities for operation. At the same time, universities can also jointly develop practical teaching courses and textbooks with enterprises to make practical teaching closer to the actual needs of enterprises.

3.4. International Perspective

Intelligent manufacturing is a global field, so the intelligent manufacturing professional curriculum system based on school-enterprise cooperation should have an international perspective. Universities should actively introduce advanced intelligent manufacturing technologies and teaching concepts from foreign countries, carry out cooperative exchanges with internationally renowned enterprises and universities, and expand students' international vision and competitiveness. At the same time, universities should also pay attention to cultivating students' cross-cultural communication and cooperation abilities to provide more opportunities for their future development on the international stage.

3.5. Student-centered

The construction of the intelligent manufacturing professional curriculum system based on school-enterprise cooperation should be student-centered, paying attention to students' individual differences and ability training. In course settings and teaching processes, students' interests, learning characteristics, and career planning should be fully considered to enable students to choose and customize their own learning paths and develop their specialties and potential. At the same time, universities should also pay attention to cultivating students' autonomous learning and lifelong learning habits to lay a foundation for their future sustainable development.

3.6. Innovation Spirit and Innovation ability

Intelligent manufacturing is constantly developing and changing, requiring practitioners to possess innovative spirit and innovation ability. Therefore, the intelligent manufacturing professional curriculum system based on school-enterprise cooperation should pay attention to cultivating students' innovative spirit and innovation ability. In teaching processes, students should be encouraged to identify problems, propose problems, solve problems, cultivate their critical thinking ability and innovative thinking ability. At the same time, universities should also cooperate with enterprises to carry out scientific research projects and innovative practices to provide students with platforms and opportunities for innovative practice, cultivating their innovative abilities and innovative consciousness.

3.7. Professional Ethics and Social Responsibility Consciousness

As future professionals in the field of intelligent manufacturing, practitioners in this field should possess noble professional ethics and social responsibility consciousness. Therefore, the intelligent manufacturing professional curriculum system based on school-enterprise cooperation should pay attention to cultivating students' professional ethics and social responsibility consciousness. In teaching processes, attention should be paid to cultivating students' professional ethics such as honesty, dedication, responsibility awareness, and strengthening cooperation with enterprises to enable students to deeply understand corporate social responsibility and industry norms, cultivating their sense of social responsibility and industry norms awareness.

The relationship of the contents (Figure 2) as following: The internal logical relationship among these principles is interrelated and mutually reinforcing. The demand-oriented approach is the foundation. Only by understanding the actual needs of enterprises can we cultivate talents that meet their needs. Interdisciplinary integration is the means, and only by realizing the cross-integration of multiple disciplines can we cultivate compound talents. Emphasis on practical teaching is the core, and only by focusing on practical teaching can we cultivate students' practical and innovative abilities. The perspective of internationalization is to expand, and only with an international vision can we cultivate talents with international competitiveness. Student-centeredness is fundamental, and only by paying attention to students' individual needs can we cultivate talents with individual characteristics. Innovative spirit and ability are the driving force, and only by focusing on cultivating students' innovative spirit and ability can we cultivate talents with innovative consciousness and ability. Professional ethics and social responsibility awareness are guarantees. Only by focusing on cultivating students' professional ethics and social responsibility awareness can we cultivate talents with noble morality and social responsibility.

4. Exploration of the Model of Cooperation Between Production and Education

There is a huge space for both schools and enterprises to cooperate in intelligent manufacturing. Here are some possible cooperation models (Fig 3) discussing:

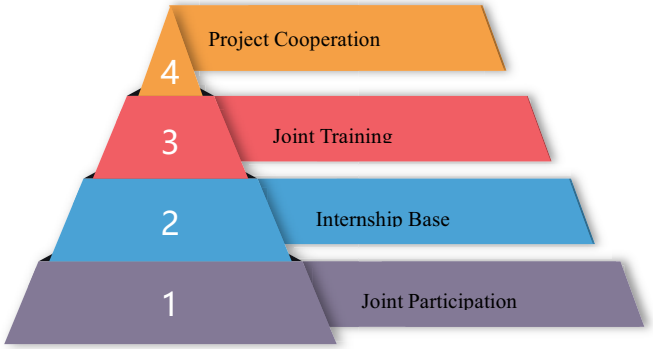

Figure 3. Exploration models

Joint Participation Model: Colleges and enterprises can jointly develop practical teaching plans, including cooperation in practical teaching content, teaching methods, practical teaching time, etc. Through the joint participation of colleges and enterprises in the development of practical teaching plans, practical teaching can be more in line with the actual needs of enterprises and closer to the development trends of the industry. At the same time, enterprises can integrate their accumulated experience and knowledge in production practices into practical teaching, making practical teaching content richer and more useful. Colleges and related enterprises establish cooperative relationships to jointly develop practical teaching plans and carry out practical teaching activities together. Colleges and enterprises can jointly carry out practical teaching activities, including experiments, internships, course design, graduation design, etc. Through the joint participation of colleges and enterprises in the development of practical teaching activities, students can have a deeper understanding of the production practices of enterprises and the application of technology, enhancing students' practical abilities and innovative spirit. At the same time, enterprises can provide internship opportunities and on-site practical experience for students, providing more opportunities and platforms for their future career development. Under this model, colleges and enterprises can jointly invest resources, share risks, and cultivate talents.

Internship Base Model: Colleges cooperate with enterprises to use the enterprise as an internship base, providing students with internship opportunities and on-site practical experience. Of course, the internship base must meet the basic requirements of practical teaching, completing practical teaching plans, practical teaching content, practical teaching management, etc. The internship base should also provide students with appropriate positions, enabling them to participate in the production practices of enterprises, mastering practical skills and management experience knowledge. The internship base should also provide students with necessary guidance and training, including safety operation procedures, quality awareness training, etc., ensuring students' practical effects and safety. The internship base should establish standardized internship management systems, including internship plans, internship assessments, internship safety management regulations, ensuring the quality and effectiveness of internships.

Joint Training Model: Joint training is an important cooperation mode in intelligent manufacturing practical teaching. Through joint training, colleges and enterprises can jointly participate in talent cultivation processes, jointly develop training programs, course settings, and teaching content to make talent cultivation more in line with enterprise and market needs, improving talent cultivation quality. Colleges and

enterprises jointly develop talent training programs based on enterprise needs for directional training. After graduation, students can directly enter the enterprise to work. Colleges and enterprises cooperate to combine internships with employment opportunities so that students can intern at enterprises while receiving enterprise training and assessments during the internship process, ultimately remaining in the enterprise to work. Colleges and enterprises jointly invest resources to build a college, jointly develop training programs, course settings and teaching content together.

Project Cooperation Model: Aiming at various technological development needs faced by enterprise industry transformation upgrades, colleges, and enterprises jointly research, develop, and solve problems to promote technological innovation and achievements transformation. Promoting technological innovation and achievements transformation can enhance the overall level of intelligent manufacturing field and cultivate students' innovative abilities. Colleges and enterprises jointly participate in industrial technology innovation alliances to jointly research, develop, and solve problems to promote industrial technology innovation andachievements transformation. Colleges and enterprises can complement each other and learn from each other to achieve industry-academia-research integration and technological innovation, improving the quality of applied talents cultivation.

5. Intelligent Manufacturing Professional Construction Needs Policy Support in School-enterprise Cooperation

As an enterprise engaged in production and operation, talent cultivation is not its main function. Therefore, the successful implementation of school-enterprise cooperation requires schools and governments to introduce relevant policies.

5.1. Policies Needed for Universities to Enhance Support to Improve Students' Practical Abilities and Innovative Spirit

Currently, most school-enterprise collaborations still remain at a relatively shallow level, such as internships and course design, which although provide some help in applying knowledge learned to practice, cannot meet the higher requirements of intelligent manufacturing practical teaching with a single cooperation model. Although these forms of collaboration have their own value, they are not sufficient to cultivate students' comprehensive abilities and innovative spirit. Both universities and governments need to introduce a series of policies as soon as possible to provide support.

As an important base for talent cultivation, universities need to continuously enhance their support policies (Figure 4) to improve students' practical abilities and innovative spirit:

- Strengthening the Construction of Practical Teaching Bases

Universities should actively cooperate with enterprises to build practical teaching bases, providing students with places and opportunities for internships and practical training. Practical teaching bases should simulate the real production environment of enterprises as much as possible, allowing students to be exposed to actual production equipment and manufacturing processes, improving the effectiveness of practical teaching. In addition, universities should increase investment in practical teaching bases, constantly updating equipment and technology to meet the latest needs of the intelligent manufacturing field.

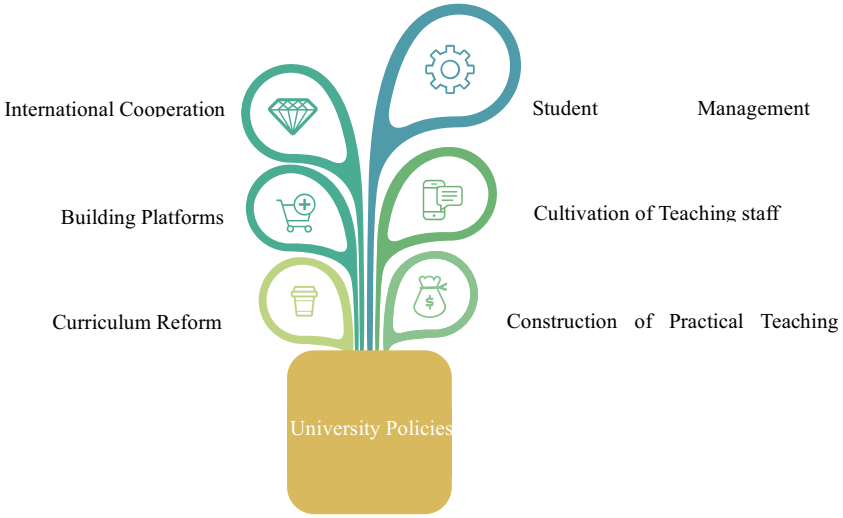

Figure 4. Universities support policies

- Strengthening the Cultivation of Teaching Staff

Excellent teachers play a crucial role in improving students' practical abilities and innovative spirit. Therefore, universities should strengthen the cultivation of teachers to improve their professional quality and practical abilities. Universities can organize teachers to participate in various training courses, academic conferences and seminars to improve their professional level. At the same time, universities can also encourage teachers to participate in enterprise technology research and development and project cooperation to improve their practical experience and practical teaching abilities.

- Perfecting Student Management Mechanisms

Universities should establish sound student management mechanisms to ensure the smooth development of school-enterprise cooperation projects and students' comprehensive development. Universities should formulate clear student management regulations, specifying students' rights and obligations, and establish a comprehensive assessment mechanism to evaluate students' performance. In addition, universities should establish smooth communication channels to timely understand students' needs and problems, and take effective measures to solve students' difficulties and concerns, creating a good study and living environment for students.

- Promoting Curriculum Reform

Universities should actively promote curriculum reform, combining practical teaching with theoretical teaching to improve students' comprehensive abilities and competitiveness. Universities can organize experts and enterprise representatives to jointly participate in course design, developing course content and teaching plans based on the actual needs of enterprises and technological development trends. At the same time, universities can also adopt advanced teaching methods such as project-based teaching methods and case teaching methods, stimulating students' learning interest and motivation, improving their autonomous learning ability and practical application ability.

- Building Innovation and Entrepreneurship Platforms

Universities should build innovation and entrepreneurship platforms for students to encourage them to carry out innovation and entrepreneurship activities, improving their innovative awareness and entrepreneurial abilities. Universities can offer innovation and

entrepreneurship courses to cultivate students' innovative thinking and entrepreneurial awareness; can organize innovation and entrepreneurship competitions to stimulate students' enthusiasm for innovation and entrepreneurship; can establish innovation and entrepreneurship parks to provide students with opportunities for entrepreneurial practice; also can invite entrepreneurs, investors, etc. to serve as mentors, providing students with professional guidance and support.

- Strengthening International Cooperation and Communication

Universities should actively strengthen international cooperation and communication to provide students with a broader vision and development space. Universities can cooperate with foreign universities or enterprises to jointly cultivate high-quality talents with an international perspective; can organize students to participate in international conferences, academic exchanges and other activities to understand the latest research achievements and development trends; also, can invite foreign experts or scholars to come to give lectures or teach courses to improve students' international awareness and cross-cultural communication abilities.

5.2. The Government Strengthens Supportive Policies to Enhance the Cooperation Enthusiasm of Both Schools and Enterprises

The forms of policy support (Figure 5) are diverse, including financial subsidies, tax preferences, talent introduction and training, etc., specifically manifested as:

Financial subsidies: The government provides financial support to enterprises, universities, and training institutions by establishing special funds and providing financial subsidies. For example, giving financial subsidies to enterprises participating in school-enterprise cooperation and supporting universities' practical teaching bases with funds.

Tax preferences: The government provides tax preference policies to eligible enterprises, universities, and training institutions to reduce their operating costs and promote their development. For example, giving tax exemptions or preferential tax treatment to enterprises participating in school-enterprise cooperation and applying preferential tax treatment to universities' practical teaching bases.

Talent introduction and training: The government attracts high-level talents to come to China to engage in research and development work in the field of intelligent manufacturing by formulating various preferential policies. At the same time, it encourages universities and enterprises to jointly cultivate talents to improve the quality and quantity of talent training.

Industrial guidance: The government encourages the development and upgrading of the intelligent manufacturing industry by formulating industrial development plans and guidance policies. For example, encouraging enterprises to increase investment in intelligent manufacturing technology and equipment, improving production efficiency and product quality.

Service support: The government provides various service supports for enterprises and universities, including financing support, intellectual property protection, information consultation, etc. For example, establishing a technology and finance service platform to provide financing support for enterprises; strengthening intellectual property protection to safeguard the legitimate rights and interests of innovative achievements; establishing an information consultation service system to provide timely and accurate information support for enterprises and universities.

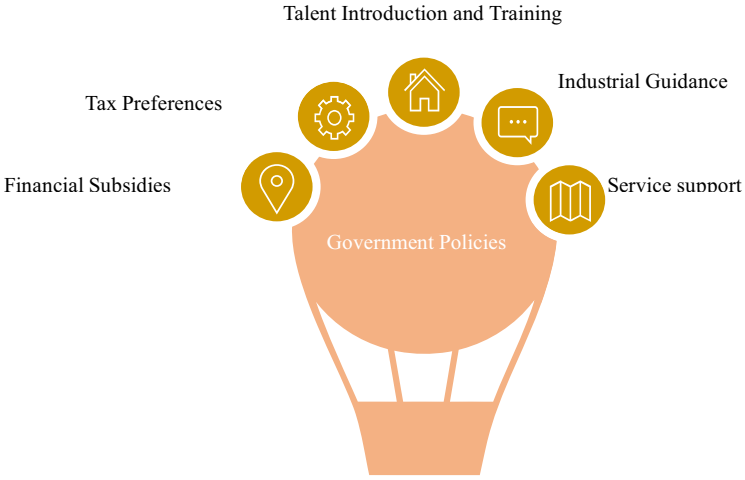

Figure 5. Government support policies

6. Conclusion and Outlook

With the rapid development of the global economy, intelligent manufacturing has become an important development direction for manufacturing. As an important way to cultivate intelligent manufacturing professionals, school-enterprise cooperation has received increasing attention. This article discusses the problems, cooperation models, and policy support needed for the construction of intelligent manufacturing majors based on school-enterprise cooperation from multiple perspectives. The construction of intelligent manufacturing majors based on school-enterprise cooperation is an important way to cultivate high-quality and highly skilled talents. Schools and enterprises should actively explore diversified cooperation models and substantive cooperation content, strengthen policy guidance, and support, and jointly promote the development and progress of intelligent manufacturing majors. In the future development, the intelligent manufacturing major will face more opportunities and challenges. The cooperation between schools and enterprises should continue to deepen the content and broaden the fields of cooperation, making positive contributions to promoting the transformation and upgrading of China's manufacturing industry and the sustainable development of the economy.

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