Study on the Demand and Influencing Factors of Vocational Skill Training for Industrial Workers in the Era of "Machine Replacement"

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Abstract

Under the current background of globalization and technological innovation, "Machine Replacement" has become an irreversible trend in many industries, which not only reshapes the demand structure of the labor market, but also poses new challenges to the career and skill requirements of laborers, especially industrial workers, and urgently needs to continuously promote the updating and development of industrial workers' skills. Based on a questionnaire survey of 281 industrial workers, this study found that age, gender, industry, and whether or not they are in the place of domicile affect industrial workers' demand for vocational skills training, and constructed a model of moderated mediating effects between industrial workers' self-efficacy, information acquisition ability, and occupational ambiguity and their willingness to be trained in skills. As a result, local governments should promote the optimal allocation of production factors and social resources for skills training, Enterprises should play a major role in vocational skills training, and vocational colleges should play a public service role in labor force skills development.

Keywords Industrial Workers; Vocational Education; Machine Tooling; Skills Training

1 Formulation of the Problem

Since the reform and opening up, China has given full play to its resource advantage and labor advantage to rank among the middle-income countries, but the development so far, China's traditional comparative advantage of low-skill-dependent industries is gradually disappearing, especially with the wide application of artificial intelligence and robotics, the labor market is undergoing unprecedented changes, the employment status of the country's nearly 220 million workforce is expected to be affected by automation technology by 2030 [1], Labor market theory posits that technological shifts alter supply-demand equilibria, displacing low-skill roles while creating demand for advanced technical competencies. "Machine Replacement" disrupts traditional labor markets by automating routine tasks, necessitating structural adjustments in skill provision. This aligns with findings that tertiary sector workers exhibit higher training willingness due to automation risks. "Machine Replacement"has become an irreversible trend in many industries, especially in the manufacturing industry, logistics industry and part of the service industry, the machine can not only replace manpower to complete simple, repetitive labor tasks, and even in some areas, the efficiency and performance of the machine has exceeded the human workers. Schumpeterian "creative destruction" underscores how innovation drives skill obsolescence and renewal. Rapid technological adoption in manufacturing and logistics accelerates skill mismatches, compelling workers to engage in lifelong learning [2]. This theory contextualizes the mediating role of information acquisition behavior—workers proactively seek knowledge to navigate technological uncertainty. Therefore, this change has led directly to the impact on the job market, which has traditionally been dominated by low-skilled industrial workers, with many jobs that had relied on manpower gradually disappearing or being replaced by technology. This means that although China currently has the world's largest workforce in terms of quantity, there is an urgent need to address the quality and structure of skills shortages and skills mismatches, as well as the question of whether skills are being "utilized" in depth. Throughout the transition process of advanced industrialized countries

from reliance on labor factors to the accumulation of technological innovations, a central role has been played by the establishment of a national system of skill formation [3].Therefore, in order to adapt to the needs of the new round of scientific and technological revolution and industrial change, and to turn the pressure and test of "huge population size" into advantages and dividends in the development of technical and skilled talents, it is necessary to deepen the structural reform of the supply side of skills, and to "rearm" oneself with continuous vocational skills training. We need to deepen the structural reform of skills supply side, "rearm" ourselves with continuous vocational skills training, and promote skills updating and development to enhance personal competitiveness and adapt to the new employment environment. However, at present, in the process of seeking vocational skills upgrading, China's industrial workers often have low interest and insufficient will in skills training, and there are also many unmet needs.

The new human capital theory believes that competence has a dynamic complementary effect, i.e., in the life cycle of human capital, human capital has to show a state of constant replenishment in order to adapt to the current development of society [4], and the formation of a skill can increase the ability to acquire skills in the next period [5], and the formation of non-cognitive skills in one stage also contributes to the formation of cognitive skills in the next stage.Therefore, this study based on the new human capital theory, analyzing how to effectively identify the drivers of industrial workers' demand for skills training and propose targeted intervention strategies has become an urgent issue for policymakers, enterprises and social organizations. This study aims to reveal the influence path of migrant workers' vocational skills training demand through multi-dimensional analysis, and provide scientific basis for differentiated provision of skills training resources and optimized allocation of training resources.

2 Research Design

2.1 Research Idea

The purpose of this study is to analyze in-depth the demand for vocational skills training for industrial workers and the factors influencing it through a combination of quantitative and qualitative research methods in the era of "Machine Replacement". The study firstly conducted a questionnaire survey on industrial workers, and at the same time selected some districts to conduct in-depth interviews, to obtain more detailed and comprehensive data and information. Secondly, through data analysis, we grasp the industrial workers' willingness to skill training, analyze the influencing factors behind it at the individual level and social level, and construct a moderated mediation effect model to reveal the complex influencing mechanism behind the demand for training and the main obstacles and needs faced by industrial workers in the process of vocational skill enhancement, so as to provide theoretical and practical support for the formulation of the government's vocational skill training policy, the construction of the enterprise's employee training system, and the optimization of the supply of institutional skill training. The model provides theoretical and practical support for the formulation of governmental vocational skills training policies, the construction of enterprise employee training systems, and the optimization of the supply of skills training in institutions.

2.2 Implementation of the Research

In the traditional sense, industrial workers refer to those who are engaged in collective production and labor activities in factories, mines, transportation, and other industries, and who live on wage income. With the changes in the industrial environment, the scope of industrial workers has been gradually expanded to include workers engaged in collective labor production in the primary industry of agriculture and forestry, the secondary industry of mining, construction, manufacturing, and heat, gas, electricity, and water production and supply, and the tertiary industry of transportation, postal services, warehousing, and information technology services, software, and information transmission, etc., and who live on their wage income [6]. In this study, a total of 306 questionnaires were distributed to industrial workers, excluding the data with an answer length of less than 60s and 38 data that did not answer important questions (scale questions), leaving 281 valid questionnaires, with a validity rate of 91.8%. The sample characteristics are as follows：

Table 1. Characteristics of a sample of industrial workers

Variant	Value	Frequency	Percent	Variant	Value	Frequency	Percent
Age	16-25	170	60.5%	Length of service	3 and under	179	63.7%
	26-35	79	28.1%		4-6	55	19.6%
	36-45	21	7.5%		7-9	22	7.8%
	46 and over	11	3.9%		46 and over	25	8.9%
Qualification	Primary School	6	2.1%	Genders	Male	129	45.9%
	Junior high school	6	2.1%		Female	152	54.1%
	General high school	23	8.2%	Annual family income	10 and under	137	48.8%
	Secondary/Junior/Vocational high school	35	12.5%		11-30	118	42%
					31-50	18	6.4%
	Post-secondary qualifications	99	35.2%		51 and under	8	2.8%
				Whether in domicile	Yes	149	53%
	Bachelor's degree	112	39.9%		No	132	47%

3 Research Findings

3.1 Strong Demand for Self-improvement among Industrial Workers

First, for the 281 industrial workers, 90% of the survey respondents had the idea of upgrading their qualifications or skills training, while only 10% of the respondents wanted neither upgrading their qualifications nor skills training.

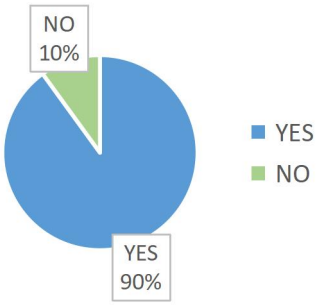

Fig. 1. Ideas for upgrading your education or skills training

Fig. 2. Preference for upgrading education and skills training

The statistical results for the 253 survey respondents who had the idea of upgrading their education or skills training showed that among upgrading their education and skills training, 168 survey respondents preferred upgrading their education, accounting for 66.4%. The remaining 33.6% of survey respondents preferred skills training.

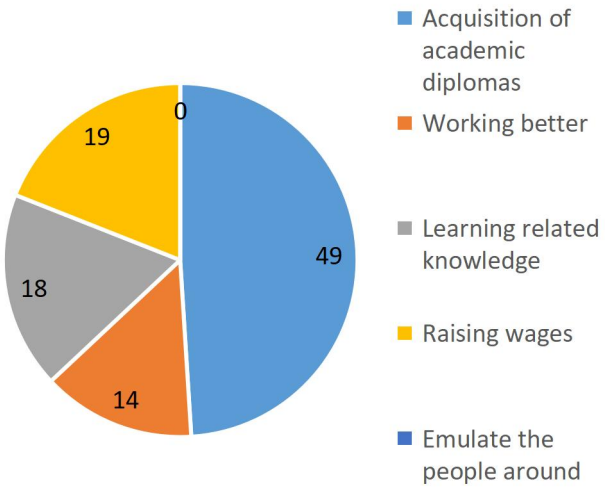

Fig. 3. Top ideas toward upgrading education

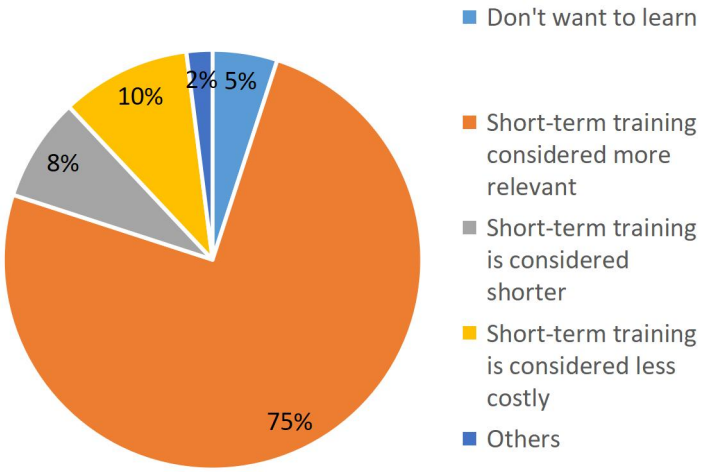

Fig. 4. Top ideas in favor of skills training

Specifically, the reasons for the tendency to upgrade qualifications were mainly due to the desire to obtain an academic diploma (48.8%), followed by the desire to improve wages and to learn relevant knowledge (19% and 17.9%, respectively). Further statistics on the 85 respondents who preferred skills training found that 75% of the respondents preferred skills training because it was more targeted, which is an advantage of skills training.

3.2 Industrial Worker Skills Certificate Examination Above Practical Action

The results of the survey show that 214 of the 281 respondents (76.2%) indicated that their current occupations required relevant vocational qualifications or skill level certificates, but only about half of them (55.6%) had obtained vocational skill level certificates, while 44.4% of the respondents had demanded for vocational certificates, but had not yet acted on them.

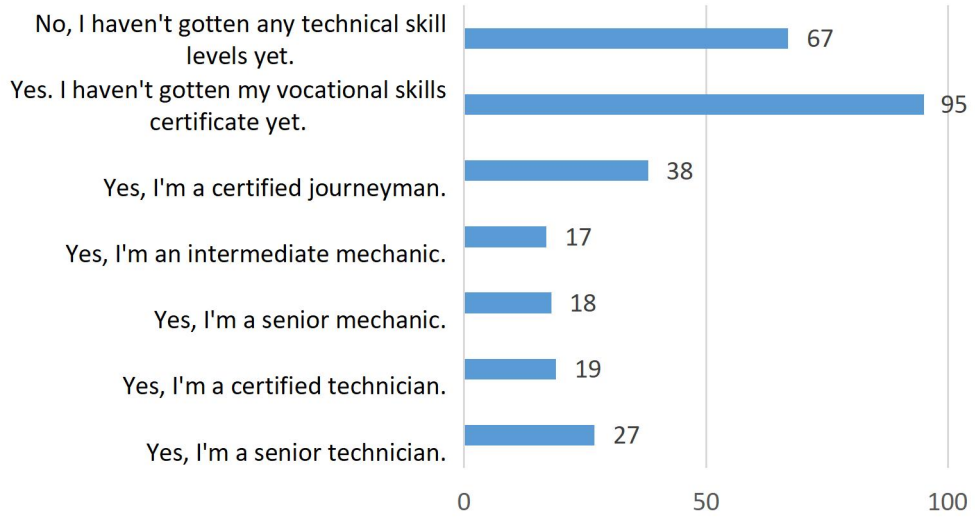

Fig. 5. Certificate demand and acquisition survey results

3.3 Industrial Workers' Willingness to be Trained in Skills is Affected by Age, Gender, Industry and Place of Domicile

First, the younger the age, the higher the willingness to educate and train. Becker's human capital theory emphasizes skill investment as a rational response to expected returns [7]. Younger workers'higher training willingness reflects longer payoff horizons, while older workers perceive diminished returns. Gender disparities (higher female participation) may stem from differentiated labor market opportunities, incentivizing women to enhance employability through training.In this study, the chi-square test of age and willingness to educate and train showed that the χ^2 value was 21.104 and the p-value was 0.049, which indicates that there is a significant difference in willingness to educate and train among individuals of different age groups. Usually the younger the age, the higher the willingness to educate and train. Older cohorts face diminishing returns, reflecting Becker's lifecycle model of human capital depreciation. This is also in line with the age profile of skills learning, where often, as they grow older, the long-term rewards that industrial workers receive from vocational skills training are not sufficient to offset the time and resources that need to be invested, and so the desire to change their employment and development paths through skills learning or educational upgrading gradually diminishes.

Table 2. Results of chi-square test for age and willingness to train in education

Willingness / Age	Very Low	Low	Mid	High	Very High	Total	χ^2	P
16-25	58	17	46	23	26	170	21.104	0.049
26-35	19	8	21	22	9	79		
36-45	5	4	3	3	6	21		
46 and over	2	0	2	4	3	11		
Total	84	29	72	52	44	281		

Secondly, women's willingness to train is slightly higher than men's. Through the chi-square test of gender and willingness to train, the results show that the χ^2 value is 18.740 and the P value is 0.001, indicating that gender has a significant effect on willingness to train. Female willingness to train is slightly higher than male. Women's higher training intent (χ^2=18.740, p=0.001) aligns with labor market segmentation theory. In China's gendered labor market, women may perceive training as critical to overcoming occupational barriers.

Table 3. Results of chi-square test of gender and willingness to education and training

Willingness / Gender	Very Low	Low	Mid	High	Very High	Total	χ^2	P
Male	40	13	28	16	32	129	18.740	0.001
Female	44	15	44	37	12	152		
Total	84	28	72	53	44	281		

Thirdly, those employed in the tertiary sector are more willing to be educated and trained. There is a statistically significant relationship between the industry to which one belongs and the willingness to educate and train by chi-square test ($\chi2$=16.615, P=0.034). Specifically, there are significant differences in the willingness to train among industrial workers in the primary, secondary and tertiary industries. The willingness of employees in the tertiary industry to receive education and training is significantly higher than that in the primary and secondary industries. This is mainly because some jobs in the tertiary industry are highly replaceable and subject to greater risk of technological shocks, and practitioners are more eager to enhance their career stability through training. At also, industrial workers in high technology content industries have a stronger demand for training due to the rapid updating of industrial skills. Tertiary sector workers exhibit stronger training intent (χ^2=16.615, p=0.034), echoing labor market theory's emphasis on technology-driven disruptions in service industries. Therefore, the tertiary industry is more willing to be trained than the primary industry and the secondary industry.

Table 4. Results of the chi-square test between the affiliated industry and willingness to educate

Willingness / Affiliated Industries	Very Low	Low	Mid	High	Very High	Total	χ^2	P
Primary Sector of Industry	7	4	10	4	12	37	16.615	0.034
Secondary Sector of Industry	17	6	6	10	8	47		
Tertiary Sector of Industry	61	20	55	38	23	197		
Total	85	30	71	52	43	281		

Fourth, foreign industrial workers are more willing to train. The chi-square test ($\chi2$=17.876,P=0.001) showed that there is a statistically significant relationship between whether or not to work in the place of domicile and willingness to train. Specifically, there is a significant difference between the willingness of those who work in the household registration area and those who do not work in the household registration area. Those who do not work in the area where they are registered show higher willingness to receive education and training, which means that the foreign population is more willing to receive skills training than the local population in order to have a better job and to integrate into the city.

Table 5. Results of the chi-square test of whether or not to be at the place of domicile and willingness to educate

Willingness / Whether working in the place of domicile	Very Low	Low	Mid	High	Very High	Total	χ^2	P
Yes	49	7	31	33	29	149	17.876	0.001
No	35	21	40	21	15	132		
Total	84	28	71	54	44	281		

3.4 The Influence of Industrial Workers' Self-efficacy on Skill Training Intentions: the Mediating Path of Information Acquisition Behavior and the Moderating Effect of Career Planning Ambiguity

This study explored the mediating role of self-efficacy (SE) on skill training intention (STI) through information acquisition behavior (IA) and examined the moderating effect of career plan ambiguity (an inverse indicator of career plan clarity) on this mediating pathway, constructing the following model.

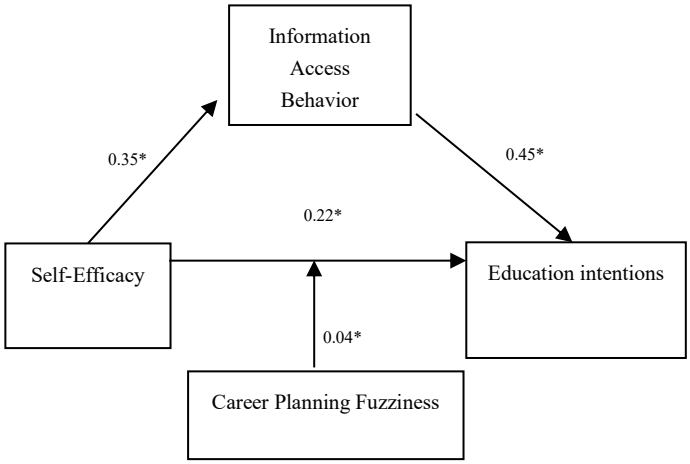

Fig. 6. Model diagram of mediating effects with moderation

Industrial workers' information acquisition behavior mediates their self-efficacy and training intentions

The core of the mediation effect test is to verify the rationality of the pathway "self-efficacy (SE)→ information acquisition behavior (IA)→skill training intention (STI)". According to the research model, the direct effect coefficient of self-efficacy was 0.2216 ($p<0.001$), indicating that self-efficacy had an independent positive effect on education and training intentions, even after controlling for the effect of information acquisition behavior. In addition, information acquisition behavior plays a partly mediating role between self-efficacy and education and training intention. That is, self-efficacy not only directly affects educational training intention, but also indirectly affects the latter through information acquisition behavior.

First, self-efficacy affects information acquisition behavior. The findings show that the regression coefficient is 0.3520 ($p<0.001$) and the explanatory power of the model $R^2=0.6144$, indicating that self-efficacy explains 61.44% of the variance in information acquisition behavior. As social cognitive theory emphasizes, an individual's behavioral choices are influenced by the interaction of cognitive factors (e.g., self-efficacy) and environmental factors. Self-efficacy, as an individual's confidence in his or her own abilities, is a key driver of information acquisition behavior. When individuals believe that they can improve their skills through training, they will search for relevant information more actively, which will enhance their willingness to participate in training, i.e., individuals with high self-efficacy are more inclined to obtain information actively. Second, information acquisition behavior affects skill training intention. Huang Qian points out that the training needs of migrant workers are limited by information acquisition channels [8]. The analysis in this study found a regression coefficient of 0.4529 ($p<0.001$), indicating that information acquisition behavior significantly and positively predicts intention. The Theory of Planned Behavior states that the formation of behavioral intentions depends not only on attitudes, but is also influenced by subjective norms and perceived behavioral control. Information acquisition plays the role of "perceived behavioral control" in this model, helping individuals to understand the resources and value of training, reducing uncertainty, and thus increasing intention. Through information acquisition, individuals are able to assess the benefits and feasibility of the training more clearly, thus increasing their motivation to participate. As a result, the mediating role of information acquisition behavior is further revealed, which makes up for the shortcomings of previous studies that only focused on individual characteristics but neglected the behavioral path.

Career planning ambiguity moderates the relationship between self-efficacy and skill training intentions

The higher the ambiguity of career planning, the weaker the contribution of self-efficacy to education and training intentions. The statistical results yielded that on the interaction term coefficient (Table 6), the interaction term coefficient between career planning ambiguity and self-efficacy was -0.0372 (p=0.012), indicating that career planning ambiguity significantly and negatively moderated the effect of self-efficacy on intention to train in skills. Specifically, the effect of self-efficacy decreased by 0.0372 for each 1-unit increase in career ambiguity. This is because a clear career goal enhances an individual's recognition of the value of training and provides direction for his or her behavior. When career planning is ambiguous, individuals lack clear career anchors, which can lead to weakening of individual training motivation, making it difficult to link vocational skills training to long-term career development, and thus presenting a low willingness to invest.

Table 6. Specific models

	coeff	se	t	p	LLCI	ULCI
Constant	-0.2354	1.3936	-0.1689	0.8660	-2.9784	2.5077
Self-Efficacy	0.2216	0.0489	4.5295	0.0000	0.1253	0.3179
Information Access Behavior	0.4529	0.0634	7.1429	0.0000	0.3281	0.5777
Career Planning Fuzziness	1.3472	0.4378	3.0774	0.0023	0.4855	2.2089
Interaction Term(Career Planning Fuzziness X Self-Efficacy）	-0.0372	0.0147	-2.5269	0.0121	-0.0663	0.0082

On simple slopes (Table 7), the effect values for self-efficacy were 0.1663 (p<0.001), 0.1262 (p<0.001), and 0.0861 (p=0.080) at low, medium, and high levels of occupational ambiguity, respectively. The effect is no longer significant at high levels of ambiguity, indicating that individuals with ambiguous career plans have difficulty in translating their confidence into action even if they have a high sense of self-efficacy. This is because individuals with high self-efficacy may be anxious about having no place to utilize their abilities due to the lack of a clear career direction, which may inhibit their ability to take action.

Table 7. Moderating effects of occupational ambiguity

Career Ambiguity	Effect	se	t	p	LLCI	ULCI
1.4855(M-1SD)	0.1663	0.0338	4.9125	0.000	0.0997	0.2329
2.5625(M)	0.1262	0.0290	4.3522	0.000	0.0691	0.1832
3.6395(M+1SD)	0.0861	0.0322	2.6701	0.080	0.0226	0.1495

4 Recommendations for countermeasures

4.1 Local Governments Should Promote the Optimal Allocation of Production Factors and Social Resources for Skills Training

The new human capital theory argues that the continuous accumulation of human capital is the key to increasing labor productivity and sustained economic growth. Heckman proposes that the process of competence formation contains multiple stages, with different types of inputs at different stages of the human capital life cycle [9]. Therefore, for individuals in society, the right to re-skill and re-capitalise should be available at all stages of their life cycle. In this survey, it was found that more than 70% of the respondents would like to be supported in terms of time and space flexibility for skills training. And in the future, the lines between internal and external skill formation paths will tend to blur [10], vocational colleges and universities are recruiting more and more workers for vocational academic education, while enterprises are increasingly front-loading their training, forming a school-enterprise co-education, thus promoting the optimal allocation of production factors and social resources. Therefore, the traditional sense of fixed time and place needs to be broken through, and local governments need to promote the optimal allocation of production factors and social resources for skills training from the perspective of an individual's entire life cycle, i.e., not only should there be flexibility and variety in training time, developing short-term training and training at different times of the day, but also diversification needs

need to be met in terms of the form of training, and the development of a combination of on-line and off-line forms of training.

On the one hand, it is necessary to improve the accessibility of the time for skills training and provide a basis for updating the skills of practitioners. The new human capital theory believes that in the life cycle of human capital, human capital has to show a state of constant replenishment in order to adapt to the development of the current society [11].Therefore, at a time when science and technology are becoming more up-to-date, it is important for individuals in society to be able to enjoy the right to reskilling and recapitalization at all stages of their life cycle. For local governments, there is a need to provide time support for practitioners facing changes in occupational status and updating of knowledge and skills, such as the current zero-worker employed persons who have become an important group of the employed population that cannot be ignored, and who tend to be easily replaced because of their low overall skill level, weak relocatability, and the fact that their previous employment was also dominated by low-skill employment. So their needs for learning, upgrading and applying diversified skills will change with the changes in the industrial structure, which calls for skills training to enhance its time accessibility and provide flexible pathways of academic education or skills learning for social students who need to upgrade their skills at any time, so as to improve their ability to switch careers.

On the other hand, it is necessary to enhance the accessibility of skills training space and create a convenient skills learning platform. Firstly, it is possible to build an online skills-learning platform and develop digital skills-learning resources to ensure that there are opportunities to learn skills "all the time". For example, Guizhou is building a skills training network for society; Zhejiang Province, relying on the Zhejiang Learning Network, is trying to realize that social workers can learn and recognize skills at any time [12]. Secondly, existing regional resource spaces, such as community cultural centers and township comprehensive cultural stations, have been coordinated to establish "skills parks" covering all counties (districts) and within a short travel time, to meet the skills-updating needs of different members of society. For example, Zhejiang Province "connects the platform of the zero-work market, integrates resources, and arranges and builds a '30-minute vocational skills training circle' covering urban and rural areas", thus breaking down the barriers of training space and realizing the goal of "learning all the time". This breaks down the barriers to training space and realizes the goal of "learning all the time".

4.2 Enterprises Should Play a Leading Role in Vocational Skills Training

The transformation and upgrading of China's industry, which is centered on medium- and high-end manufacturing, is highly dependent on the upgrading of "human" skills, which requires enterprises to play a leading role in vocational training. However, the data shows that in skills training, the enterprise skills investment willingness is low, according to the IBM Value Institute research data, 81% of Chinese enterprises prefer to dig skills from the labor market rather than their own training [13]. Therefore, we need to mobilize the enthusiasm of enterprises in vocational training, so as to achieve the goal of "a vocational skills training system that is enterprise-oriented, based on vocational colleges and universities, and combines government promotion with social support" [14]. First, the various functional departments need to work together on incentive policies to pry the enthusiasm of enterprises to carry out skills training, and they can also use the level of the structure of skilled personnel in enterprises as a reference basis for projects such as bidding, and at the same time, they can also be provided with customized training services by training institutes or vocational colleges for enterprises. Secondly, enterprises should focus on the training and development of front-line skilled workers, and in addition to training new employees or re-educating workers, they should also flexibly provide or buttress value-added skills training and job-transfer training in accordance with the needs of the enterprise and the development of individual careers. In short, the only way to effectively reduce the direct costs of skills training for enterprises and to safeguard the long-term benefits of enterprises is to stimulate the main consciousness of enterprises to take the initiative to carry out skills training.

4.3 Vocational Institutions Play a Public Service Role in Workforce Skills Development

At present, with the rapid change of production technology, the public need to continuously update their skills to cope with more complex skills content and application situations, and their needs for lifelong learning and on-the-job training are becoming more and more obvious. However, as described in Chapter 5, higher vocational education, which has been the mainstay of a skills-based society, has not been sufficiently responsive to the needs of the public for vocational training, and has not supported its

position as the mainstay of the skills strategy and skills development system. Therefore, in recent years, policy documents have constantly emphasized the need to "Improve the modern vocational education system, which emphasizes both academic education and training"[15]"Implementation of the statutory duty of vocational institutions to give equal emphasis to both academic education and training"[16],there are all highlighting the skills retraining function of vocational institutions. Among them, provinces (regions) have also promoted the social training initiative and autonomy of vocational colleges and universities through the promulgation of policy documents, such as Anhui, Guizhou, Ningxia, Shandong and other provinces (regions), which have stipulated the amount of performance pay to be allocated to vocational education in terms of the income derived from undertaking social training. Therefore, vocational colleges and universities, especially public vocational colleges and universities, should broaden the definition of their targets and expand their social functions and roles to meet the learning needs of students in the education system as well as to provide skills updating services for the employed. Specifically, on the one hand, the government should increase the proportion of vocational colleges in the provision of skills training services in the evaluation of the performance of vocational colleges, and improve the incentive system for skills training in the performance pay and career development of teachers in vocational colleges. On the other hand, vocational colleges and universities should pay attention to the reality of specific groups, take on the function of vocational training, and contribute to narrowing the gap between urban and rural residents in terms of skill literacy and meeting the skill needs of industrial workers in various fields. This will not only realize the rational allocation of training resources, the effective matching of training supply and demand, and the improvement of trainers' quality and ability, but also promote the change and transformation of vocational institutions [17].

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Conflicts of Interest

The authors declare no conflicts of interest.

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Biographies

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「機器換人」時代產業工人職業技能培訓需求及影響因素研究

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摘要：在當今全球化與技術創新的背景下，「機器換人」已成為眾多行業的不可逆轉趨勢。這一趨勢不僅重塑了勞動力市場的供需結構，還對勞動者，尤其是產業工人的職業與技能要求提出了新挑戰，迫切需要持續推進產業工人技能的更新與發展。本研究基於對281名產業工人的問卷調查，發現年齡、性別、行業以及是否在戶籍所在地工作等因素會影響產業工人對職業技能培訓的需求，並構建了產業工人的職業效能感、信息獲取能力與職業模糊性對其技能培訓意願的有調節的中介效應模型。因此，地方政府應促進生產要素與社會資源在技能培訓方面的優化配置，企業應在職業技能培訓中發揮主導作用，職業院校則應承擔起在勞動力技能開發方面的公共服務職能。

關鍵詞：產業工人；職業教育；機器換人；技能培訓

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