A Study on the Causes and Countermeasures of Structural Imbalances in Manufacturing Employment among University Graduates in China's Yangtze River Delta from the Perspective of Supply-Demand Matching

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Abstract:Amidst a new round of technological revolution and industrial transformation, the digital and intelligent transformation of manufacturing in China's Yangtze River Delta has reshaped the structure of labour market demand. The dual predicament of "difficulties in finding employment" for Chinese university graduates and "difficulties in recruiting workers" in the manufacturing sector has persisted for a long time, becoming a key bottleneck constraining the cultivation of "new-quality productive forces". Based on the theory of supply-demand matching, this paper conducts an in-depth questionnaire survey of manufacturing and technology-based enterprises in the Yangtze River Delta region, constructing a "dynamic supply-demand matching model" that encompasses multiple dimensions including skills, cognition and regional factors. The research reveals that digital transformation has driven a surge in corporate demand for interdisciplinary, multi-skilled talent, whilst university graduates exhibit a significant supply lag in core competencies such as industrial software application and data analysis. After further analysing underlying causes such as the "time lag effect" and "information silos", the paper proposes countermeasures including the establishment of an AI-powered employment matching platform and the implementation of a dynamic "micro-specialisation" curriculum adjustment mechanism. These measures aim to achieve dynamic coupling between talent development and industrial demand, thereby providing support for resolving the structural employment dilemma in the manufacturing sector.

Keywords: Matching of Supply and Demand; Manufacturing Job; Structural Imbalance; Education Integration in the Industry; Digital Transformation

1.Introduction

The national economy is based on manufacturing; the cornerstone of the nation, the tool of its well-being, the foundation of its power. The manufacturing industry in China is moving towards smart manufacturing because of Made in China 2025 and the creation of Digital China. The convergence of next-generation information technology and manufacturing is creating new industries and business models that is radically transforming the labour market.

The quantity of undergraduate graduates in China is expected to continue to rise (to over 12 million by 2025) creating overcrowding in employment opportunities and spawning such phenomena as slow employment; however, the high-tech areas of the manufacturing industry are experiencing a lack of highly skilled personnel, with cases of equipment waiting to be used by skilled workers and offers of monthly salaries over 10, 000 yuan with This paradox of the people without jobs/jobs without people is a typical example of structural imbalance, not an absolute lack.

The conventional employment studies have mostly concentrated on macro-level external influences without considering the micro-level job requirement and without considering the tension between skill reiteration and talent provision through the prism of dynamic supply-demand correspondence. Otherwise, it will lead to the squandering of human capital, postponement of the reorganization of the manufacturing sector, and hamper the formation of new-quality productive forces. It is against this background that this study, informed by the Yangtze River Delta, a manufacturing hub, examines the causes of this disequilibrium by conducting empirical surveys involving

enterprises and offering countermeasures, hence, offering grounds to resolve any structural employment contradictions.

2. Literature Review

2.1 Digital Transformation and the Evolution of Labour Demand

The development of artificial intelligence and digital technologies has reshaped the structure of labour demand within enterprises, and academic research in this area continues to deepen. Babashahi et al. (2024) found that the application of AI alters corporate workflows, driving an increased demand for employees possessing digital skills, interdisciplinary knowledge and soft skills; Ubalde and Alarcón (2023) noted that, against the backdrop of automation, skills such as language and cognitive abilities-which are difficult to replace-are becoming increasingly valued.

Research by Gulati et al. (2025) indicates that roles involving generative AI require an average increase of approximately 36.7% in cognitive abilities, whilst the demand for social skills has also risen significantly. This suggests that AI does not merely replace labour, but rather elevates the demand for higher-order cognitive and composite skills. Furthermore, the impact of technological progress on employment operates through multiple mechanisms, exerting a greater impact on low-skilled, repetitive roles whilst driving a sustained rise in demand for high-skilled, knowledge-intensive positions.

Existing research largely focuses on macro-level analyses of technology's impact on employment structures, with insufficient attention paid to micro-level changes in the skill profiles of specific corporate roles. There is a lack of in-depth analysis regarding the demand for the integration of digital skills with traditional professional skills; therefore, examining the evolution of labour demand in the manufacturing sector from a supply-demand matching perspective remains of significant value.

2.2 A Multi-Dimensional Interpretation of Skills Mismatch

Against the backdrop of digital transformation, the issue of skills mismatch has attracted significant academic attention. This refers to the misalignment between workers' capabilities and job requirements, encompassing forms such as skills shortages and skills surpluses, and exhibiting complex dynamic characteristics. James Bessen (year to be added) et al. point out that new technologies alter the structure of job tasks; when the pace of adjustment within the education system lags behind technological change, structural mismatches are likely to arise, manifesting both as firms' inability to recruit multi-skilled talent and as the obsolescence of workers' existing skills.

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2.3 Shortcomings of Existing Research

Existing research on employment structures has largely focused on the macro level, examining institutional factors such as economic cycles, remuneration and household registration systems, whilst neglecting the micro-level impacts of changes in firms' job demand structures. Against the backdrop of the digital economy and the development of smart manufacturing, skill requirements for manufacturing roles are continuously evolving; however, due to the lengthy adjustment cycles for academic programmes and curricula, higher education talent development systems struggle to respond promptly to industrial transformation. Existing research lacks a dynamic analysis of the interactive relationship between corporate demand and talent supply, nor has it thoroughly explored the issue of 'matching lag' between skill iteration and talent development.

3. Research Design and Framework Reconstruction

3.1 Data Sources and Sample Characteristics

Between September and October 2025, the project team conducted a questionnaire survey targeting manufacturing and technology service

enterprises in Zhejiang, Jiangsu, Shanghai and other regions of China's Yangtze River Delta, recovering 163 valid responses. The surveyed enterprises were predominantly private enterprises, covering high-end equipment manufacturing sectors such as smart manufacturing (35%), electronic information (28%) and automotive components (20%). Over 70% were in the growth and expansion phase or the mature and stable phase, with strong demand for labour. The enterprises were geographically concentrated in major manufacturing hubs such as Jiaxing, Hangzhou and Suzhou, providing a good reflection of the characteristics of the labour market under the integration of the Yangtze River Delta.

3.2 Variable Measurement and Questionnaire Design

The questionnaire was designed around the core concept of 'supply-demand matching', comprising 25 items divided into three modules: first, basic enterprise characteristics and the degree of digital transformation, to construct an enterprise profile; second, job demand characteristics and skills gaps, to examine the types of urgently needed talent and core skills; and third, the current status and evaluation of supply-demand matching, to quantify recruitment difficulty and mismatch patterns, whilst also surveying enterprises' willingness to use AI-powered matching platforms, thereby providing data support for policy research.

3.3 Reconstruction of the Theoretical Framework: Dynamic Supply-Demand Matching Model

Employment matching is a process that dynamically adjusts in response to industrial technology, regional economies and individual career preferences. This study innovatively proposes a "Dynamic Supply-Demand Matching Model", introducing variables of time and the rate of change to transcend the traditional static matching perspective. In the model, the demand side is a function of the rate of technological progress, exhibiting exponential growth; the supply side is a function of the rate of educational reform, exhibiting stepwise linear growth. The root cause of structural imbalances lies in the supply side's response lagging behind the demand side, with this "matching lag" being amplified during the period of accelerated digitalisation.

(1) Demand-Side Function Model

With the rapid development of artificial intelligence, the Industrial Internet and digital technologies, enterprises' demand for highly skilled and multi-skilled talent is showing a marked trend of accelerated growth. Technological progress drives the continuous upgrading of corporate job structures, shifting from traditional labour-intensive roles to technology-intensive ones. Therefore, this paper posits that the demand for talent in the manufacturing sector exhibits an exponential growth relationship with technological progress, expressed by the following function:

$$D(t)=D_0e^{\alpha t}$$

Where: D(t) : The scale of demand for highly skilled talent in the manufacturing sector at time t

D_0: The scale of talent demand at the initial time

e: The base of the natural logarithm

α: The rate of technological progress (speed of digital transformation)

t: The time variable

This function indicates that, driven by digital transformation, the demand for talent in the manufacturing sector exhibits an exponential growth trend; the faster the pace of technological progress, the more rapid the growth in talent demand.

(2) Supply-side Function Model

Compared to the demand side, the supply of talent from higher education institutions exhibits distinct institutional cyclicality. Adjustments to university specialisations, curriculum systems and training programmes are typically made on an academic year or training cycle basis, exhibiting a marked lag. Consequently, changes in talent supply generally manifest as a slow linear growth trend. This paper represents the university talent supply function as:

$$S(t)=S_0+\beta t$$

Where: S(t): Scale of university graduate talent supply at time t

S_0: Initial scale of talent supply

β : Rate of educational reform and talent development adjustment

WhenM(t) >0, it indicates that corporate job demand exceeds talent supply, resulting in 'difficulty in recruiting';

When M(t)<0, it indicates that talent supply exceeds job demand, resulting in 'difficulty in finding employment'.

This study also introduces "multidimensional matching theory", expanding the matching

dimensions from a single "hard skill" to include "soft skills", "values", "development expectations" and "regional preferences", integrating multidisciplinary theories to accurately identify the pain points and bottlenecks of employment imbalances.

Substituting the demand and supply functions yields: $M(t)=D_0e^{\alpha t}-(S_0+\beta t)$

where: $M(t)$: the degree of structural imbalance in manufacturing employment

When $M(t) > 0$, it indicates that corporate job demand exceeds talent supply, resulting in 'difficulty in recruiting';

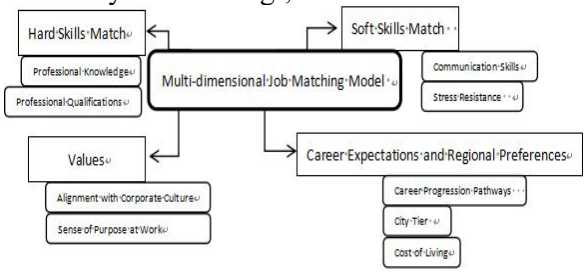

Figure 1. Theoretical Framework for Multi-Dimensional Job Matching

4. Empirical Analysis

4.1 Changes on the Demand Side: Digitalisation Raises the Bar for "Quality"

Survey results indicate that over 85% of enterprises report that digital transformation has had a significant or even very significant impact on job structures, leading to marked changes in talent demand. Firstly, talent demand has become increasingly technology-intensive, with "smart manufacturing/automation engineers", "R&D engineers" and "senior technical workers" emerging as the most urgently needed talent types. Traditional, purely manual labour roles are rapidly disappearing; even front-line operators now require the ability to read digital drawings and operate CNC machines. Secondly, multi-skilled professionals have become an urgent necessity. Over the next 3-5 years, enterprises will have a pressing need for expertise in "industrial software and data analysis", "AI and machine learning applications", and "interdisciplinary capabilities". Graduates with a single-discipline background will struggle to adapt to smart manufacturing environments, whilst T-shaped professionals-who possess a broad understanding of processes, data and management-will become a scarce resource in the market.

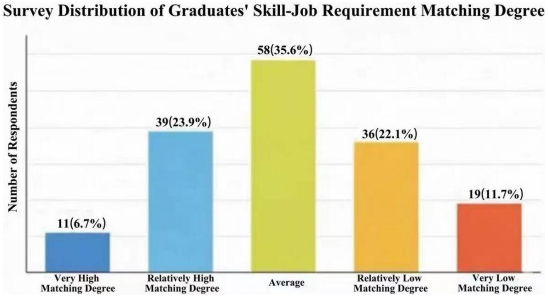

Figure 2. Analysis of the Match between Graduate Skills and Job Requirements

4.2 Supply-Side Lag: a Dual Mismatch of Skills and Perception

In stark contrast to the transformations on the demand side, there is a severe lag in talent supply on the supply side, manifesting as a dual mismatch of skills and perception. Firstly, there is a positive correlation between the extent of a company's digital transformation and the difficulty of recruitment; the deeper the transformation, the greater the recruitment challenge, indicating a severe shortage of high-end digital talent. Secondly, there is a significant gap in hard skills, with "lack of practicality in course content" and "insufficient digital/intelligent skills" being the most prominent manifestations of this mismatch. Engineering graduates generally lack the ability to operate industrial software actually used in enterprises, requiring extensive training after joining the workforce. Finally, there are discrepancies in soft skills and perceptions: whilst enterprises value graduates' practical problem-solving abilities and professional attitude, many graduates are "all talk and no action", harbouring stereotypes about the manufacturing work environment and displaying low willingness to enter the sector, which further exacerbates the brain drain in manufacturing.

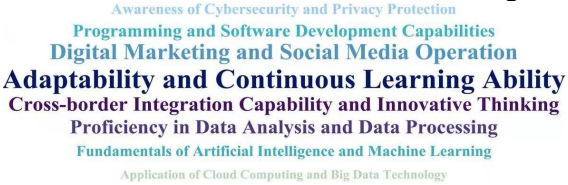

Figure 3. Word Cloud of Core Skill Requirements for Manufacturing Roles

5. Analysis of Causes of Structural Distortion and Imbalance.

5.1 "Time Lag Effect" and "Information Silos" in Supply and Demand Communication.

The failure of the supply-demand information

transmission mechanism is the key factor that leads to structural distortion and imbalance. University talent development plan is adjusted every 4 years based on previous disciplinary experience; while the iteration period of manufacturing technology has already been compressed into several months or even weeks. Therefore, time lag always makes the talents trained by universities lagging behind.

On the other hand, there are also serious "information silos" between universities and enterprises. Although it is always promoting the integration of industry and education, the proportion of enterprises involved in the curriculum construction of universities and the practical training guidance of universities is still extremely low. Therefore, the enterprise's demand cannot be transformed into teaching links, and universities also lack the support of scenarios and data in industries, leading to the phenomenon of "selling and buying in isolation".

5.2 Misalignment in Evaluation System.

Universities have long maintained an evaluation system that always values academic papers and research but ignores teaching and practice. Under the impetus of promotion for associate professors in universities, teachers will tend to write more theoretical content, ignoring the latest engineering practices in the industry; and the student evaluation system based on examination results also makes students place more emphasis on theoretical teaching and ignore the cultivation of engineering practical ability and innovative thinking. This one-dimensional evaluation system seriously restricts the space for cultivating engineering and technical talents that the manufacturing field needs, causing the mismatch between the supply and demand of talents.

5.3 Polarization Effect of Regional and Industrial Attractiveness

From the perspective of regional economy, there are also very large differences in the attractiveness of talents in various cities in the Yangtze River Delta. As the core city of the Yangtze River Delta, Hangzhou and Suzhou play the role of "siphon" for the graduates with their advantages in digital economy and public service; while the peripheral cities such as Jiaxing and Huzhou still have certain difficulty in attracting high-end talents due to the restriction of city development level and living environment. At the same time, the salary disadvantage of manufacturing compared with the Internet and finance further aggravates the employment environment of manufacturing, reducing the attractiveness of manufacturing for graduates.

5.4 The Polarization of Intergenerational Career Values

As digital natives, graduates of post-2000 also have undergone great polarization in their career values. They place more emphasis on work experience, freedom and self-realization and find it difficult to adapt to the traditional manufacturing with hierarchical management and strict attendance. The industry's emphasis on discipline, standardization and process naturally collide with the values of this new generation; even if the salary is higher, it is also very difficult to attract the young people to enter the manufacturing through the material stimulation, leading to the polarization of employment at the level of values.

6. Countermeasures and Suggestions

6.1 Technology Empowerment: Developing an AI-based Smart Employment Matching Platform

Due to the information distortion of supply and demand, as well as the low matching efficiency, a "Smart Employment Matching Platform" based on big data and artificial intelligence should be developed. Its data layer extracts data from graduates' CVs and internship experiences to generate accurate talent profiles by using natural language processing technology; it also does semantic analysis of corporate job descriptions to establish corresponding competency models for positions. Its algorithm layer uses deep learning algorithms to calculate the matching degree between talents and positions by considering indicators such as hard skills, region and culture. Its application layer aggregates regional talent supply and demand data to generate reports on talent trend forecasts, offering references for the adjustment of programs for governments and universities.

6.2 Institutional Innovation: Developing a Dynamic Curriculum Adjustment System for "Micro-Majors" and Dual-Mentors.

Universities should establish a labor market

monitoring and early warning system. By scraping data from recruitment websites and analyzing the changes in industrial skills demand in real time, a 'curriculum suspension and new addition mechanism' should be established. Given that the undergraduate program adjustment cycle is relatively long, in addition to traditional majors, 'micro-majors' or 'modules' should be flexibly introduced into the curriculum, and their content should include big data analysis, industrial software applications, etc. After graduation, students will be awarded a certificate for the micro-major they studied, which can meet the digital skill requirements of enterprises.

Deeply promote the integration of industry and education, and fully implement a comprehensive "industry mentor + academic mentor" dual-mentor system. Senior engineers from enterprises should be appointed as part-time lecturers to participate deeply in final-year projects and practical training courses. Through the way of "enterprises proposing problems, students solving problems, and dual mentors guiding problems", the engineering projects from enterprises in the real world are transformed into teaching cases, so as to reduce the time for students to bridge the gap from "academics" to "professionals".

6.3 Regional Coordination: Enhancing the construction of Yangtze River Delta Regional Talent Attractiveness Evaluation System and Talent Mobility Mechanism.

The government should not only focus on one-dimensional talent subsidies, but also optimize the environment of talent development “ecosystem”, establish a scientific “Regional Talent Attraction Evaluation System”, and regularly release the list of rare manufacturing talents and salary guidelines to guide market expectations. At the policy level, in addition to hardware support such as housing subsidies and talent apartments, due consideration should be given to solving the soft needs of young talents such as social networking and children’s education, so as to create a livable place that unites industry, city and people, which can alleviate graduates’ worries about their future.

Break down institutional obstacles to build a Yangtze River Delta Manufacturing Talent Alliance to achieve recognition of academic qualifications and cross-enterprise and -sector recognition of professional titles and social security benefits.

Strengthen construction in areas such as evaluation of professional titles in a special channel for frontline engineering and technical personnel in the manufacturing industry and avoiding a reliance on publication records, so as to give full play to the value of contributions made by these workers to engineering practice and raise the social status and honour of manufacturing talent and make the manufacturing industry more attractive to talent.

7. Conclusion

The problem of structural imbalances in employment in the manufacturing industry is a growing pain that must inevitably be experienced during the period of industrial transformation and upgrading, and the challenge that is extremely acute and which higher education reform must promptly tackle. This paper develops an analytical framework, which is dynamic in view of the supply-demand fit, The results indicate that the digital transformation has induced a wholesomely new job requirements in the manufacturing sector towards composite skills that includes digital skills, engineering technology and overall literacy. Nonetheless, the talent development system within the higher education sector is far behind in the disciplinary formulation, development of skills and career orientation. This imbalance between the rate of development and competency demands on the supply and demand sides has eventually led to structural contradiction in which university graduates encounter problems in securing jobs whilst manufacturing firms encounter problems in hiring employees. To address this paradox, one has to give up the classical model of supply and demand matching in the market and put into place a data-driven dynamic matching mechanism of supply and demand. The technological empowerment, innovation in the education mechanism, and collaboration across the region can provide the exact match between supply and demand. In particular, a job matching platform based on AI can be created to increase efficiency in harnessing talent to fit job openings. Through micro-specialisations and the dual-mentor model, integration of industry and education would be enhanced further to enhance digital capabilities of students and their engineering practice skills. At the same time, the rationalisation of the regional industrial

ecosystem and the overall attractiveness of manufacturing careers would encourage active interaction between the supply of university talent and the needs of the manufacturing industry on various levels, which would allow to overcome the structural employment crisis.

The research offers a new analytical model of how talent supply and demand in the manufacturing industry are related to the digital transformation. Its results and the policy recommendations are practical guidelines to the universities wishing to reform the talent cultivation models and optimise the programme and curriculum design as well as offer a theoretical base to governments in developing policies on the recruitment and development of manufacturing talent and regional talent mobility. It has a great practical value in terms of the high-quality employment of university graduates and the digital and intelligent transformation, the high-quality development of the manufacturing sector. Meanwhile, this research has some limitations. Future studies might include generalising the results to the entire nation or even various industrial regions to determine the validity of the results; more extensive data on employment and corporate recruiting might be included to run more detailed quantitative software; and the dynamic supply-demand matching model may be improved. Moreover, with the integration of Geographic Information System (GIS) technology to map the regional distribution of talent mobility, more accurate data support and decision-making sources could be offered on how regional policies of talent mobility should be developed and how industrial development planning should be optimised.

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