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Research on the Adaptive Path of Multi-dimensional Resources and Job Demands for Adult Continuing Education in the Digitally-Transformed Automobile Aftermarket

Shuai Leng *

School of Traffic Engineering, Changchun Automobile Vocational and Technical University, Changchun, Jilin, 130013, China
*** Corresponding author:** Shuai Leng

Abstract: In the context of the transformation of the Chinese automobile industry towards electrification, intellectualization and digitization, the post-Jongchun automobile city is rebuilding the structure and capability standards of the post-market. Continuing adult education is aimed at improving the skills of in-service practitioners. However, there are still significant supply and demand imbalances, such as outdated curricula, outdated training institutions, insufficient capacity of digital teachers and weak collaborative governance. The study is aimed at the post-Jongchun automobile market, using resource theory, human capital theory, precise supply theory. The analysis covered six dimensions of the curriculum, teaching staff, training practices, digital platforms and certification cooperation mechanisms to clarify the current supply and demand situation. Establishment of an educational system for government-industry-university-enterprise cooperation, the formation of a comprehensive curriculum system of post-course-competition-certificate, the training of digitalized dual-energy teachers, the introduction of a flexible mix of teaching and the improvement of a multi-dimensional system of evaluation and safeguards. The findings of this paper are of practical value for the development of an integrated pool of highly skilled people and for the promotion of quality development in the region ' s automobile industry.

Keywords: Automobile Aftermarket; Digital Transformation; Adult Continuing Education; Multi-dimensional Educational Resources; Supply-Demand Adaptation; Entropy-weight TOPSIS.

1. Introduction

1.1. Research Background

The Chinese automobile industry has entered a new era of electrification, intellectualization and networking. The after-sale of cars, which are the core support, has been recast digitally. Traditional enterprises, mainly for mechanical maintenance and routine maintenance, have contracted, new energy vehicles have been overhauled, smart connection systems have been calibrated and digital customer operations have risen, and new requirements have been put on the staff.

As the birthplace of the Chinese automobile industry, Changchun exaggerated the leadership of the FAW group, the entire industrial cluster of the Hungch brand. Local after-sales include maintenance, parts circulation, second-hand car sales and digital after-sale services. The supply model of continuing education for local adults employed after the market is still widespread. Common problems include slow curricula, poor training equipment and inadequate cooperation between business schools, resulting in mismatches between the supply of talent and the structure of industrial job requirements. The national Jilin policy emphasizes the need for precise matching of vocational education and industrial requirements and the need to optimize resources for continuing education. It would therefore be useful to know how continuing adult education could be matched with after-car salesmen in the long spring [1].

1.2. Literature Review

To date, research in the country has focused mainly on the reform of human training in full-time vocational education, and specialized research in adult continuing education for amateurs remains low. Most of the existing analyses look at curriculum development from a single perspective and do not systematically organize the resources involved - teachers, practical training facilities and collaborative measures. From a methodological point of view, qualitative descriptions and empirical summaries dominate, while empirical quantitative measurements of how supply adapts to demand remain very weak. There are also fewer regional studies of traditional auto manufacturing centres such as Changchun. As a result, few operational research results combine local lead enterprises with vocational school resources, and little support is given to optimizing local talent training.

1.3. Research Ideas and Innovations

This paper has developed a four-stage framework for analysis from demand identification and supply analysis to adaptation measurement, institutional design and path optimization. The Changchun University of Automobile Profession and Technology is considered as a practical carrier, and the Entropy-Wenty TOPSIS model is used for quantitative empirical analysis. These innovations are reflected in three areas: first, the regional dimension of the study fills a specific research gap in the post-Spring city of the digital transition; Second, the analytical framework covers six resource levels, using quantitative models to improve the objectivity of research; Thirdly, an optimisation path based on the practice of local vocational colleges is highly implementable to the regional industrial environment.

2. Core Concepts and Theoretical Foundations

2.1. Core Concepts

The digitalization of automobiles is a deep integration of digital technology and after-sale service enterprises, supported by large data, physical networking, artificial intelligence, re-establishing service workflows, advancing intelligence failure diagnosis, digital supply chain management, and fine customer service.

The present document on continuing education for adults is a vocational training in academic continuing education for employed employees in the post-Jongchun Automobile city. It is characterized by employment property, practical orientation, and sporadic learning, which differs from full-time vocational training.

The multidimensional resources are the total resources for quality continuing adult education. It covers six basic areas: courses, teaching staff, practical training conditions, digital learning platforms, professional certificate assessment systems and government-industry-university-business cooperation mechanisms. Compatibility to work is defined as a high degree of consistency between educational knowledge and competencies and those required to work in order to achieve an accurate matching of work capacities[2] .

2.2. Theoretical Foundations

The human capital theory and the emphasis on education and training are the most basic ways to increase individual labour productivity. The digital transition has accelerated the depreciation of skills, and formal adult continuing education is necessary to keep staff up to new job requirements.

Resource-based theory and emphasis on systemic efficiency through the integration and optimization of allocated resources provide theoretical support for reconstruction and the quality of multidimensional continuing education resources.

Accurate supply arguments favour demand-driven education as a substitute for a wide range of supplies, with precise matching of resources and industry needs, are the core theoretical basis for addressing supply and demand. The theory of lifelong learning and back-curve-competition-certificate integration further refines the theoretical basis of the study.

3. Job Demand Characteristics of the Changchun Automotive Aftermarket in the Digital Transformation Era

3.1. Industrial Development Status

Changchun has benefited from the major local automobile industry, with a large and complete car after-sale and a large number of practitioners. Following the firm establishment of the NEV industry, the specialized company for the repair of domestic motor vehicles has continued to be contracted. The commissioning and digitalization of new energy triple maintenance and smart connectivity systems have become high demand industries. Digital failure diagnosis, online customer management and so on are becoming industry norms, driving a shift in talent demand from traditional machine repair to complex digital skills.

3.2. Post Structure and Competency Requirements

Significant changes in post structure. The reduction in the proportion of traditional mechanical maintenance posts highlights three new post clusters: maintenance of new energy vehicles, operation and maintenance of smart connectivity systems, and operation of digital services. Develop a three-dimensional competency system for practitioners.

In terms of knowledge, the focus is on three-power technology for new energy vehicles, the rationale for on-board intelligent connectivity, digital diagnostic techniques and industrial safety rules. In terms of skills, what is important is practical capabilities, such as three power system failure, smart sensor calibration, trouble data analysis and digital customer service management. With regard to literacy, digital literacy, learning autonomy, responsibility for safety and teamwork are highly valued by local enterprises.

4. Supply Status and Dilemmas of Adult Continuing Education Resources in Changchun

4.1. Overall Supply Pattern

There are a number of providers in the local adult continuing education market: vocational colleges, trade associations, in-company training centres and private training institutions. The Changchun Automotive University is the main provider of academic and educational skills training. FAWCO and Hongqi after-sales training centres provide services for in-house training at companies, and industry associations and private institutions provide short-term intensive skills training. However, these suppliers work essentially independently. Educational resources are still fragmented and there is no unified plan, and therefore no coherent area for the continuation of educational service ecosystems.

4.2. Dilemmas of Multi-dimensional Resource Supply

Most of the existing teaching content is still focused on mechanical maintenance of fuel vehicles, and new energy vehicles, intelligently connected vehicles and digital operations are inadequate. Modularization and project-oriented design are imperfect and there are virtually no locally appropriate FAW Jiefang model courses[3] . The slow pace of curriculum updating has not kept pace with technological changes in the industry, resulting in a clear gap between the actual needs of the trainees and the actual needs of the job.

Unbalanced team of teachers. Full-time university teachers have extensive experience with traditional motor technology, but are not systematically exposed to new energy sources and intelligent connections. Part-time instructors recruited from the company have solid experience, but without training in a systematic teaching programme, it is difficult to establish a stable team of teachers with a high turnover rate [4].

This is the most acute question. Most of the training equipment is for fuel vehicles, while the calibration facilities for batteries, engines and ECU overhauls and intelligent connections are seriously inadequate. The virtual simulation platform is slow, and the company ' s advanced training resources are rarely available for continuing education participants, thus limiting their opportunities to practice.

The availability of digital learning platforms is mainly on-

demand theory-course replay. Dispersed adult learning is appropriate for micro-learning and virtual simulation cases are insufficient. Lack of monitoring of learning processes and individual learning support functions. It does not achieve a dynamic tracking of trainees ' training[5] .

The content of the assessment of vocational certificates is still common, there are no norms governing the evaluation of jobs at the end of the local market, and some social certificates are not highly recognized in industry.

Inadequate collaboration hinders the development of talent. At present, school-business cooperation is largely at the framework agreement level, and in-depth cooperation in curriculum development, teacher development and sharing of training resources is rare, and the implementation of a flexible education system that is not suitable for the alternation of work and learning of adult learners exacerbates the mismatch between supply and demand.

4.3. Summary of Core Problems

The bottom line is the mismatch between supply and demand. Educational resources are fragmented rather than centralized. There is no mechanism to update the requirements with technological changes in the industry, and there is no supply system solely for work needs. Similarly, teaching methods, assessment systems and support schemes lag behind industrial transformation and adult students. Together, these constraints impede the role of local adult education in labour force upgrading[6] .

5. Empirical Analysis on Adaptation Degree between Continuing-education Resources and Job Demands

5.1. Construction of Evaluation Indicator System

We have designed a two-dimensional system of indicators covering both supply and demand. Demand component, we design three levels: knowledge, skills and expertise; Twelve Level 2 to understand the main working capacity of the post-car city. In the supply component, we have established 6 levels I: curricula, teaching staff, practical training, digital platforms, accreditation resources, cooperation mechanisms and 11 levels II to explain the characteristics of the existing educational resources at the current level. En weighting is used to allocate objective weights and then to calculate the degree of convergence between supply and demand through TOPSIS.

Table 1. Indicator System for Job Demands and Entropy Weight Determination

Primary indicator	Secondary indicator	Entropy weight
Knowledge demand	New-energy vehicle three-electric knowledge	0.18
	Intelligent-connected on-board system knowledge	0.22
	Digital diagnosis and big-data knowledge	0.15
	Safety specifications and laws & regulations	0.12
Skill demand	Three-electric detection and maintenance skill	0.20
	Intelligent diagnostic-equipment operation skill	0.19
	Fault-data reading and analysis skill	0.16
	Digital service and operation skill	0.14
Literacy demand	Digital literacy and autonomous-learning capability	0.17
	Safety responsibility and quality awareness	0.15
	Communication, cooperation and service literacy	0.13
	Craftsman spirit and innovation awareness	0.12

Table 2. Availability of resources for continuing education - indicator system and Entropy weight

Primary indicator	Secondary indicator	Entropy weight
Curriculum resource	Content matching job requirements	0.19
	Modularization and practical-oriented level	0.17
Teaching-staff resource	Proportion of dual-qualified teachers	0.16
	Enterprise practice experience and digital capability	0.15
Practical-training resource	New-energy & intelligent-connected training equipment	0.21
	Virtual-simulation training conditions	0.14
Platform resource	Convenience of online learning	0.13
	Systematization and update speed of resources	0.12
Certificate resource	Connection with vocational-skill grade certificates	0.11
Mechanism resource	School-enterprise collaboration and work-study alternation	0.20

5.2. Calculation Results and Cause Analysis

The degree of alignment from the calculations is shown in table 3.

Table 3. Results of the Supply–Demand Coupling Coordination Degree Assessment

Evaluation item	Value / Grade
Coupling coordination degree	0.48
Evaluation grade	Moderate maladjustment
Resource bottleneck ranking	Practical training resource < Curriculum resource < Teaching-staff resource < Platform resource < Certificate resource < Collaborative mechanism resource

The overall alignment is 0.48, leaving the system at a moderate level of imbalance. The knowledge and skills provided for routine vehicle maintenance are relatively abundant, while the resources for new energy vehicles, intelligent network vehicle diagnostics and digital operations are severely inadequate. Practical training, training and teaching staff are the greatest obstacles to the quality of training.

There are three reasons for this moderate inequality. First, there is a lack of a systematic mechanism to determine employment opportunities, so providers of continuing education are unable to track changes in the capacity required for subsequent jobs in the local market, and thus supply lags behind. Second, the investment structure of resources is distorted: capital flows to traditional rather than new technologies, to classrooms rather than to practice. The third reason is that governance among stakeholders remains inadequate. The resources available to Governments, industries, enterprises and colleges have not been effectively integrated to establish, share or monitor continuous mechanisms for quality[7] .

6. Construction of Multi-dimensional Resource Adaptation Mechanism and Optimization Paths

6.1. Five-in-one Closed-loop Adaptation Mechanism

To adapt to the mismatch between supply and demand, we have developed a five-part comprehensive closed adaptation mechanism. Using the resources available at the Changchun Automotive University and working with the FAW and other local leading enterprises (including its Hungqi, Jiefang), it has five related components:

i. Precision of demand management in the introduction: regular implementation of regional outpost studies and real-time updating of job competency maps.

Two. National multi-dimensional resource integration: integration courses, teachers, college training resources and company sharing techniques, positions, certification of resources.

Three dynamic pedagogical reconstructions: updating of modules based on industrial technology.

Four closed-circuit evaluations of the joint school-enterprise evaluation system to provide feedback training for excellence.

5. Five. Conditions of support: Funding and institutional support for maintenance of the region ' s adult continuing education ecosystem.

6.2. Specific Optimization Paths

6.2.1. Build Government-industry-university-enterprise Collaborative Education System

Launching of the Union of Continuing Education Colleges in the Automobile Industry of Jilin Province, Association of Automotive Maintenance Industries, after-sales service centres in local leading enterprises. Create a regional shared resource repository and provide customized courses for local after-sale maintenance of new energy vehicles. The Academy Virtual Simulation and New Energy Training Centre is available to Alliance members. Implementation of a two-way teacher exchange programme: College teachers hold temporary positions at companies and company technical specialists at universities. Establish a uniform regional quality standard for continuing education training, focusing on the adaptation of the curriculum, the results of training and the rate of selection[8] .

6.2.2. Reconstruct Post-curriculum-competition-Certificate Integrated Curriculum System

Targeting of three local post clusters (new energy maintenance, smart connection maintenance, digital operation) and development of modular and project-based practical courses. The requirements for the evaluation of vocational skills have been incorporated into the curriculum, and practical training materials for pine leaf have been compiled. Establishment of a new energy vehicle repair module, an intelligent connection teaching module, focusing on the Hongch New Energy Three Major Repairs, covering on-board network detection and sensor calibration, and a digital operating module involving large vehicle data. Integration of industrial skills competitions into daily teaching and learning in competitions.

6.2.3. Cultivate Digital-oriented Dual-qualified Teaching Staff

Launching of a special promotion programme for “twinish” teachers and organizing systematic training for teachers in schools on new energy sources, smart interconnection techniques and digital teaching; Implementation of a policy of business practice for professional teachers, establishment of standardized access for part-time teachers in enterprises, training and evaluation systems, upgrading of teaching capacities of teachers, establishment of joint school-enterprise teaching and research platforms, joint development of teaching cases, implementation of training programmes and materials.

6.2.4. Innovate Flexible Blended Teaching Mode to Ease Work-study Conflicts

For working adult learners, there are mixed models, i.e. a combination of online microlearning and offline block training, which alternate work and learning. The key knowledge points are refined into micro-lecture resources for mobile research. Practical training takes place either at weekends or monthly stages. Virtual simulations are used for training missions that are high-risk or costly in the physical environment. The flexible learning system enables trainees to adapt their learning schedules to their work commitments.

6.2.5. Improve Multi-dimensional Evaluation and Guarantee System

Establish integrated school-business collaborative

assessment mechanisms, including process and outcome assessments. Data on learning time and course completion and useful training performance are collected from digital platforms to assess the process. Theoretical knowledge testing, skills testing and the evaluation of results of the enterprise ' s on-the-job performance as part of the outcome assessment. Establishment of a visual quality monitoring platform with a joint school-enterprise monitoring team to achieve quality improvements in closed circuits. Strengthening financial and system security: establishment of specific funds to upgrade training equipment, digital resources and teacher capacity-building; Establishment of incentives and improvement mechanisms for quality management of teaching.

7. Conclusion and Prospects

The digital transformation is reshaping post-spring demand for staff, digital technology, and talent in many disciplines. Currently, there is still a slight change in the work and needs of adult continuing education resources on the ground. Practical training and curricula and teachers are the main weaknesses. Fragmentation of resources, inadequate multi-party cooperation and the absence of dynamic trajectories have led to education lagging behind industrial technological upgrading. The paper proposes a five-to-one closed-circuit retrofit and five concrete optimization paths, using the Long Spring Air Professional University as a practical carrier. This could provide a viable solution to the structural supply-demand gap and contribute to improving staff capacity in the post-employment market.

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