CULTIVATING GREEN MARKETING TALENT IN VOCATIONAL COLLEGES FOR THE NET-ZERO TRANSITION: AN AI-ENABLED COMPETENCY FRAMEWORK AND DEVELOPMENT PATHWAY

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Abstract: Against the dual backdrop of China's "carbon peaking–carbon neutrality" strategy and the accelerating global net-zero transition, green marketing has shifted from a peripheral competitive instrument to a core mechanism for value creation and sustainable transformation. This shift calls for a new type of "green + intelligent" talent in vocational education—graduates who combine ecological literacy with data-driven and AI-enabled marketing capabilities. Drawing on competency-based education (CBE), ecological literacy, and AI-empowered education, this study reviews relevant international and domestic research and policy practices and maps them onto authentic job tasks and situational demands in green marketing roles. We develop a three-tier, five-dimensional competency framework (foundational–intelligent–innovative) and propose an end-to-end development pathway in which AI is embedded across curriculum design, practice-based training, assessment, and employment alignment. The framework comprises five dimensions: (1) green cognition and ecological literacy, (2) industry fundamentals and market adaptability, (3) AI/digital technology application, (4) cross-boundary collaboration and communication, and (5) innovative practice and sustainable development. It positions ecological literacy as the value foundation, AI as the technical engine, and lifelong learning as the growth trajectory, forming a closed loop of "task scenarios–competency progression–assessment feedback." For implementation, the paper proposes an integrated scheme consisting of curriculum restructuring and interdisciplinary projects, intelligent learning and virtual simulation-based training, industry–education collaboration and job alignment, whole-process intelligent assessment and digital portfolios, and continuous learning with governance optimization. The proposed framework and pathway provide actionable guidance for vocational colleges in curriculum development, training-base construction, industry–education integration, and competency assessment, thereby supporting the supply and quality improvement of green marketing talent for the net-zero transition.
Keywords: Net-zero transition; Green marketing talent; AI empowerment; Competency framework; Talent development pathway

1 INTRODUCTION

Global climate change and mounting constraints on resources and the environment have intensified in recent years, pushing "carbon peaking" and "carbon neutrality" to the forefront of the global sustainable development agenda. China has set explicit targets to peak carbon emissions before 2030 and achieve carbon neutrality before 2060, establishing "green and low-carbon" development as a central principle for economic transformation and industrial upgrading. Under these conditions, the net-zero transition has become an irreversible macro trend. Corporate competitiveness is increasingly defined not only by efficiency but also by sustainability capabilities that incorporate environmental performance; environmental, social, and governance (ESG) performance is becoming a salient yardstick for firm value.

Accordingly, marketing activities are no longer confined to facilitating transactions. They are expected to steer sustainable consumption, communicate green brand commitments, and operationalize corporate environmental responsibility. As an effective vehicle for advancing corporate green transformation and innovating green business models, green marketing has made the urgency of professional talent development increasingly evident. Meanwhile, the rapid rise of next-generation technologies such as artificial intelligence (AI) and big data is reshaping green marketing practices and raising competency requirements: practitioners are expected to integrate ecological literacy with digital and intelligent capabilities.

As the primary channel for supplying high-quality technical and skilled talent, vocational colleges have, in recent years, actively explored green marketing talent development from multiple angles—curricular reform, digital-technology enablement, deepened industry–education integration, and training-base construction—thereby providing important human-capital support for the green economy and industrial upgrading. Nonetheless, current practice faces substantial challenges. On the one hand, curriculum structures and teaching content often lag behind fast-evolving industry needs; under the net-zero imperative, new themes such as green concepts, carbon management knowledge, and ESG communication have not been sufficiently integrated, and students' overall ecological literacy remains in need of improvement. On the other hand, the integration of data intelligence into training remains limited, and responses to the digital-technology revolution—especially AI—are not timely enough. In scenarios where AI can empower environmental public-opinion analysis, generate personalized green marketing content, or optimize communication

along low-carbon supply chains, training designs tend to be narrow and fail to simulate the complex business environments in which AI is deeply embedded. As a result, the development of students' practical competencies and innovative thinking is constrained. These challenges expose a pronounced mismatch between talent-development systems and rapidly iterating industry demands. The persistent "theory–practice gap" leaves graduates' competency structures misaligned with the real requirements of green and intelligent transformation, making the improvement of both ecological and data literacy increasingly urgent.

Against this backdrop, the present study addresses a central question: in response to national strategies and industry demands associated with the net-zero transition, how should vocational colleges construct a new marketing competency framework that integrates ecological literacy with AI-related skills, and how can they systematically design an innovative development pathway in which AI provides end-to-end empowerment? To answer this question, the paper situates its inquiry in the strategic context of the net-zero transition, synthesizes relevant domestic and international scholarship, and—grounded in competency-based education, ecological literacy, and AI-empowered education—derives a "three-tier, five-dimensional" competency structure. It further proposes an integrated development scheme spanning curriculum, training, assessment, and collaboration, aiming to advance the practical adoption of a "green + intelligent" talent-development model. Ultimately, this work seeks to strengthen vocational colleges' capacity to support industrial green development and corporate net-zero transformation, thereby contributing to China's green economic transition and the high-quality development of vocational education.

2 LITERATURE REVIEW

2.1 Demand for Green Marketing Talent in the Context of the Net-Zero Transition

Escalating climate change is compelling economies worldwide to accelerate transitions toward net-zero emissions, with the green economy evolving from a conceptual aspiration to a systemic reconfiguration across policy and industrial practice. In this context, effective corporate green transformation depends on robust talent support—especially interdisciplinary green marketing professionals who can translate sustainability goals into market value propositions and implement them across products, communications, and channels [1-2]. Research indicates that systematic green marketing can strengthen competitive advantage and business performance, yet it requires environmental considerations to be embedded deeply into the marketing mix (4Ps) and supported by verifiable evidence and data [3].

Consequently, green marketing talent for the carbon-neutral era must demonstrate clear advances across three categories of competency. First is environmental and carbon literacy, including an understanding of life-cycle assessment and emissions reduction along value chains [4]. Second is data and digital-tool capability, encompassing the application of big data analytics and AI to green segmentation, demand forecasting, and compliance in content and claims [5-7]. Third is value co-creation capability oriented toward circular economy and low-carbon innovation—namely, the ability to transform circular design, servitization, and closed-loop recycling into customer value that is perceivable, comparable, and purchasable [8]. Accordingly, higher education should place "key sustainability competencies" at the core, foreground ecological civilization and green core literacy, and strengthen cross-disciplinary curricula and practice-driven training scenarios to better support the consumer market's shift toward low-carbon and green choices [2,9].

2.2 The Influence of AI on Marketing Talent Development

AI has become increasingly embedded in vocational education, reshaping teaching and assessment and providing scalable technical foundations for integrated "smart classrooms–adaptive learning–digital training." Evidence suggests that personalized interventions based on intelligent tutoring and learning analytics can significantly improve learning outcomes and problem-solving performance, especially in domains where skills iterate rapidly [10-12]. In practice-oriented instruction, virtual simulation and immersive environments can enhance presence and engagement [13].

For marketing talent development, AI not only transforms firms' value-creation chains and toolchains—enabling new approaches from customer insight, segmentation, and pricing to content generation and automated outreach—but also reshapes job competency structures. Curricula therefore need to evolve from "tool operation" toward a composite competency framework emphasizing human–AI collaboration, intelligent analysis, and data-driven decision-making. This shift places greater weight on data literacy, causal inference, model interpretability, and implementation in business scenarios [14-15]. In addition, China's national policy initiatives (e.g., the Action Plan for Artificial Intelligence Innovation in Higher Education) provide institutional levers and implementation pathways for AI-enabled talent development, accelerating supply-side reform in emerging areas such as green marketing.

2.3 Pathways for Constructing a Green Marketing Competency Framework

Scholars generally argue that green marketing talent should possess interdisciplinary knowledge, ethical responsibility, and innovative marketing thinking. For competency framework construction, research recommends using key sustainability competencies as the foundation and coupling them with the practical logic of green marketing, thereby forming a four-dimensional structure that integrates "environment and sustainability knowledge–green marketing

skills–green values and ethics–communication, collaboration, and cross-boundary co-creation." Typical dimensions include environmental knowledge, green skills, value ethics, and cross-boundary collaboration [2,16].

From a marketing-specific standpoint, the "green marketing orientation" framework can be leveraged to translate abstract sustainability literacy into operational competency elements relevant to job performance [3,16-18]. A commonly suggested method is a four-step approach—"standards–jobs–courses–assessment"—including: anchoring standards by mapping key tasks to occupational standards; aligning courses by embedding modules such as life-cycle assessment, green compliance, and behavior change; implementing evidence-based assessment using situational tasks and anti-greenwashing checklists; and enabling iterative mechanisms through industry–education collaboration to keep competencies dynamically updated [17,19]. Such iterative updating mechanisms are essential for meeting net-zero transition talent needs.

2.4 Exploring Innovative Pathways for Green Marketing Talent Development

In an era where the net-zero transition and digitalization advance simultaneously, green marketing talent development needs systemic innovation across four stages: "industry–education collaboration, contextualized learning, standards-based assessment, and continuous credentialing." With key sustainability competencies as the main thread, curricula and practice should be constructively aligned so that systems thinking, normative judgment, strategic action, and cross-boundary collaboration are operationalized into executable tasks within marketing contexts [2,16-17]. Pedagogically, work-process orientation and project-based learning can bring real corporate data and business scenarios (e.g., product carbon footprint accounting) into classrooms and training. For high-risk or high-cost contexts, virtual simulation and immersive environments can be used to improve training efficiency [13,18].

With respect to assessment and certification, studies advocate building authenticity-based assessment systems aligned with industry standards, while exploring micro-credentials and mutual recognition mechanisms in collaboration with firms and industry associations to enhance the transferability of learning outcomes to employability [20-21]. At the same time, AI-enabled personalized learning and learning analytics can support composite competency development centered on "human–AI collaboration, intelligent analysis, and data-driven decision-making," highlighting data literacy, experimentation and causal inference, and model interpretability, while incorporating digital ethics—such as privacy protection and algorithmic bias—into curriculum design and assessment [22-24].

2.5 Summary and Research Gaps

Overall, the theoretical foundations, competency frameworks, and AI-enabled innovation pathways for green marketing talent development have become increasingly clear. Scholars broadly agree that AI technologies can catalyze upgrades in green marketing competencies, promote collaborative innovation, and support the internalization of ecological values. Nevertheless, several limitations remain: insufficient integration between competency frameworks and development pathways; inadequate coupling between AI empowerment and authentic green marketing scenarios; and a shortage of systematic research tailored to vocational colleges on cultivating "green + intelligent" composite talent.

Focusing on (1) competency framework construction for green marketing talent in the net-zero transition and (2) AI-enabled innovation in vocational talent-development pathways, this study aims to strengthen the linkage between theory and practice and to provide guidance for improving the supply and quality of green marketing talent in the context of net-zero transformation.

3   CONSTRUCTING A COMPETENCY FRAMEWORK FOR GREEN MARKETING TALENT ORIENTED TO THE NET-ZERO TRANSITION

3.1 Theoretical Foundations and Analysis of Practical Needs

3.1.1 Competency-based education and competency models
Competency-Based Education (CBE) emphasizes observable and assessable competencies as the organizing principle for redesigning learning outcomes, curricular content, and assessment standards, with the aim of improving learners' holistic performance in authentic work tasks. As a key methodological pillar of CBE, competency models structure the knowledge, skills, attitudes, and behavioral characteristics that differentiate high performers from average performers, and have become a common approach in vocational curriculum reform and occupational standards development [18-19]. In green marketing contexts, CBE requires the integration of green knowledge, marketing skills, and ethics/social responsibility into actionable competency elements, and the use of evidence-based assessment to ensure that competencies are observable and transferable [16-17].

3.1.2 Ecological literacy and key sustainability competencies
Ecological literacy emphasizes an organic unity of ecological knowledge, ecological ethics, and ecological behavior, and seeks to foster a holistic understanding of the relationship between humans and nature and responsible action through education [25-26]. In higher and vocational education, UNESCO's Education for Sustainable Development (ESD) learning objectives and the widely cited "key sustainability competencies" framework provide operational references for curriculum design and competency assessment—such as systems thinking, anticipatory competence, normative competence, strategic competence, and interpersonal/collaboration competence [2,27]. Accordingly, the competency structure for green marketing talent should embed ecological literacy into core tasks such as value

proposition design, green product/packaging design and disclosure, and compliant communication that prevents "greenwashing."

3.1.3 AI-empowered education and data/intelligent literacy

AI is bringing systemic capabilities to vocational education—precision instruction, intelligent assessment, and personalized support [28-29]. Systematic reviews show that AI applications in higher and vocational education commonly include learner profiling and early warning, intelligent tutoring and adaptive learning, automated assessment, and learning-analytics decision support, and can improve learning outcomes while optimizing resource allocation [30-31]. Meta-analytic evidence further indicates that intelligent tutoring systems are particularly effective for complex problem-solving and transfer tasks, offering repeatable and scalable pathways for skill formation and competency assessment in vocational contexts [10]. At the same time, immersive simulation can increase presence and strengthen procedural skills in high-risk or high-cost scenarios, though learning gains depend on rigorous instructional design and evidence-based scripted supports [13].

For green marketing education specifically, AI is also reshaping job competency structures: from data acquisition, cleaning, and integration to causal inference, interpretable modeling, and A/B testing optimization; and from multi-channel intelligent delivery to compliant communication. Human–AI collaboration is increasingly a core competency requirement [32-33].

3.1.4 Aligning practical needs with the competency framework

Net-zero emissions have become a central global target for addressing climate change and advancing sustainable development. Driven by China's "carbon peaking–carbon neutrality" goals and increasingly stringent global regulation, corporate green transformation is accelerating, and the market demand for interdisciplinary, composite green marketing talent is rising. Job requirements increasingly include: value proposition and product/packaging design grounded in ecological literacy; life-cycle thinking and carbon accounting aligned with ISO 14040/14044; evidence-based verification of green claims and transparent disclosure; and cross-functional and supply-chain collaboration for governance.

In response, a competency framework should integrate CBE's principles of observability and assessability with key sustainability competencies, translating them into an integrated "curriculum–training–assessment–credentialing" scheme: defining competency indicators using sustainability competency frameworks; implementing work-process-oriented, project-based learning in authentic corporate scenarios; validating transfer through authentic assessment and portfolio/quasi-experimental evidence; and maintaining ongoing alignment with industry standards via industry–education collaboration and micro-credentials [2].

3.2 Principles for Framework Construction

The competency framework for green marketing talent oriented to the net-zero transition follows four core principles:

3.2.1 Systematic integration
integrating "green" and "intelligent" requirements; horizontally combining ecology–industry–intelligence and vertically progressing from foundational to advanced to innovative competencies.

3.2.2 Task- and scenario-orientation
using authentic task scenarios such as corporate green strategy, market campaigns, and AI-assisted business processes, with a strong emphasis on applicability.

3.2.3 Operationalizability and assessability
ensuring that each competency dimension (e.g., green technical practice, data analytics, intelligent collaboration) has clear sub-indicators and assessment standards.

3.2.4 Innovation and future orientation
strengthening cross-boundary integration, digital innovation, and ecological ethics to meet emerging "green + intelligent" job demands.

3.3 Designing the Competency Dimensions

Drawing on mainstream competency models and research on green marketing and AI literacy, and considering vocational learners' development needs, this study proposes five core competency dimensions:

3.3.1 Green cognition and ecological literacy
This dimension focuses on knowledge and value identification related to ecology, carbon neutrality strategy, and sustainable development, including:
(1) the ability to identify green economy policies, regulations, and standards;
(2) corporate social responsibility awareness and ecological-ethical literacy;
(3) the ability to communicate and advocate sustainable and green consumption concepts.

3.3.2 Industry fundamentals and market adaptability
This dimension emphasizes foundational knowledge and skills for green industry chains, green branding, and green consumption demand, as well as industry sensitivity, including:
(1) innovative design and evaluation of green products and services;
(2) analysis of green consumer/market data and opportunity identification;
(3) tracking industry trends and responding to policy impacts.

3.3.3 AI/Digital technology application
This dimension highlights the application of AI in green marketing—data-driven insight, intelligent decision-making, and innovative use of digital tools, including:
(1) collecting, analyzing, and deriving intelligent insights from green marketing-related data;
(2) operating and optimizing AI marketing platforms (e.g., intelligent recommendation, customer profiling, green e-commerce platforms);
(3) applying emerging tools such as virtual simulation and intelligent interaction in scenarios and exploring innovative uses.

3.3.4 Cross-boundary collaboration and communication
This dimension integrates green thinking, AI literacy, and team innovation, focusing on collaboration and communication among multiple stakeholders (enterprises, government, NGOs), including:
(1) jointly conducting green marketing projects with diverse stakeholders (e.g., collaborative low-carbon consumption campaigns);
(2) using AI tools to support efficient communication and joint decision-making in interdisciplinary teams;
(3) international perspective and cross-cultural communication/negotiation for green projects.

3.3.5 Innovative practice and sustainable development
This dimension concerns continuous innovation and self-improvement in dynamic industry and technology environments, including:
(1) innovation in business models, products, and processes based on AI and green concepts;
(2) participation in green marketing training, corporate projects, and entrepreneurship/innovation competitions;
(3) lifelong learning, self-reflection, and autonomous competency development.

3.4 Core Connotations of AI Enablement and the Mechanism of Competency Progression

Under AI enablement, competency progression for green marketing talent is reflected in three main ways:
3.4.1 Transformation toward digitally driven decision-making
with AI, practitioners can leverage big data analytics, visualization, and predictive models to understand green consumer behavior, product preferences, and policy trends more precisely.
3.4.2 Virtualized task scenarios and multi-party collaboration
virtual simulation training, digital twins, and intelligent project-management systems provide interactive environments that are closer to real business processes and allow iterative development for both tasks and learning.
3.4.3 Upgrading competency assessment through intelligent analytics
AI-based digital portfolios, process assessment, and holistic competency profiling enhance objectivity and personalize feedback and support.

3.5 Model Articulation: A Five-Dimensional Competency Framework for Net-Zero-Oriented Green Marketing Talent

Based on the above principles and operational requirements, this study proposes a Five-Dimensional Competency Framework for Green Marketing Talent in the Net-Zero Transition. Building on CBE, the framework integrates ecological literacy, AI enablement, and lifelong learning, and is organized into three tiers and five dimensions:
Foundational tier: (1) green cognition and ecological literacy; (2) industry fundamentals and market adaptability
Intelligent tier: (3) AI/digital technology application; (4) cross-boundary collaboration and communication
Innovative tier: (5) innovative practice and sustainable development
The five dimensions mutually reinforce and form a cycle of improvement. The model positions ecological literacy as the value foundation, AI as the technical engine, and lifelong learning as the growth trajectory, thereby establishing a dynamic closed loop of "task scenarios–competency progression–assessment feedback." The framework is presented in Table 1.

Table 1 Five-Dimensional Competency Framework for Net-Zero-Oriented Green Marketing Talent

Tier	Competency dimension	Key competency indicators	Examples (illustrative)
Innovative tier	Innovative practice and sustainable development	Innovation practice based on AI and green concepts; experience in real corporate projects and social service; autonomous learning and competency self-diagnosis; professional ethics and willingness for lifelong learning	Entrepreneurship/innovation; continuous learning; practical capability
Intelligent tier	Cross-boundary collaboration and communication	Interdisciplinary teamwork; coordination and organization in multi-stakeholder green projects; efficient AI-assisted communication and expression; cross-cultural interaction and negotiation in green marketing	Teamwork; AI-supported collaboration; international communication
	AI/digital technology	Data acquisition and analytics for green marketing; operation of AI tools and platforms; use of	Data analysis; AI tool use; content creation

Tier	Competency dimension	Key competency indicators	Examples (illustrative)
Foundational tier	application	recommendation and customer profiling methods; creation of digital marketing content and virtual simulation capability	
	Industry fundamentals and market adaptability	Green product/service development; sensitivity to industry trends and green market data; green brand and communication strategy planning; policy environment analysis and response	Green products; market sensitivity; brand planning
	Green cognition and ecological literacy	Understanding of carbon peaking/carbon neutrality policy; identification of environmental regulations and green standards; ecological ethics and CSR; communication of green consumption and sustainable development concepts	Carbon-neutrality knowledge; ecological ethics; regulations/standards

4 INNOVATION IN THE AI-ENABLED DEVELOPMENT PATHWAY FOR GREEN MARKETING TALENT IN VOCATIONAL COLLEGES

This study proposes a systematic talent-development pathway driven by the five-dimensional competencies and enabled by AI across the full chain—focusing on curriculum restructuring, intelligent platforms and training, industry–education integration, assessment optimization, and continuous growth—to build a vocational green marketing development model characterized by "green + intelligent," integration of knowledge and action, and continuous improvement. This pathway aims to address persistent bottlenecks such as "skill silos" and "outdated knowledge," and to respond to the dual demands of green transformation and an intelligent society.

4.1 Practical Challenges and the Need for Developmental Reform

As the global net-zero transition accelerates, demand for green marketing talent becomes more specialized and composite. As a key platform serving local industries and emerging sectors, vocational colleges face deep-rooted issues in green marketing talent development: lagging training objectives, fragmented competencies, and a persistent split between theory and practice. The penetration of AI technologies offers a new opportunity to break these constraints. AI is not merely a tool; it is an engine that can reshape educational content, processes, and models, enabling systematic innovation in vocational green marketing talent-development pathways.

4.2 AI-Enabled Restructuring of the Curriculum System

4.2.1 Digital and intelligent upgrading of curriculum content
With "green + intelligent" as the guiding orientation, vocational colleges should move beyond single-track theoretical instruction and systematically integrate frontier elements such as AI, data analytics, and green decision simulations into green marketing curricula. Example modules may include "AI-driven market research and consumer insight" and "recommendation systems and green product marketing." Such designs both deliver green domain knowledge and strengthen hands-on big-data and digital skills. AI can also support dynamic updates of curriculum content to keep pace with industry demand—an essential mechanism for curriculum construction.

4.2.2 Interdisciplinary integrated courses and project-based learning
Green marketing should be integrated with AI, sustainability management, environmental law, and related fields to develop interdisciplinary integrated courses. Project-based learning can organize authentic corporate green marketing tasks in which AI modeling, data insight generation, and green communication skills are cultivated holistically through team projects. This approach mitigates the problem that fragmented knowledge cannot be readily translated into integrated competencies.

4.3 Innovation in intelligent teaching platforms and training systems

4.3.1 Personalized instruction via AI-supported learning platforms
By leveraging AI-enabled learning analytics and intelligent recommendation, vocational colleges can implement differentiated and customized instruction. Platforms can push personalized learning paths and resource packages based on students' ecological literacy, digital skills, and interests, supporting both remediation of weaknesses and development of potential. In addition, process assessment and intelligent feedback based on learning data can enhance the adaptability and closure of the "teaching–learning–assessment" loop.

4.3.2 Virtual simulation and enterprise-grade training base construction
Colleges can develop virtual simulation platforms for green marketing and AI-driven scenario simulation systems that allow students to operate within projects such as "net-zero product launch" and "intelligent green e-commerce." Through human–AI interaction, data simulation, and AI scenario reasoning, students can practice cross-boundary problem solving and innovation as required in real jobs. In parallel, colleges and enterprises can co-build intelligent training bases that integrate real green marketing projects and AI tools into campus training, thereby promoting the integration of knowledge and practice.

4.4 School–Enterprise Collaboration and Deep Industry–Education Integration Mechanisms

4.4.1 Industry demand as a driver for rapid upgrading of courses and competency structures
Through joint research, co-training agreements, co-development of courses, and the creation of education communities, vocational colleges can ensure that green marketing talent development is aligned with real needs in the green economy and intelligent transformation. Mechanisms such as industry mentor pools, enterprise case repositories, and job competency lists can be established to promote "dual alignment" between curriculum and competency standards.

4.4.2 Multi-party collaborative education models enabled by AI
A "dual-cycle" collaboration model can be strengthened: colleges focus on theoretical foundations and literacy development, while enterprises lead AI practice training and incubation of real projects. AI mentors and corporate executives responsible for green transformation can be introduced to co-teach and co-supervise projects, forming an ecosystem in which teachers, students, enterprises, and AI tools co-develop. Expanded internships and exchanges in green enterprises can further enhance students' collaborative innovation capabilities across cultures and ecosystems.

4.5 Intelligent Competency Assessment and Growth Feedback Systems

4.5.1 Whole-process intelligent competency assessment
Using AI and intelligent assessment systems, colleges can implement "holistic tracking" of student competencies: collecting and analyzing process data, conducting intelligent tests at key competency milestones, and generating dynamic digital portfolios. This can improve the efficiency and accuracy of identifying students' growth in ecological cognition, AI tool application, collaboration, and innovation, enabling a closed loop that links selection, instruction, learning, and assessment.

4.5.2 Multi-stakeholder assessment and feedback
By integrating enterprise evaluations, AI-supported peer review, and self-assessment, colleges can conduct multidimensional assessments of students' green marketing competence, AI application skills, and innovation/entrepreneurship literacy. Data-driven assessment reports can be used to adjust curriculum content, training strategies, and individualized development plans in a timely manner.

4.6 Continuous Optimization and Dynamic Innovation Mechanisms

4.6.1 A joint improvement mechanism combining intelligent monitoring and expert governance
An AI-based dynamic monitoring system can be established to periodically track the effectiveness of implementing the competency framework and development pathway. An expert committee comprising industry experts, experienced faculty, and AI consultants can conduct cyclical reviews and optimizations to ensure coordinated upgrading of AI enablement and ecological literacy.

4.6.2 Continuous learning and support systems for competency progression
A "lifelong growth service" supported by AI recommendations and personalized tutoring can help graduates continuously update green marketing knowledge, AI tools, and emerging industry technologies, thereby cultivating self-driven, adaptive green innovation talent.

5   CONCLUSION

The green and low-carbon transition represented by "carbon peaking" and "carbon neutrality" is reshaping global economic governance and industrial structures, and it demands a new generation of green marketing talent that is more specialized, composite, and intelligent. In response to complex and rapidly changing industry ecosystems and technological environments, how vocational colleges can effectively address these challenges and leverage AI enablement has become a pivotal issue for upgrading vocational education in China and beyond.

From a perspective that integrates theory and practice, this paper constructs a competency framework for green marketing talent oriented to the net-zero transition. It identifies five core competency dimensions—green cognition and ecological literacy; industry fundamentals and market adaptability; AI/digital technology application; cross-boundary collaboration and communication; and innovative practice and sustainable development—and further specifies key competency indicators, providing a scientific and operational model for talent development.

In terms of pathway innovation, the paper proposes a systematic reform route characterized by AI as the engine, five-dimensional competencies as the core, and deep industry–education integration as the guarantee, including:

(1) restructuring curricula around the "green + intelligent" value orientation and deepening the integration of interdisciplinary learning and project-based teaching;

(2) leveraging smart learning platforms and virtual simulation training bases to enable personalized learning and competency progression driven by authentic tasks;

(3) deepening collaboration with enterprises and industry to strengthen job alignment and enhance practical competencies and AI application capabilities in green transformation;

(4) introducing whole-process intelligent assessment and growth feedback systems to support scientific multi-competency evaluation and continuous optimization.

These measures address the long-standing fragmentation in vocational education where "knowledge–skills–application" are separated and lack an integrated closed loop, and they enhance both occupational competence and sustainable development potential for green marketing graduates.

The theoretical contributions of this study include: (1) integrating ecological literacy, intelligent technology, industry demand, and innovative practice into a unified model, thereby enriching competency modeling for green marketing talent; and (2) positioning AI as an end-to-end enabler and incorporating data intelligence, virtual scenarios, and digital assessment into vocational education's green transformation pathways, strengthening the coupling between technological innovation and educational governance. Practically, the proposed framework and pathway offer clear methodological guidance for vocational colleges in curriculum development, training-base construction, industry–education integration, competency assessment, and growth support, with strong potential for transfer and scaling.

Given the rapid evolution of green transition agendas and AI technologies, green marketing talent-development systems will require continuous dynamic refinement. Future research may focus on differences in framework applicability across regions, industries, and job roles; deeper application of AI-driven assessment technologies in competency measurement; and cross-national comparisons of vocational green talent cultivation, thereby sustaining innovation capacity for green transformation in China and globally.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

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