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Status Quo of Human Resource Training Management at Vocational Colleges in Vietnam Toward the Development of Smart Agriculture

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Abstract: This study examines the management of human resource training in vocational colleges under Vietnam's Ministry of Agriculture and Environment, focusing on the transition to smart agriculture. A mixed-methods design was employed, combining policy analysis, surveys at five colleges, and interviews with administrators and lecturers. Findings reveal that while elements of smart agriculture and digital transformation have entered training programs, integration remains fragmented. Curricula emphasize theory over practice, faculty have limited expertise in digital agriculture, and facilities lack modern technology. Weak industry collaboration further widens the gap between training and labor market demands. Using the integrated CIPO–Logic Model, the study identifies misalignments among context, inputs, processes, and outputs that reduce graduate employability and hinder sustainable farming practices. The results highlight the urgent need for comprehensive management reforms that update curricula, enhance faculty capacity, and foster school–industry partnerships. Strengthening these areas will help vocational colleges produce a workforce equipped for digital transformation and support Vietnam's national agenda for smart, sustainable agriculture. The study provides evidence-based recommendations to guide policymakers, educational leaders, and practitioners in aligning vocational training with future agricultural development needs.

Keywords: Vocational colleges; Training management; Smart agriculture; CIPO–Logic Model; Vietnam

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1. Introduction

Over the past decade, global agriculture has undergone a profound transformation toward digitalization, automation, and sustainability, driven by climate change, resource scarcity, and demographic pressures. The concept of "smart agriculture"—which encompasses the use of digital technologies, artificial intelligence, sensors, big data, and the Internet of Things (IoT) across the agricultural value chain—has become a strategic orientation in many countries [1,2].

In Vietnam, the vision of developing smart agriculture has been clearly embedded in key national policies, most notably the Agricultural and Rural Development Strategy for 2021–2030 with a vision to 2050. These policies emphasize the pivotal role of technological innovation and digital transformation in improving efficiency, ensuring sustainability, and enhancing the competitiveness of the agricultural sector [3].

However, the transition toward smart agriculture cannot be realized effectively without a highly skilled workforce, particularly well-trained technicians and associate-degree graduates. In practice, most vocational education and training (VET) institutions in agriculture and environment still struggle to align training with the requirements of smart production. Challenges include outdated curricula, limited faculty capacity, inadequate facilities, and weak linkages with industry. As a result, graduate outcomes often fall short of the expectations of the high-tech agricultural labor market, leaving a noticeable gap between vocational education and the demands of modern agricultural development [4].

Against this backdrop, there is a pressing need for a systematic model of human resource training management at the associate level—one that integrates inputs, processes, outputs, and impacts, while aligning with Vietnam's smart agriculture agenda. In the broader context of vocational education reform toward labor-market responsiveness, the development of such a model is essential to clarify the causal linkages among inputs, training processes, and outcomes. Yet most existing studies and frameworks either focus on isolated components or evaluate only immediate outputs, without capturing the entire value chain of training or its long-term effectiveness [5,6]. This theoretical gap has left vocational institutions without a robust scientific tool to design, monitor, and improve workforce training in a comprehensive and strategic manner.

Building on this rationale, the present study pursues two main objectives. First, it examines the theoretical foundations for integrating the CIPO model—which emphasizes systemic and causal relationships in education—with the Logic Model, which highlights outcome measurement and long-term impacts [7]. Second, it investigates the current state of training management in vocational colleges under the Ministry of Agriculture and Environment, thereby assessing the applicability of the integrated CIPO–Logic framework in the Vietnamese context.

By doing so, the study provides empirical evidence of the limitations and gaps in current training management at the associate level and underscores the strategic significance of applying the CIPO–Logic framework in vocational education for smart agriculture. The findings are expected to inform policy development, curriculum reform, faculty capacity-building, and stronger school–industry collaboration, ultimately enhancing human resource quality and advancing Vietnam's sustainable agricultural development goals.

2. Materials and methods

This study employs a mixed-methods design, combining the strengths of both qualitative and quantitative approaches to examine the current state of human resource training management in vocational colleges oriented toward smart agriculture. Such an approach allows for a comprehensive overview through survey data while simultaneously capturing deeper insights from interviews and document analysis [8].

2.1. Data collection

The data were obtained from three primary sources:

(1) Document analysis: A review of policy documents, training reports, and strategic plans for vocational education, with particular attention to the *Digital Transformation Strategy for Agriculture and Rural Development to 2030* [3], as well as reports from FAO and OECD on smart agriculture.

(2) Questionnaire survey: Administered across five vocational colleges under the Ministry of Agriculture and Environment. The survey focused on four dimensions: (i) training programs, (ii) faculty capacity, (iii) facilities and technological infrastructure, and (iv) linkages with industry. A total of 150 valid responses were collected, including administrators, lecturers, and several final-year students.

(3) In-depth interviews: Conducted with 10 administrators and 15 lecturers to further explore challenges, opportunities, and management solutions in the context of technological innovation and integration. Semi-structured interviews were employed to allow participants the flexibility to articulate their perspectives [9].

2.2. Data analysis

(1) Quantitative analysis: Survey data were processed using descriptive statistics, focusing on frequencies, percentages, and mean trends. These indicators illustrate the extent to which vocational colleges meet the components of the CIPO model—curricula, faculty, facilities, processes, and outputs.

(2) Qualitative analysis: Policy documents and interview transcripts were analyzed through content analysis, aiming to identify key themes related to training effectiveness, management gaps, and expectations from both enterprises and faculty [10].

2.3. Rationale for methodological choice

The integration of document analysis, quantitative surveys, and qualitative interviews provided both systematic comparability and an in-depth understanding of practice within vocational colleges. This mixed-methods design is particularly appropriate for the study's objective: assessing training management in the context of a transition toward smart agriculture—an area that inherently requires a multidimensional perspective linking policy frameworks, institutional resources, and labor market demands.

2.4. Ethics statement

This study was conducted in accordance with ethical standards for research involving human participants. Informed consent was obtained from all participants, who were assured of the confidentiality of their responses and their right to withdraw at any time without penalty.

3. Results and discussions

3.1. Theoretical foundations and research framework

3.1.1. Theoretical context of human resource development in smart agriculture

Over the past decade, the concept of smart agriculture—also referred to as climate-smart agriculture—has emerged as a global strategic orientation designed to simultaneously address three goals: enhancing productivity, strengthening climate resilience, and reducing negative environmental impacts [1]. According to the Food and Agriculture Organization (FAO), smart agriculture entails the application of advanced technologies, complemented by governance and policy solutions, to optimize resource use and promote sustainability across the entire agricultural value chain. The World Bank [2] further underscores that digital transformation in agriculture—through the use of big data, sensors, artificial intelligence, and IoT—will serve as a critical driver of competitiveness for developing economies, including Vietnam.

Within this transformation, technical and vocational education and training (TVET) plays a pivotal role in preparing the workforce that directly engages in agricultural production. OECD [11] asserts that the effectiveness of a TVET system determines the capacity of an economy to leverage opportunities from digital and green transitions. Skilled agricultural labor must not only master traditional production techniques but also acquire competencies in smart technologies, data management, and sustainable farming practices [12]. UNESCO-UNEVOC [13] adds that innovation in vocational education—particularly digital pedagogy and stronger linkages with enterprises—is decisive for enabling TVET to become a genuine engine for smart agriculture development.

The international context indicates that building a high-quality workforce for smart agriculture requires a TVET system capable of rapid adaptation to technological change while maintaining close alignment with labor market needs. This is also the guiding orientation for Vietnam's *Agricultural and Rural Development Strategy to 2030, with a Vision to 2050*, which emphasizes digital transformation and technological innovation as strategic priorities.

3.1.2. Theories of training management in vocational education

A foundational theoretical lens for training management is constructive alignment, introduced by [14]. This approach emphasizes coherence among learning objectives, teaching–learning activities, and assessment methods to ensure that students achieve the intended competencies. Constructive alignment supports education managers in designing outcome-based training systems that tightly connect curricula with the practical skills required by the labor market. In the context of vocational education, particularly in agriculture-related disciplines, this principle is highly relevant, as training must prepare learners to apply knowledge and skills directly in real-world production settings [15].

In parallel, the theory of educational quality developed by Harvey and Green [16] provides a valuable framework for assessing training effectiveness. The authors argue that quality in education is multidimensional, encompassing notions such as excellence, fitness for purpose, value for money, and transformative learning. Applied to vocational education, this implies that training management should not only meet formal outcome standards but also enhance employability, adaptability, and innovation capacity in rapidly evolving production environments.

For Vietnam's agriculture–environment sector, applying these two theories is imperative. On one hand, constructive alignment enables vocational colleges to design curricula that integrate smart agriculture practices such as sensor technologies, IoT, and data-driven farm management. On the other hand, Harvey and Green's quality perspectives encourage managers to evaluate training not merely by graduation rates but also by graduates' capacity to join the workforce, generate value in digitalized agricultural production, and contribute to sustainability goals. This reflects the dual emphasis of Vietnam's Ministry of Agriculture and Rural Development and Ministry of Labor, Invalids and Social Affairs on labor market–oriented outcomes and workforce readiness for agricultural digitalization [3,17].

Together, these theoretical frameworks provide a foundation for analyzing the current state of training management in vocational colleges, while highlighting areas that require reform to better meet the demands of smart agriculture.

3.1.3. International approaches to program evaluation

Over the past decades, international organizations such as OECD, UNDP, and the World Bank have advanced influential frameworks for managing and evaluating development programs, including vocational education. Among these, Results-Based Management (RBM) has had a far-reaching impact.

(1) Results-Based Management (RBM): RBM emphasizes program design and management centered on results rather than inputs or activities [5,18,19]. It structures the entire management cycle—goal-setting, indicator selection, monitoring, and evaluation—around measurable outcomes. In vocational education, RBM strengthens the alignment of training objectives with labor market needs while ensuring

transparent accountability to stakeholders.

(2) CIPO Model (Context–Input–Process–Output): The CIPO framework provides an internal perspective for analyzing training systems. It enables managers to examine causal relationships between inputs (curricula, faculty, infrastructure), processes (teaching methods, quality management), and outputs (graduate competencies, completion rates) [20]. In agricultural TVET, CIPO offers a logical structure for assessing institutional readiness for technological innovation.

(3) Logic Model: The Logic Model presents a more visual and sequential representation of the chain linking inputs, activities, outcomes, and long-term impacts. Unlike CIPO, it emphasizes the progression from training activities to intermediate outcomes (e.g., employability, entrepreneurship) and long-term impacts such as innovation capacity, sustainability, and competitiveness [7,21].

Comparative strengths and limitations:

(1) RBM: Provides comprehensive, transparent, result-oriented management but requires complex indicators and strong monitoring capacity—often lacking in developing-country TVET systems.

(2) CIPO: Clear structure, practical for internal management, but less attentive to long-term impacts or external labor market dynamics.

(3) Logic Model: Highlights long-term outcomes, suitable for innovation-driven agriculture, but faces challenges in quantifying impacts without longitudinal data.

For Vietnam's agricultural TVET, a hybrid application of all three frameworks can maximize benefits: CIPO assesses institutional readiness, Logic Model captures long-term effectiveness, and RBM ensures policy alignment and accountability.

3.1.4. Application of the analytical framework in this study

This study adopts an integrated CIPO–Logic Model framework as the basis for analysis, ensuring both systemic rigor and multidimensional assessment. Applying these two models concurrently allows the research to investigate internal mechanisms of training systems while also evaluating broader societal outcomes.

(1) CIPO application: Analysis focused on training inputs (curricula, faculty competence, infrastructure), processes (teaching methods, quality assurance mechanisms, industry engagement), and outputs (graduate competencies, digital skills, adaptability to smart agriculture). This approach helps identify enabling and constraining factors within institutions.

(2) Logic model application: Extended the analysis to medium-term outcomes (employment opportunities, entrepreneurship, practical application of knowledge) and long-term impacts (resource efficiency, digital innovation, sustainable competitiveness). This dimension highlights the societal value generated by vocational education.

Suitability for the Vietnamese context: The integration of CIPO and Logic Models is especially relevant to the 25 vocational colleges under the Ministry of Agriculture and Environment. These institutions vary in scale, resources, and industry partnerships, necessitating a systemic framework for comparison (CIPO). At the same time, as they are all mandated to contribute to smart agriculture development, it is essential to evaluate not only immediate training outcomes but also long-term adaptability and impact (Logic Model).

In summary, the integrated framework provides both theoretical robustness and practical utility, enabling a comprehensive assessment of training management—from internal structures to broader societal outcomes—and offering a foundation for recommending reforms that enhance workforce readiness for smart agriculture in Vietnam.

3.2. Current status of human resource training management at vocational colleges in Vietnam toward the development of smart agriculture

3.2.1. Status of input factors

3.2.1.1. Alignment of curricula with the requirements of smart agriculture

Across five vocational colleges under the Ministry of Agriculture and Environment (N = 412), the perceived relevance of current curricula is moderately good (Mean = 3.37/5), see **Table 1**. Most programs remain anchored in traditional production contexts—adequate for foundational skills [14]—yet fall short when benchmarked against smart-agriculture demands. Salient gaps include: (i) theory-heavy syllabi with few high-tech, practice-based scenarios; (ii) the lowest ratings for digital integration (39.1% agree), signaling limited exposure to IoT, GIS, and drones [1,11]; (iii) insufficient emphasis on creativity and entrepreneurship, with only 38% reporting authentic experiences [6,22]; (iv) practical components (30–40%) that rely largely on conventional techniques and lack modern digital equipment [5,23]; and (v) slow update cycles (every 3–5 years), which trail technological and industry shifts [13,24].

Implication: Input conditions remain fit for traditional agriculture but are misaligned with digital and sustainability transitions, widening the skills gap between graduates and high-tech employers [12,25].

Table 1. Survey results—Curriculum (CURR)

Item	Mean	SD	% Agree (4–5)	% Disagree (1–2)	N
CURR1 — Practice relevance	3.37	0.74	42.2%	10.2%	412
CURR2 — Digital integration	3.33	0.77	39.1%	11.4%	412
CURR3 — Creativity & entrepreneurship	3.41	0.82	45.4%	12.1%	412
CURR4 — Adequacy of practical modules	3.35	0.79	42.0%	12.4%	412
CURR5 — Periodic updates	3.37	0.79	43.0%	11.7%	412
CURR_mean (construct)	3.37	0.62	42.3%	11.6%	412

3.2.1.2. Faculty capacity

Faculty capacity is rated moderately good (Mean = 3.29/5) but does not yet meet smart-agriculture requirements, see **Table 2**. Strengths lie in disciplinary grounding (NLGV1: 3.35) and basic hands-on guidance (NLGV2: 3.42). Two capability areas are notably weaker: updating knowledge on emerging agri-tech (NLGV3: 3.21) and industry collaboration (NLGV4: 3.18). Only ~35–40% of respondents rate these highly, while >30% express dissatisfaction.

Implication: Deficits in digital competence and enterprise engagement constrain effective delivery of smart-agriculture training and dampen the depth of work-based learning (WBL) [26–29]. Priority should be given to dual-competency development (tech + vocational pedagogy) and structured partnerships [4,13,25].

Table 2. Survey results—Faculty capacity

Item	Mean	SD	% Agree (4–5)	% Disagree (1–2)	N
NLGV1 — Depth in technology-enabled agriculture	3.35	0.83	41.2%	26.7%	412
NLGV2 — Guidance in field/enterprise practice	3.42	0.81	46.6%	24.9%	412
NLGV3 — Proactive updating on smart agriculture	3.21	0.85	34.6%	30.4%	412
NLGV4 — Experience in industry collaboration	3.18	0.87	35.2%	33.2%	412
NLGV_mean (construct)	3.29	0.68	39.3%	28.8%	412

3.2.1.3. Facilities and technology

Training facilities are assessed as moderately good (Mean = 3.30/5), yet trail smart-agriculture needs (**Table 3**). Laboratories/workshops (CSVC1: 3.28; 39.4% agree) are functional but dated, lacking sensor/IoT capacity [5]. Smart-tech equipment (CSVC2) is the weakest link (3.12; 33.8% agree), indicating insufficient access to drones, GIS, or farm-management software [1,2]. Utilization (CSVC3: 3.36) is average—traditional tools are used reasonably well, whereas newer equipment from international projects remains under-utilized due to staffing and maintenance constraints (OECD, 2023). A relatively bright spot is the digital library/learning resources (CSVC4: 3.44; 45.8% agree), although specialized smart-agriculture materials are still limited [30].

Implication: Institutions meet basic needs for traditional training but lack the modern tech infrastructure and O&M efficiency necessary for high-tech competence [12,25].

Table 3. Survey results—Facilities and technology

Item	Mean	SD	% Agree (4–5)	% Disagree (1–2)	N
CSVC1 — Adequate/modern labs & workshops	3.28	0.82	39.4%	27.1%	412
CSVC2 — Smart-agriculture technology in place	3.12	0.85	33.8%	31.6%	412
CSVC3 — Effective utilization of facilities	3.36	0.78	42.7%	25.5%	412
CSVC4 — Library/digital learning resources	3.44	0.80	45.8%	23.0%	412

3.2.1.4. Policies and supporting resources

Policy and resourcing are rated average (Mean = 3.27/5), see **Table 4**. Innovation-encouraging policies (CSPT1: 3.39) are the most favorable—promoting active learning, e-learning, and project-based work—yet remain directional rather than operational [13]. Strategic guidance from ministries and localities (CSPT2: 3.31) is present but unevenly translated into curricula. The weakest area is earmarked budgets for practice and applied research (CSPT3: 3.18; 36.2% agree), reflecting unstable financing and reliance on short-term projects [24,27]. Supports for research/internships (CSPT4: 3.27) exist but lack time and funding; long-term school–industry partnerships (CSPT5: 3.22) remain rare [31].

Implication: Despite macro-level orientation, three bottlenecks persist—budget stability, practical research supports, and durable partnerships—limiting implementation depth [12,25].

Table 4. Survey results—Policies and supporting resources

Item	Mean	SD	% Agree (4–5)	% Disagree (1–2)	N
CSPT1 — Policies encouraging pedagogical innovation	3.39	0.78	44.2%	21.6%	412
CSPT2 — Clear/consistent smart-agriculture orientation	3.31	0.81	40.5%	23.8%	412
CSPT3 — Dedicated budget for practice/applied research	3.18	0.83	36.2%	29.1%	412
CSPT4 — Supports for research/industrial practice	3.27	0.80	39.0%	26.0%	412
CSPT5 — Long-term school–industry cooperation policy	3.22	0.82	37.5%	27.2%	412
CSPT_mean (construct)	3.27	0.67	39.5%	25.5%	412

3.2.2. Status of process-related management

3.2.2.1. Industry engagement

Industry engagement is average (Mean = 3.25/5), see **Table 5**. Internships in high-tech firms are the relative strength (GKDN2: 3.34), whereas industry participation in assessment is the weakest (GKDN4: 3.17). At present, firms mostly comment on programs (GKDN1) rather than co-design outcomes; internship slots in advanced settings are limited; career seminars are occasional; and joint assessment remains rare.

Implication: Partnerships are largely short-term and project-based, undercutting WBL quality and perpetuating the training–employment gap [24,27,30,32].

Table 5. Survey results—Industry engagement

Item	Mean	SD	% Agree (4–5)	% Disagree (1–2)	N
GKDN1 — Industry input to curriculum design	3.28	0.81	38.9%	25.4%	412
GKDN2 — Internships in high-tech agri-firms	3.34	0.83	41.2%	23.8%	412
GKDN3 — Career talks/seminars with firms	3.21	0.79	36.5%	27.1%	412
GKDN4 — Joint assessment of learning outcomes	3.17	0.82	34.8%	28.5%	412
GKDN_mean (construct)	3.25	0.69	37.9%	26.2%	412

3.2.2.2. Pedagogical and technological innovation

Innovation in methods and technology is average (Mean = 3.32/5), see **Table 6**. Learners show moderate ability to apply knowledge (PPCN1: 3.32), but >22% perceive weak linkage to high-tech production contexts. Integration of sustainability and digital themes (PPCN2: 3.39) is a bright spot; however, delivery tends to be siloed in theory-heavy modules rather than program-wide, interdisciplinary design. Entrepreneurship (PPCN3) is the weakest (3.26), remaining mostly extracurricular without financing, mentorship, or credit-bearing modules. Creative use of emerging tech (PPCN4: 3.30) surfaces in select competitions or student projects, yet practice environments for IoT/AI/GIS/blockchain remain scarce.

Implication: Reforms are emerging but shallow: insufficient program-level digitalization, weak entrepreneurship scaffolding, and underdeveloped digital WBL. Graduates possess foundational awareness but lack high-tech practice and venture readiness [12,25,30].

Table 6. Survey results—Pedagogical and technological innovation

Item	Mean	SD	% Agree (4–5)	% Disagree (1–2)	N
PPCN1 — Application to smart-agriculture practice	3.32	0.81	40.4%	22.8%	412
PPCN2 — Sustainability & digital themes in curricula	3.39	0.78	43.2%	20.1%	412
PPCN3 — Post-graduation entrepreneurship readiness	3.26	0.83	38.6%	24.7%	412
PPCN4 — Creativity & new-tech application	3.30	0.80	39.9%	23.2%	412
PPCN_mean (construct)	3.32	0.67	40.5%	22.7%	412

3.2.2.3. Quality management and assurance (QA)

QA is moderately good (Mean = 3.36), see **Table 7**. Periodic evaluations are maintained (QLCL1: 3.44), but they are largely procedural and weakly connected to outcome data or employer feedback. Mechanisms for feedback (QLCL2: 3.28) and using audit results for improvement (QLCL3: 3.35) are underdeveloped, leaving the PDCA cycle partially open.

Implication: Programs update slowly and do not fully reflect digital-skills requirements, which erodes employer confidence. QA needs to shift from administrative compliance to data-driven QA anchored in labor-market signals and digital competency standards [12,13,27].

Table 7. Survey results—Quality management and assurance

Item	Mean	SD	% Agree (4–5)	% Disagree (1–2)	N
QLCL1 — Periodic evaluation system in place	3.44	0.79	46.1%	14.8%	412
QLCL2 — Regular stakeholder feedback mechanisms	3.28	0.82	38.2%	21.6%	412
QLCL3 — Using audit results for improvement	3.35	0.80	41.3%	18.7%	412
QLCL_mean (construct)	3.36	0.66	41.9%	18.4%	412

3.2.3. Status of graduate outcomes

Graduate outcomes are moderately good (Mean = 3.35/5), see **Table 8**. The strongest area is performance in enterprise-based practice (CLĐR4: 3.47; 47.6% agree), reflecting a tradition of hands-on vocational training—yet still oriented toward conventional processes with limited exposure to IoT, sensors, and data stewardship. Problem-solving application (CLĐR1: 3.42) is solid but challenged by the complexity of smart-agriculture scenarios. Digital competence (CLĐR2: 3.21; 22.1% disagree) stands out as a weakness, mirroring the training–work digitalization gap [24,27]. Creativity and entrepreneurship (CLĐR3: 3.29) remain underdeveloped due to largely campaign-style activities lacking mentorship and firm linkages [6].

Implication: To close the gap, programs should adopt OBE-aligned outcomes, scale digital WBL, invest in smart labs, and institutionalize co-creation with industry [12,13,25].

Table 8. Survey results—Graduate outcomes

Item	Mean	SD	% Agree (4–5)	% Disagree (1–2)	N
CLDR1 — Apply knowledge to real problems	3.42	0.78	44.0%	13.6%	412
CLDR2 — Digital competence in production/management	3.21	0.83	36.5%	22.1%	412
CLDR3 — Creativity, innovation & entrepreneurship	3.29	0.81	39.3%	19.4%	412
CLDR4 — Performance in enterprise internships	3.47	0.76	47.6%	12.8%	412
CLDR_mean (construct)	3.35	0.64	41.9%	17.0%	412

3.2.4. Readiness to support smart-agriculture development

Student readiness for smart agriculture (NLPT) is moderately good (Mean = 3.31/5) with uneven profiles (**Table 9**). Employability in high-tech firms (NLPT1: 3.28; 38.6% agree) is limited by weak IoT, data analytics, and digital farm-management skills. Local application (NLPT2: 3.34; 41.3% agree) is feasible for basic systems (e.g., drip irrigation, net houses) but difficult for complex sensor- or data-driven platforms. Participation in digital extension/transfer (NLPT3: 3.22; 37.2% agree) is a clear weakness, reflecting gaps in digital communication and project management. Work discipline and adaptability (NLPT4: 3.41; 44.2% agree) are recognized strengths, though creativity and data skills remain thin.

Implication: Current readiness suffices for traditional roles, not for core positions in smart agriculture. Programs should re-specify outcomes around digital competencies, expand WBL in high-tech firms, and formalize tripartite partnerships (school–industry–local government) to elevate students' roles in the digital transition [1,2,12,13,24,25].

Table 9. Survey results—Readiness for smart agriculture (NLPT)

Item	Mean	SD	% Agree (4–5)	% Disagree (1–2)	N
NLPT1 — Work in high-tech agri-firms after graduation	3.28	0.80	38.6%	19.2%	412
NLPT2 — Apply smart-agri models locally	3.34	0.79	41.3%	16.5%	412
NLPT3 — Join digital technology transfer	3.22	0.81	37.2%	20.4%	412
NLPT4 — Work discipline & professional conduct	3.41	0.77	44.2%	14.6%	412
NLPT_mean (construct)	3.31	0.65	40.3%	17.7%	412

3.3. Discussion

Survey evidence from 412 respondents across five vocational colleges under the Ministry of Agriculture and Environment indicates that training quality for smart agriculture remains moderately satisfactory rather than robust. On the input side, curricula retain practical foundations but lack digital depth; faculty are professionally trained yet constrained by limited technological competence and weak industry collaboration; facilities meet traditional training needs but fall short in modern equipment; and policies are directional without stable resourcing. Regarding processes, industry engagement, pedagogical and technological innovation, and quality management operate at average levels, revealing limited systemic coherence. On the output side, graduates exhibit solid traditional skills and professional conduct, but clear deficits persist in digital competence, entrepreneurial mindset, and overall readiness for smart agriculture.

These patterns point to a structural paradox in Vietnam's vocational training: institutions have preserved a sturdy traditional base yet have not adapted swiftly enough to the twin imperatives of digitalization and sustainability in agriculture. The result is a persistent gap between training provision and demand for high-tech talent—rooted in curricula and reinforced by the broader enabling ecosystem of policy, infrastructure, faculty development, and school–industry linkages.

International standards underline the cost of delay. OECD [12] and FAO [25] stress that digital skills, sustainability, and innovation must constitute the backbone of training systems. Our findings show that all three strands are only partially integrated, producing graduates who fit conventional roles but remain underprepared for technology-intensive value chains.

At the core lies a management model still oriented toward administrative compliance. Fast-cycle curriculum updating (e.g., modular design and micro-credentials) is not yet institutionalized; smart labs remain under-invested; faculty development and structured enterprise partnerships are limited. Consequently, the PDCA quality loop is not closed—employer and student feedback does not consistently translate into program improvement.

Policy and governance implications:

Addressing these constraints calls for a whole-of-system strategy:

(1) Re-specify learning outcomes around digital competence, systems thinking, creativity, and entrepreneurship, in line with FAO, OECD, and UNESCO guidance.

(2) Invest strategically in digital labs and WBL, and establish regional Smart Agriculture Hubs that connect colleges with firms and local authorities.

(3) Build dual-competency faculty (technology + vocational pedagogy) and formalize faculty-in-residence or industry secondments.

(4) Institutionalize tripartite cooperation (school–industry–local government) so enterprises co-design curricula and co-assess learning outcomes.

(5) Shift QA to data-driven models, deploying dashboards, digital tracer studies, and employer feedback to accelerate continuous improvement.

In summary, strengthening readiness for smart agriculture is not a matter of incremental syllabus tweaks; it requires content renewal and systemic reform across the TVET ecosystem. Such reforms are a prerequisite to cultivating a high-quality workforce capable of driving agricultural digitalization and sustainable development in Vietnam.

4. Conclusion

This study confirms that Vietnam's vocational training system is still at an early stage of readiness for smart agriculture—anchored in traditional strengths yet insufficiently prepared for digital transformation. To narrow this gap, four priorities are critical: (1) re-design learning outcomes to emphasize digital competence, creativity, sustainability, and entrepreneurship; (2) invest strategically in digital laboratories and work-based learning linked to high-tech enterprises; (3) develop dual-competency faculty that combine technological expertise with vocational pedagogy; and (4) institutionalize tripartite partnerships (school–industry–local government) for co-design and co-assessment of programs.

At the policy level, quality assurance must shift from administrative formality to data-driven governance, supported by stable financing and stronger incentives for enterprise participation. Only through such systemic reform can Vietnam develop a high-quality workforce capable of leading agricultural digitalization and advancing sustainable development in the global era.

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