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# Developing Management Solutions for Human Resource Training in Vietnam's Colleges Toward Smart Agriculture

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**Abstract:** This study develops a comprehensive framework of ten management solutions to strengthen human resource training in Vietnam's colleges in response to the transition toward smart agriculture. Drawing on the CIPO and Logic Model frameworks, the research integrates theoretical synthesis with contextual evidence from Vietnam's vocational education system. The proposed solutions address key management domains such as curriculum innovation, faculty development, institutional governance, digital transformation, and quality assurance. Each solution is conceptually grounded in international practices while being adapted to the Vietnamese context. The study contributes to the literature by operationalizing a systemic reform pathway that links digitalization, sustainability, and governance transformation in agricultural training institutions. The framework provides a strategic foundation for policymakers and institutional leaders to modernize vocational training toward a smart and sustainable agricultural workforce.

**Keywords:** Vocational education and training; Management solutions; Smart agriculture; Human resource development; Vietnam

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## 1. Introduction

The global transition toward smart agriculture has transformed the competencies required of the agricultural workforce. In this digital era, farmers, technicians, and managers must not only master production techniques but also possess digital literacy, data analytics, and entrepreneurial problem-solving skills. As emphasized by the OECD [1] and the FAO [2], agricultural transformation in developing countries depends on the capacity of vocational and higher education institutions to supply a new generation of workers capable of integrating technology, sustainability, and innovation into production systems.

In Vietnam, the agricultural sector remains a crucial pillar of the economy, employing nearly 30% of the national labor force [3]. To align with the government's digital transformation and green growth strategies, agricultural colleges under the Ministry of Agriculture and Environment (MOAE) play a vital role in developing

mid-level human resources. However, evidence from recent institutional assessments shows that training programs in these colleges still rely heavily on traditional, theory-based models. The baseline survey results indicated low adaptation to smart agriculture in curriculum design (M = 3.24/5), teaching methods (M = 3.15/5), and learning facilities (M = 3.27/5), signaling an urgent need for systemic reform.

These deficiencies reveal structural constraints in training management, including limited faculty digital competence, outdated infrastructure, fragmented policy coordination, and weak linkage between training and labor market demand. Without comprehensive managerial reforms, agricultural colleges will struggle to meet the human resource requirements of Vietnam's smart agriculture vision.

To address these systemic gaps, this study conceptualizes a coherent set of ten management solutions designed to strengthen human resource training in agricultural colleges. The development of these solutions draws upon the CIPO (Context–Input–Process–Output) framework [4] and the Logic Model approach [5], enabling the design of evidence-based, outcome-oriented, and contextually adapted interventions. Together, these frameworks provide the analytical foundation for linking policy, institutional capacity, and training outcomes, ensuring that reform is both theoretically grounded and practically feasible.

## 2. Literature review and theoretical framework

### 2.1. Management of training in vocational and agricultural education

Training management in vocational education has been widely analyzed as a multi-dimensional process that integrates planning, organization, implementation, and evaluation [6,7]. In agricultural contexts, effective management requires balancing technical training with innovation, sustainability, and digital transformation [8,9]. Several international studies emphasize that agricultural colleges should act as "knowledge enterprises," not merely training institutions, linking education with production, research, and community service [1,10].

In Vietnam, agricultural vocational training remains constrained by fragmented policies, outdated teaching methods, and limited enterprise engagement. While government reforms have promoted autonomy and outcome-based approaches, many colleges still lack systematic quality assurance, modern facilities, and faculty competence in digital agriculture. This gap calls for a coherent management framework aligning institutional capacity with the national strategy for smart and green agriculture.

### 2.2. International perspectives on smart agriculture and human resource development

Globally, smart agriculture represents the convergence of artificial intelligence (AI), Internet of Things (IoT), big data, and sustainable farming systems. According to FAO [2], human resource development in this field requires integrating digital skills, data management, and ecological thinking. The World Bank emphasizes that successful agricultural transformation depends on human capital—particularly technicians capable of operating smart equipment, analyzing data, and innovating production systems [3].

OECD highlights that vocational education and training (VET) institutions should redesign curricula around emerging "green" and "digital" skills [1]. Similarly, UNESCO–UNEVOC recommends embedding lifelong learning and technology adoption into agricultural training programs, ensuring alignment with the UN Sustainable Development Goals (SDGs) [9]. However, few studies have proposed an integrated management framework that connects these competencies with institutional governance and operational mechanisms.

### 2.3. Research gap and rationale

Although previous studies provide insights into digital transformation in education and agricultural innovation,

there remains a lack of context-specific management solutions for agricultural colleges in developing countries. In Vietnam, most reforms have focused on curriculum content or short-term projects rather than a holistic management approach encompassing policy, faculty, infrastructure, quality assurance, and labor-market linkages. Consequently, a gap persists between national policies for smart agriculture and the managerial capacities of agricultural colleges. Addressing this gap requires designing comprehensive management solutions grounded in both international frameworks and local realities.

### 2.4. Theoretical foundation: CIPO and Logic Model frameworks

This study adopts two complementary theoretical frameworks—CIPO (Context–Input–Process–Output) and the Logic Model—to guide the development of management solutions.

(1) CIPO framework [4]: conceptualizes educational management as a system influenced by environmental context (policy, resources), institutional inputs (faculty, facilities), training processes (curriculum, pedagogy), and outputs (graduate competencies, labor outcomes).

(2) Logic Model [5]: visualizes cause–and–effect relationships, linking resources and activities to measurable outputs, outcomes, and impacts. It provides a structured pathway for planning, implementing, and evaluating educational interventions.

Integrating both frameworks enables the design of solutions that are not only evidence-based and outcome-oriented but also adaptable to the specific context of Vietnamese agricultural colleges. This dual theoretical lens ensures that management innovations are systematic, measurable, and sustainable—bridging the gap between policy aspirations and operational realities.

## 3. Methodology

The study employed a qualitative-descriptive design focusing on the systematic development of management solutions for human resource training in agricultural colleges under the Ministry of Agriculture and Environment (MOAE) of Vietnam. The process integrated theoretical analysis, synthesis of international frameworks, and contextual validation through expert consultation and field evidence.

The formulation of solutions was grounded in a review of international studies and policy recommendations. OECD emphasized systemic and coherent management in vocational education and training (VET), balancing inputs, processes, and outcomes [1,6]. UNESCO–UNEVOC advocated competence-based training linked with digital transformation and lifelong learning [9]. FAO [8,10] highlighted the role of IoT, agricultural data, and precision technologies in building high-quality agricultural human resources, while the World Bank [3] underscored the need to integrate digital and green skills for sustainable development.

Empirical evidence identified major weaknesses in curricula, faculty qualifications, facilities, and governance structures across MOAE colleges. These findings revealed systemic inefficiencies—such as outdated teaching methods and fragmented policies—that informed the rationale for designing the ten proposed management solutions.

The research followed a structured four-stage procedure:

(1) Diagnosis: Analyze the current status of training management based on data and interviews with college leaders.

(2) Theoretical integration: Apply the CIPO (Context–Input–Process–Output) and Logic Model frameworks to map cause–and–effect relationships in management.

(3) Solution design: Formulate ten solutions corresponding to strategic management dimensions—curriculum, faculty, infrastructure, policy, pedagogy, quality assurance, cooperation, entrepreneurship, outcome standardization, and monitoring.

(4) Expert validation: Consult 11 senior institutional leaders to refine and verify the scientific and practical relevance of each solution.

All participants were informed of the study's objectives and gave consent for their input to be used anonymously. The research adhered to academic integrity standards, ensuring transparent citation, data confidentiality, and respect for institutional autonomy.

## 4. Results: Proposed management solutions

Ten interrelated management solutions were formulated to enhance human resource training in agricultural colleges toward smart agriculture. Each solution was developed through theoretical synthesis, empirical validation, and alignment with the CIPO and Logic Model frameworks.

### 4.1. Solution 1: Curriculum innovation

Curriculum innovation is positioned as the foundational solution for advancing human resource training toward smart agriculture. The primary goal is to modernize training programs by embedding digital technologies, sustainability, and circular economy principles, thereby addressing existing curricular gaps that remain largely traditional and disconnected from labor market needs (average baseline score = 3.24/5). Beyond content revision, curriculum reform fosters a triadic partnership among faculty, enterprises, and institutional governance, ensuring coherence with national standards and international benchmarks [1,9].

This innovation involves four interrelated dimensions:

(1) Program review and alignment: Existing curricula are reviewed against the Vietnamese Qualifications Framework (VQF) and ASEAN TVET standards, reducing overly theoretical modules and emphasizing applied, practice-based learning.

(2) Integration of smart-agriculture technologies: Modules on IoT, AI, drones, GIS, and data-driven environmental management are incorporated, supported by digital laboratories and simulation farms.

(3) Embedding sustainability and circular economy content: Courses on low-carbon agriculture, waste management, and sustainable production are linked to UN SDGs 2, 12, and 13 [8].

(4) Pedagogical and assessment reform: Blended and project-based learning models are introduced alongside entrepreneurship and innovation modules to cultivate creativity and employability.

Implementation is guided by collaborative curriculum co-design involving faculty, agribusiness enterprises, and international experts (FAO, GIZ). The CDIO framework (Conceive–Design–Implement–Operate) is applied to connect theoretical learning with practical skill development [11]. Pilot testing of new modules in selected disciplines precedes large-scale deployment, while ongoing labor-market surveys and skills forecasts ensure adaptability to evolving demands [1,12].

Enabling conditions include supportive policy frameworks from the Ministry of Agriculture and Environment, diversified funding through state budgets, ODA projects, and enterprise partnerships, as well as systematic faculty retraining in digital agriculture. The establishment of regional "Smart Agriculture Hubs" provides shared digital infrastructure and practical learning environments. As curricula represent the backbone of training, this solution serves as the entry point for all subsequent reforms in faculty development,

infrastructure modernization, and pedagogical innovation. Without curriculum transformation, other solutions would yield limited and unsustainable impacts.

## 4.2. Solution 2: Faculty capacity development

Faculty capacity development is identified as a critical enabler for the success of curriculum and pedagogical reforms in smart agriculture training. The central objective is to comprehensively strengthen instructors' technical, pedagogical, and digital competencies so they can deliver content aligned with emerging technologies such as IoT, AI, and data analytics. Faculty capacity constitutes a key "input" in the CIPO framework [4] that determines the effectiveness of training processes and learning outcomes. Field data confirmed that while most lecturers are academically qualified, few possess advanced applied or digital skills—creating a bottleneck for modernization. This finding aligns with international evidence that teacher competence remains the most decisive factor in TVET quality [7,13].

The solution encompasses three major components:

(1) Competency standards for instructors in smart-agriculture education. These include (i) technical expertise in IoT, AI, big data, and circular production; (ii) digital pedagogy skills such as designing e-learning materials, using LMS and blended-learning models; and (iii) research and enterprise collaboration competencies. Standards are adapted from international frameworks [1,9] and contextualized to Vietnam's conditions.

(2) Continuous professional development programs, including short-term (3–6 month) courses on digital and precision agriculture, combining online modules (MOOCs, OERs) with hands-on practice in smart farms or agribusinesses.

(3) International and enterprise partnerships, allowing lecturers to participate in cooperative projects (FAO, GIZ, World Bank) that foster technology transfer, curriculum co-design, and exposure to global innovations.

Implementation requires colleges to establish structured faculty development plans integrating in-house training, enterprise internships, and international mobility. Policies at the national level should institutionalize faculty certification in digital agriculture to ensure recognition and consistency. Funding can be mobilized from state budgets, ODA projects, and enterprise sponsorships, ensuring long-term sustainability.

As lecturers are the mediators between curriculum and learners, enhancing their capacity is both feasible and pivotal. Strong faculty development amplifies the effects of all other reforms—ensuring that investments in curricula, infrastructure, and quality assurance translate into improved learning outcomes, innovation capacity, and employability of graduates.

## 4.3. Solution 3: Modernization of facilities and digital infrastructure

Modernization of training facilities and digital infrastructure is essential for establishing experiential learning environments that mirror real-world smart agriculture practices. Empirical data show that most agricultural colleges still rely on outdated laboratories and workshops with minimal digital capability, limiting students' exposure to automation, precision technologies, and data-driven farming. Upgrading physical and digital infrastructures is, therefore, a strategic priority for bridging the gap between theory and practice.

The modernization process encompasses four key actions:

(1) Upgrading laboratories and greenhouses: Each college should develop "Smart Agriculture Laboratories" equipped with IoT-based sensors, drones, automated irrigation, and climate-control systems. Practice

workshops and simulation farms replicate digital production processes from seeding to harvesting, allowing students to learn through direct technological engagement.

(2) Developing digital infrastructure: Colleges are to implement integrated learning management systems (LMS) connected with national databases, open educational resources (OER), and global repositories (FAO, OECD, UNEVOC). Big data analytics and AI-based monitoring tools enhance both training and institutional management.

(3) Building digital libraries and open resource hubs: Establishing online repositories of digital and open-access materials on high-tech agriculture, while connecting college libraries with international networks to ensure updated and accessible learning resources.

(4) Enhancing facility utilization efficiency: Introducing shared-lab models among MOAE colleges enables cost optimization and joint use of modern equipment. Regular maintenance and operation protocols, managed by dedicated technical staff, prevent equipment redundancy and promote sustainable usage.

Implementation requires multi-level collaboration. The government should provide initial capital investment, while enterprises and ODA-funded projects (e.g., World Bank, GIZ) contribute to technology transfer and infrastructure support. Colleges must integrate maintenance and sustainability plans into their annual management cycles to ensure long-term usability.

Facilities and digital infrastructure form the contextual backbone of vocational education under the CIPO model. Without modernized environments, curriculum reform and pedagogical innovation cannot be effectively realized. This solution thus plays a pivotal role in transforming agricultural colleges into innovation-driven institutions capable of producing digitally skilled human resources for smart and sustainable agriculture.

## 4.4. Solution 4: Policy and resource enhancement

Supportive policy frameworks and sustainable resource mobilization are indispensable for ensuring the long-term viability of smart agriculture training reforms. While curricula, pedagogy, and faculty development can be managed internally by colleges, systemic transformation requires an enabling policy environment and secure financial foundations. Current evidence shows that fragmented policies and short-term funding cycles often hinder innovation and continuity in Vietnam's vocational education system. Addressing these constraints demands institutionalized mechanisms that integrate financial autonomy, multi-source funding, and performance-based incentives.

This solution focuses on three interlinked dimensions:

(1) Policy coherence and legal frameworks: Establishing synchronized regulations between the Ministry of Agriculture and Environment (MOAE) and the Ministry of Labour, Invalids and Social Affairs (MOLISA) to guide program accreditation, curriculum design, and funding allocation for smart agriculture education. The issuance of inter-ministerial circulars and decrees would clarify the rights and responsibilities of colleges in mobilizing and managing resources.

(2) Diversified and sustainable funding: Combining state budget allocations with public–private partnerships, enterprise training contracts, and Official Development Assistance (ODA) projects to finance modernization initiatives. A dedicated Smart Agriculture Training Fund may be established to channel scholarships, digital transformation investments, and equipment procurement [9].

(3) Incentive mechanisms for innovation: Introducing scholarship schemes for students, professional recognition and workload credits for lecturers adopting digital pedagogy, and institutional rewards for colleges demonstrating effective innovation and industry collaboration. These incentives reinforce

motivation and accountability across the system.

Implementation requires coordination between central ministries, local authorities, and colleges. The MOAE should define a roadmap for integrating smart agriculture training into national vocational strategies, while colleges develop institutional plans specifying key disciplines, budgets, and enterprise partners. Establishing internal Resource Management Boards ensures transparent allocation and monitoring of financial flows, preventing waste and duplication. Regular public–private dialogue forums should review policy impacts and propose timely adjustments.

By providing coherent policy guidance and sustainable resource mechanisms, this solution serves as the structural foundation for all other reforms—curriculum innovation, faculty development, and infrastructure modernization. Without supportive governance and adequate financing, other reform initiatives risk fragmentation and short-lived effects.

## 4.5. Solution 5: Renewal of pedagogy and assessment

Pedagogical and assessment renewal represents a pivotal solution to enhance the effectiveness and relevance of training for smart agriculture. The goal is to shift from content-centered, lecture-based teaching to competency-based, learner-centered, and technology-supported approaches. Traditional instructional methods in agricultural colleges have proven insufficient to equip students with practical, problem-solving, and digital skills demanded by the modern agricultural workforce. This solution aligns with experiential learning theory [14] and international recommendations emphasizing the integration of digital pedagogy into TVET [15,16].

The reform encompasses three key dimensions:

(1) Innovative teaching methods: Adoption of project-based learning (PBL), problem-based learning (PrBL), and blended learning models that combine classroom instruction with digital resources. Projects are drawn from real enterprise contexts, such as designing automated irrigation systems or planning data-driven agribusiness strategies. These methods foster creativity, teamwork, and practical problem-solving abilities.

(2) Technology-enhanced instruction: Expanding the use of Learning Management Systems (LMS) to deliver lessons, assignments, and feedback, and employing simulations, virtual reality (VR), and augmented reality (AR) to reproduce smart agriculture processes. Such tools enable students to experience technology-driven farming even where physical facilities are limited.

(3) Outcome-based assessment: Reforming evaluation from rote testing to competency-based rubrics that measure students' applied skills—such as drone operation, data analysis, and digital farm management. Formative assessment, self- and peer-evaluation, and digital portfolios are used to promote reflection and continuous learning.

Implementation involves faculty retraining in modern pedagogy and digital assessment design, integration of enterprise projects into coursework, and ongoing refinement of rubrics aligned with learning outcomes. Institutions should also develop repositories of digital learning materials and open educational resources (OER) to support self-directed learning.

By cultivating learner autonomy, innovation, and digital competence, this solution bridges the gap between academic learning and practical application. It complements curriculum innovation and faculty development by ensuring that students not only acquire knowledge but also demonstrate measurable competencies essential for the smart agriculture workforce.

## 4.6. Solution 6: Enterprise linkages and international cooperation

Strengthening partnerships with enterprises and international organizations is a pivotal solution to ensure that training programs are responsive to market demands and aligned with global agricultural innovations. At present, enterprise participation in Vietnam's colleges remains limited, and collaboration with international institutions is often project-based and short-lived. This disconnection contributes to the persistent gap between vocational education outcomes and labor market needs.

This solution focuses on four complementary dimensions:

(1) Enterprise co-design of curricula and training programs: Establishing mechanisms for agribusinesses to participate in curriculum committees, co-develop modules, and define skill standards based on production and digital technology trends. This aligns with international models of dual and cooperative training systems [17].

(2) Internships and apprenticeships: Expanding enterprise-based learning through structured internship programs, field projects, and mentorship schemes that provide students with direct exposure to smart agriculture technologies and management practices.

(3) International cooperation and knowledge transfer: Partnering with organizations such as FAO, GIZ, and UNESCO–UNEVOC to access expertise, teaching materials, and digital training platforms. Such cooperation promotes benchmarking with international standards and fosters faculty and student mobility [10].

(4) Public–private partnerships (PPPs): Building multi-stakeholder platforms that bring together government agencies, enterprises, and colleges to co-finance and co-manage smart agriculture initiatives, enhancing both sustainability and innovation.

Implementation requires establishing formal memoranda of understanding (MoUs) with enterprises, appointing employer representatives to institutional advisory boards, and embedding cooperation indicators into annual performance evaluations. Colleges should designate "Industry Liaison Units" responsible for managing partnerships, internship placements, and project coordination.

By integrating enterprise input and international expertise, this solution creates a dynamic, demand-driven ecosystem for training. It provides students with practical experience, strengthens global perspectives among faculty, and opens channels for technology transfer and employment. In the long term, sustained enterprise and international engagement will transform agricultural colleges from training providers into strategic partners in Vietnam's smart and sustainable agricultural development.

## 4.7. Solution 7: Quality management and digital transformation

This solution aims to institutionalize results-based quality management (RBQM) systems while accelerating digital transformation in the governance of vocational training. Although several agricultural colleges have piloted ISO 21001 or HACCP-based quality management systems, these efforts remain fragmented and largely procedural. A unified, digitalized approach is required to ensure transparency, accountability, and continuous improvement across the training process.

The reform involves three major dimensions:

(1) Results-based quality management systems: Colleges should develop quality assurance frameworks linking inputs, processes, outputs, and outcomes through measurable indicators. Key metrics include graduate employability, satisfaction rates, and alignment between training outcomes and labor market needs [3].

(2) Digital transformation in monitoring and evaluation: Integrating digital dashboards, learning management systems (LMS), and data analytics tools allows real-time tracking of teaching, learning, and administrative processes. Learning analytics generate actionable insights to improve student performance and instructional quality [1].

(3) Standardization and quality culture: Developing institutional regulations for quality assurance, training staff in data-based decision-making, and embedding a culture of evidence-driven improvement. The adoption of international standards such as ISO 21001 provides a common reference for both national and international benchmarking.

Implementation requires colleges to establish dedicated Quality Management Units responsible for data governance, reporting, and digital tool integration. Capacity-building programs should train managers and faculty in RBQM methodologies and digital literacy. Investment priorities include LMS enhancement, cloud-based data storage, and analytical dashboards connecting academic, administrative, and financial operations.

By institutionalizing a quality culture and leveraging digital transformation, this solution enhances accountability, transparency, and adaptability. It ensures that agricultural colleges not only comply with national accreditation standards but also evolve toward international quality frameworks. More importantly, it strengthens the feedback loop between policy, management, and practice—turning data into decisions and ensuring continuous improvement in smart agriculture training systems.

## 4.8. Solution 8: Standardization of learning outcomes

Standardizing learning outcomes is essential to ensure coherence, comparability, and labor market recognition across agricultural colleges. Currently, learning outcomes in vocational education remain fragmented and inconsistently linked to digital and entrepreneurial competencies. This inconsistency weakens the alignment between training programs, employer expectations, and national qualification frameworks. Outcome-based standardization thus provides a unified foundation for curriculum design, assessment, and accreditation within the smart agriculture context.

The reform involves three core dimensions:

(1) Alignment with national and regional frameworks: Learning outcomes should be explicitly aligned with the Vietnamese Qualifications Framework (VQF) and ASEAN TVET standards to ensure regional recognition and mobility of graduates. Competency descriptors must incorporate digital literacy, environmental awareness, and innovation capacity, following OECD [1] and UNESCO–UNEVOC [9] guidelines.

(2) Development of smart-agriculture competency standards: Colleges, in collaboration with sector experts and enterprises, should define learning outcomes covering technological, managerial, and entrepreneurial competencies for smart agriculture. These include skills in IoT-based production, AI-supported decision-making, and sustainable resource management.

(3) Integration into program design and quality assurance: Competency standards are to be embedded into curriculum mapping, teaching strategies, and outcome-based assessment rubrics. Periodic reviews informed by labor market surveys, graduate tracer studies, and employer feedback ensure continuous relevance.

Implementation requires coordinated action between the Ministry of Agriculture and Environment (MOAE), the Ministry of Labour, Invalids and Social Affairs (MOLISA), and agricultural colleges. National advisory boards should be established to develop sector-wide learning outcome frameworks and monitor adoption

across institutions. Colleges, in turn, should institutionalize internal outcome review mechanisms that feed into program accreditation and quality assurance processes.

By standardizing learning outcomes, this solution creates a common benchmark for evaluating training effectiveness and ensuring graduates' competencies meet the evolving requirements of smart and sustainable agriculture. It strengthens transparency, facilitates mobility and mutual recognition, and enhances employer confidence in vocational graduates' qualifications.

## 4.9. Solution 9: Employment and entrepreneurship ecosystem development

Developing a comprehensive employment and entrepreneurship ecosystem is essential for extending the impact of vocational training beyond graduation. In many agricultural colleges, career support and start-up incubation remain fragmented or nonexistent, resulting in weak linkages between training and employment outcomes. Establishing a cohesive ecosystem that integrates career guidance, business incubation, and innovation networks can transform graduates from job seekers into job creators within the smart agriculture value chain.

The solution comprises four interrelated components:

(1) Career development and job placement services: Each college should establish a dedicated Career and Employment Center responsible for job counseling, employer engagement, and graduate tracer studies. These centers act as intermediaries between students, alumni, and the labor market.

(2) Entrepreneurship education and incubation: Embedding entrepreneurship training modules into curricula enables students to develop innovation and business planning skills. Incubators and start-up labs within colleges should provide workspace, mentoring, and access to venture capital and technology transfer [18].

(3) Industry and community partnerships: Partnerships with agribusinesses, cooperatives, and local authorities can provide opportunities for internships, business acceleration, and rural innovation projects. Joint programs with financial institutions can expand access to start-up funding and microfinance for young entrepreneurs.

(4) Monitoring and support mechanisms: Regular graduate tracer studies and employment analytics inform institutional decision-making and guide continuous improvement in training and career support services.

Implementation requires collaboration among colleges, enterprises, local governments, and the Ministry of Agriculture and Environment (MOAE). Faculty should be encouraged to serve as mentors in student innovation projects and integrate entrepreneurial learning outcomes into course design. National policies promoting entrepreneurship education and start-up ecosystems in TVET [9] should be localized within institutional strategies.

By fostering career readiness, entrepreneurial mindsets, and innovation capacity, this solution strengthens the employability of graduates and contributes to sustainable rural development. It empowers agricultural colleges to function not only as training providers but as incubators of innovation and economic growth within smart and green agriculture systems.

## 4.10. Solution 10: Monitoring and evaluation of training outcomes

A systematic monitoring and evaluation (M&E) framework is indispensable for ensuring accountability, measuring performance, and driving continuous improvement in human-resource training for smart agriculture. Despite growing policy emphasis on evidence-based management, most agricultural colleges still lack

comprehensive mechanisms to track training effectiveness, graduate employability, or the long-term impact of programs. The absence of feedback loops undermines data-driven reform and limits the system's adaptability.

The proposed solution adopts a results-based management approach encompassing four interrelated components:

(1) Framework design: Develop an integrated M&E model covering inputs, processes, outputs, and outcomes in alignment with the CIPO and Logic Model frameworks [4,5]. Indicators should include graduation rates, skill attainment, job placement, income growth, and contributions to sustainable agriculture.

(2) Data collection systems: Establish digital databases that draw on Learning Management Systems (LMS), employer feedback, and graduate tracer studies. This allows real-time tracking of performance and longitudinal monitoring of employment outcomes [3].

(3) Institutional capacity building: Train staff in M&E methodologies, data analytics, and report preparation to ensure reliability and transparency of findings. The Ministry of Agriculture and Environment (MOAE) should provide technical guidance and toolkits to harmonize practices across institutions.

(4) Feedback and policy linkage: Findings must be communicated back to managers, policymakers, and faculty to guide resource allocation, curriculum revision, and strategic planning. Periodic evaluation reports serve as the basis for accreditation and policy adjustment.

Implementation requires colleges to establish dedicated M&E Units or integrate this function within existing Quality Assurance Departments. Collaboration among MOAE, employers, and international development partners (e.g., FAO, GIZ) can strengthen methodological rigor and data comparability. Regular publication of evaluation results enhances transparency and stakeholder trust.

By institutionalizing monitoring and evaluation, this solution closes the management loop, transforming data into actionable insights. It ensures that training reforms genuinely enhance workforce competence, promote employability, and contribute to the modernization and sustainability of Vietnam's agricultural sector.

## 5. Discussion

The ten proposed management solutions form an integrated reform roadmap for advancing human-resource training toward smart agriculture in Vietnam's vocational education system. Rather than isolated interventions, these measures interact dynamically within a unified management framework based on the CIPO (Context–Input–Process–Output) and Logic Model paradigms. Each component contributes to system transformation through a sequence of mutually reinforcing actions. Curriculum innovation and faculty capacity development constitute the foundation—the "input" layer that defines content and human resources. Infrastructure modernization and policy and resource enhancement create the enabling context that supports implementation. Pedagogical renewal, quality management, and standardization of learning outcomes ensure that instructional processes align with competency-based and data-driven training. Finally, entrepreneurship ecosystem development and monitoring and evaluation (M&E) close the reform loop by linking training outcomes with employment, innovation, and evidence-based governance.

This interdependence suggests that reform must follow a structured sequence:

1. Curriculum reform → 2. Faculty development → 3. Facilities modernization → 4. Policy and resource alignment → 5. Governance, quality assurance, and digital transformation → 6. Employment and entrepreneurship ecosystem → Monitoring and evaluation. Each phase reinforces the next, forming a

continuous improvement cycle consistent with results-based management (RBM) principles. The sequencing reflects the natural evolution of institutional change—from revising what and how colleges teach to ensuring that these efforts produce measurable, sustainable outcomes in the labor market. Empirical evidence from the survey of institutional leaders supports this systemic logic. The highest urgency ratings were attributed to curriculum reform and infrastructure improvement, whereas the highest feasibility ratings were observed for faculty development and quality management. This indicates a realistic progression: start with reforms that are both achievable and foundational, then scale toward more resource-intensive and policy-dependent initiatives.

Overall, these solutions collectively reframe Vietnam's colleges as learning organizations capable of adaptive governance, innovation, and social responsibility. When executed cohesively, they provide a replicable model for managing vocational training transformation across other emerging economies pursuing smart and sustainable agriculture.

## 6. Conclusion

This study constructs a theoretically grounded and practice-oriented framework comprising ten management solutions for developing human-resource training in Vietnam's colleges toward smart agriculture. The solutions—ranging from curriculum innovation and faculty development to digital transformation and monitoring—collectively address both structural and operational dimensions of vocational training reform.

By integrating the CIPO and Logic Model frameworks, the paper demonstrates how management reform can be systematically designed, implemented, and evaluated through interconnected solutions. Each component contributes to a self-reinforcing cycle of improvement: curricula define learning goals, faculty translate them into practice, infrastructure and governance provide the enabling context, and monitoring ensures feedback for continuous adaptation. The proposed model not only responds to the national demand for modernization in vocational education but also aligns with global trends emphasizing digitalization, sustainability, and employability. While the framework was developed from Vietnam's context, it offers transferable insights for other emerging economies seeking to build smart-agriculture-ready workforces.

Future studies should empirically test the effectiveness of these solutions through pilot implementation, longitudinal tracking, and cross-institutional comparisons. Such empirical validation will be critical for refining policies and ensuring sustainable transformation within the vocational education and training (VET) system.

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