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What Drives Certified Fresh-Produce Supply Chain Performance? Evidence from VietGAP Fruit and Vegetable Chains in Hanoi

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Abstract
Certification defines how fresh produce should be grown and documented, but it does not by itself ensure that products arrive on time, retain quality, or generate acceptable returns. This study examines how six supply chain capabilities, logistics and warehousing management, information sharing, relationship commitment, risk management, information technology application, and financial capability, shape the performance of VietGAP-certified fruit and vegetable chains serving Hanoi, Vietnam. The analytical sample contains 516 complete observations measured with 33 reflective indicators. Partial least squares structural equation modeling (PLS-SEM) was performed in SmartPLS 4, with inference based on 5,000 bootstrap subsamples. The measurement model demonstrated satisfactory indicator reliability, internal consistency, convergent validity, and discriminant validity. The six predictors jointly explained 62.3% of the variance in supply chain performance. All hypothesized effects were positive and statistically significant. Information sharing had the strongest effect ($\beta = .269$), followed by risk management ($\beta = .211$), information technology application ($\beta = .180$), relationship commitment ($\beta = .148$), logistics and warehousing capability ($\beta = .128$), and financial capability ($\beta = .098$). A descriptive impact–level comparison further showed that risk management had the lowest observed implementation level despite being the second-strongest performance driver. In contrast, financial capability had the highest level but the smallest structural effect. The findings position certified-chain performance as the outcome of a complementary capability portfolio rather than certification compliance alone. For managers and policymakers, the results favor shared planning and market-feedback routines, joint risk protocols, and interoperable traceability and operations systems over capital-only interventions.

Keywords: VietGAP, Supply Chain Performance, Information Sharing, Risk Management, Vietnam

1. Introduction
Good agricultural practice certification has become an important governance mechanism in food systems because it translates broad expectations about food safety, production discipline, traceability, environmental responsibility, and worker welfare into auditable requirements. GLOBALG.A.P.'s Integrated Farm Assurance standard, for example, covers primary production through postharvest handling and emphasizes food safety, traceability, environmental management, and continuous improvement (GLOBALG.A.P., n.d.) [11]. Vietnam has pursued a parallel domestic pathway through VietGAP. The scale of this transition is no longer marginal: as of November 2025, the Ministry of Agriculture and Environment reported more than 8,300 VietGAP-certified facilities and more than 2,000 safe agricultural supply chains nationwide (Ministry of Agriculture and Environment, 2025) [18].

However, certification is a necessary condition for assured production, not a sufficient condition for supply chain performance. Fruits and vegetables are perishable; quality can deteriorate rapidly after harvest; production is exposed to weather and disease; and urban distribution must reconcile variable supply with short lead times and demanding buyers. These characteristics make performance contingent on what supply chain actors can do together after formal standards have been adopted: exchange timely information, synchronize harvesting and delivery, maintain product integrity, respond to disruptions, use digital tools, honor commitments, and finance the operating cycle. A chain can therefore be compliant on paper while still suffering from avoidable losses, delayed deliveries, weak price realization, or poor profitability.

This distinction is especially salient in Hanoi. Prior research on safe-vegetable chains in the city documented weak interorganizational relationships associated with limited trust, incomplete information transparency, and inadequate benefit sharing. It also showed that traceability adoption remained at an early stage, while distribution-stage control lagged production-stage attention (Ngo *et al*., 2019) [19]. Earlier work on low-pesticide vegetables similarly emphasized that market governance and the coordination of actors determine whether safer production translates into credible market value (Van Hoi *et al*., 2009) [26]. These studies provide rich contextual diagnoses, but quantitative evidence remains limited on the relative contributions of the operational, relational, digital, risk, and financial capabilities that certified chains can develop.

The present study addresses that gap by answering two questions. First, to what extent do logistics and warehousing management capability, information sharing, relationship commitment, risk management, information technology application, and financial capability affect the performance of VietGAP-certified fruit and vegetable supply chains serving Hanoi? Second, which capabilities offer the greatest leverage when their structural effects are considered alongside their observed implementation levels?

The study contributes in three ways. Theoretically, it combines the resource-based view and the relational view to explain performance as the product of both organization-level capabilities and interorganizational routines (Barney, 1991; Dyer & Singh, 1998) [1, 7]. Empirically, it tests an integrated six-driver model with 516 observations and reports the measurement and structural model evidence needed for transparent PLS-SEM assessment. Practically, it distinguishes strong drivers from highly implemented capabilities. This distinction matters because a capability that is already common but weakly associated with incremental performance may deserve a different policy response from a capability that is underdeveloped yet strongly associated with performance.

2. Theoretical Background and Hypotheses

2.1 Certified fresh-produce supply chain performance

Supply chain performance is multidimensional. It encompasses efficient use of resources, effective fulfillment of customer requirements, product quality, delivery dependability, and economic outcomes (Fugate *et al*., 2010; Li *et al*., 2005) [10, 17]. In agri-food chains, these dimensions are tightly coupled. Delayed harvesting or transport can reduce freshness; inadequate storage can transform a service failure into physical loss; and volatile output quality can weaken buyer confidence and depress returns. Accordingly, the focal construct in this study encompasses on-time execution, low damage and quality deterioration, logistics cost optimization, buyer evaluations of freshness and quality, and overall profit and economic efficiency.

Certification changes the performance problem without eliminating it. Audit requirements can standardize production records and provide credible signals, but the economic value of certification still depends on downstream execution. GLOBALG.A.P. explicitly links assurance to traceability, production processes, postharvest handling, and supply chain transparency (GLOBALG.A.P., n.d.) [11]. In Hanoi, however, the practical conversion of certification into market value has been constrained by weak relationships, opaque information, and uneven control over distribution (Ngo *et al*., 2019) [19]. The core proposition of this study is therefore that certified-chain performance arises from a portfolio of complementary capabilities.

The resource-based view argues that valuable, inimitable resources and capabilities can support superior performance (Barney, 1991) [1]. Applied to certified fresh produce, logistics assets, skilled staff, digital systems, working capital, and risk routines, these productive capabilities are productive because they enable actors to meet quality and timing requirements under uncertainty. The relational view extends the unit of analysis beyond a single organization: interorganizational routines, knowledge sharing, complementary resources, and effective governance can generate relational rents that no actor could create independently (Dyer & Singh, 1998) [7]. Information sharing and relationship commitment are therefore not merely favorable attitudes; they are mechanisms through which farms, cooperatives, collectors, distributors, and retailers coordinate interdependent work.

2.2 Logistics and warehousing management capability

Logistics performance depends on the joint achievement of efficiency, effectiveness, and differentiation (Fugate *et al*., 2010) [10]. For fresh produce, this means more than moving goods at low cost. Chains require appropriate collection and storage facilities, cold or specialized transport where needed, packaging and grading routines, trained personnel, and routing systems that can adapt to urban congestion and narrow delivery windows. Inadequate postharvest infrastructure and handling practices increase both physical losses and quality deterioration (Food and Agriculture Organization of the United Nations [FAO], 2011) [8].

In certified chains, logistics capability also protects the credibility of the standard. A product grown under audited practices may still fail buyer specifications if temperature, handling, lot segregation, or delivery timing is poorly managed. Conversely, coordinated harvesting, packaging, and transport can preserve freshness, reduce claims, and improve asset utilization. Logistics and warehousing management capability should thus improve operational reliability and economic performance.

H1. Logistics and warehousing management capability positively affect the performance of the certified fruit and vegetable supply chain.

2.3 Information Sharing

Information sharing reduces the informational delays that create supply–demand mismatches and costly corrective action. Inventory research shows that the value of shared information comes from better decisions, not from data exchange in and of itself (Cachon & Fisher, 2000) [4]. In broader supply chain research, information sharing is a central element of integrated practice because it supports coordinated planning and faster response (Li *et al*., 2005; Simatupang & Sridharan, 2005) [17, 24].

For Hanoi’s certified fruit and vegetable chains, useful information includes buyer quality requirements, projected harvest volume, delivery schedules, prices, consumer preferences, inspection feedback, and unexpected changes in demand. Accuracy, timeliness, and accessibility are critical. A shared Zalo group, digital record, or software platform creates value only when actors post decision-relevant information and use it in joint planning. The local evidence that weak transparency constrains safe-vegetable chains reinforces the importance of this capability (Ngo *et al*., 2019) [19]. Timely information should reduce spoilage, prevent over- or undersupply, align quality expectations, and facilitate rapid adjustment.

H2. Information sharing positively affects the performance of the certified fruit and vegetable supply chain.

2.4 Relationship Commitment

Relationship commitment reflects the willingness of exchange partners to sustain a valued relationship and invest in its continuity. Buyer–seller relationship development depends on credible expectations, cooperation, and the progressive institutionalization of exchange (Dwyer *et al*., 1987) [6]. Supply chain partnerships likewise require partners to move beyond episodic transactions toward coordinated processes and shared objectives (Spekman *et al*., 1998) [25].

The need for commitment is pronounced in certified agriculture. Production plans are made before harvest, quality investments are often relationship-specific, and disruptions may require contract adjustment rather than strict short-term enforcement. Commitment is expressed through contract compliance, mutual trust, fair renegotiation, risk sharing, support for chain linkages, and a long-term orientation. The relational view predicts that these governance conditions reduce opportunism and support joint adaptation (Dyer & Singh, 1998) [7]. Recent evidence also suggests that commitment can improve performance by enabling deeper customer integration, although its effects may depend on the coordination mechanisms through which it is enacted (Ruzo-Sanmartín *et al*., 2023) [23].

H3. Relationship commitment positively affects the performance of the certified fruit and vegetable supply chain.

2.5 Risk Management

Fresh-produce supply chains face correlated and time-sensitive risks: adverse weather, pests and diseases, input price volatility, quality failures, transport disruptions, sudden buyer rejection, and demand instability. Supply chain risk management involves identifying, assessing, mitigating, and monitoring such exposures before they become performance losses (Ritchie & Brindley, 2007) [22]. Empirical agri-food research has connected risk and risk-management practices directly to supply chain performance (Nyamah *et al*., 2017) [20].

Risk management in the present context includes technical prevention, disease-response scenarios, solutions for input-price fluctuations, alternative market channels, and training in risk recognition and prevention. These practices create option value. Alternative buyers reduce dependence on a single outlet; predefined disease responses shorten reaction time; and trained actors are more likely to identify weak signals before losses spread. Because certification does not eliminate biological or market uncertainty, risk-management capability should be a direct driver of performance.

H4. Risk management positively affects the performance of the certified fruit and vegetable supply chain.

2.6 Information technology application

Information technology can improve supply chain integration by increasing data visibility, transaction speed, process standardization, and decision accuracy (Gunasekaran & Ngai, 2004) [12]. In certified agri-food chains, digital tools can connect electronic traceability, order processing, warehouse and transport management, field monitoring, and payment. Their value lies in creating a consistent information backbone across organizational boundaries.

Traceability is particularly important because it links product claims to auditable records. Digital traceability technologies can enhance the visibility and integrity of agri-food information, although organizational adoption and data quality remain decisive (Bosona & Gebresenbet, 2023) [3]. IT also interacts with relationship governance: empirical evidence indicates that technology and relationship commitment can jointly support coordination (Huo *et al*., 2015) [16]. In Hanoi, where QR-based traceability has expanded from a limited base, the practical use of IT should reduce manual errors, shorten information cycles, improve lot control, and support trusted fulfillment (Ngo *et al*., 2019) [19].

H5. The application of information technology positively affects the performance of the certified fruit and vegetable supply chain.

2.7 Financial Capability

Financial capability refers to the ability to fund operating needs and capability-enhancing investments. Certified production may require expenditures on approved inputs, greenhouses, handling facilities, documentation, audits, packaging, and traceability. Working capital is also needed to bridge the time between production expenditure and buyer payment. Small and medium-sized enterprises commonly experience financing constraints that limit growth and investment (Beck & Demirgüç-Kunt, 2006) [2], and similar constraints can affect farms and cooperatives.

In a certified chain, finance may come from internal capital, preferential credit, buyer advances, input support, or public programs. Adequate financing can prevent production interruptions, enable compliance-preserving investments, and help actors withstand delayed payments or temporary shocks. Finance is nevertheless expected to be an enabling capability rather than an automatic source of performance: capital produces value only when it is allocated to effective operational and relational routines.

H6. Financial capability positively affects the performance of certified fruit and vegetable supply chains.

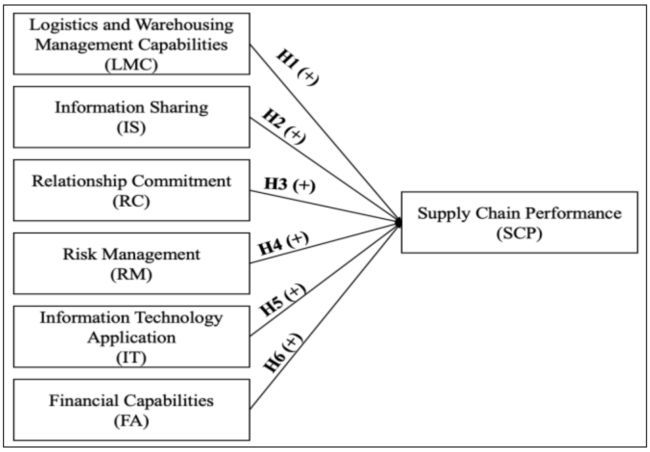

Fig 1: Conceptual model and hypotheses

3. Methodology

3.1 Research setting and analytical sample

The study focuses on actors in VietGAP-certified fruit and vegetable supply chains serving the Hanoi market. Hanoi is an analytically relevant setting because certified products must move through a dense urban distribution system while maintaining freshness, traceability, and buyer-specified quality. The supplied analytical dataset contains 516 observations and 33 manifest variables. All observations are complete for the indicators used in the PLS-SEM model; no missing-value replacement was required.

The analytical files provided for this manuscript did not include respondent demographics, the sampling frame, fieldwork dates, response rate, or survey-administration mode. To avoid fabricating evidence, these characteristics are not inferred from the indicator data. They should be inserted from the original field records before journal submission. The current analysis is therefore complete with respect to the supplied measurement and structural model, while sample-description metadata remains pending author verification.

3.2 Measures

All constructs were operationalized reflectively using five-point Likert-type items coded from 1 to 5. The instrument contained five items for logistics and warehousing management capability (LMC), five for information sharing (IS), five for relationship commitment (RC), five for risk management (RM), four for information technology application (IT), four for financial capability (FA), and five for supply chain performance (SCP). The direction of all items was positive; higher scores indicate stronger capability or performance.

Table 1: Construct operationalization and evidence-based

Code	Construct	Items	Content domain	Selected foundations
LMC	Logistics and warehousing management capability	5	Storage, transport, packaging/traceability labeling, personnel, urban routing	FAO (2011) [8]; Fugate *et al.* (2010) [10]; Ngo *et al.* (2019) [19]
IS	Information sharing	5	Requirements, plans, feedback, shared channels, transparency	Cachon and Fisher (2000) [4]; Li *et al.* (2005) [17]; Simatupang and Sridharan (2005) [24]
RC	Relationship commitment	5	Compliance, trust, fair adjustment, linkage support, long-term orientation	Dwyer *et al.* (1987) [6]; Spekman *et al.* (1998) [25]
RM	Risk management	5	Weather, disease, input-price, market, and prevention responses	Nyamah *et al.* (2017) [20]; Ritchie and Brindley (2007) [22]
IT	Information technology application	4	Electronic traceability, operations software, smart devices, digital payment	Bosona and Gebresenbet (2023) [3]; Gunasekaran and Ngai (2004) [12]
FA	Financial capability	4	Working capital, credit, buyer support, public financial support	Beck and Demirgüç-Kunt (2006) [2]
SCP	Supply chain performance	5	Timeliness, loss/quality, logistics cost, buyer evaluation, economic efficiency	Fugate *et al.* (2010) [10]; Li *et al.* (2005) [17]; Nyamah *et al.* (2017) [20]

Item content was grounded in established supply chain research and contextualized to certified fresh produce and Hanoi. The operational and performance domains draw on research in logistics and supply chain performance (Fugate *et al.*, 2010; Li *et al.*, 2005) [10, 17]. Information sharing and coordination reflect work on information value and collaborative practice (Cachon & Fisher, 2000; Simatupang & Sridharan, 2005) [4, 24]. Relationship commitment draws on buyer–seller and partnership research (Dwyer *et al.*, 1987; Spekman *et al.*, 1998) [6, 25]. Risk-management items follow supply chain and agri-food risk frameworks (Nyamah *et al.*, 2017; Ritchie & Brindley, 2007) [20, 22]. IT items cover electronic traceability and operations technology (Bosona & Gebresenbet, 2023; Gunasekaran & Ngai, 2004) [3, 12], whereas the financial-capability items capture working capital, credit, buyer support, and public support (Beck & Demirgüç-Kunt, 2006) [2]. Local contextualization was informed by documented challenges in coordination and traceability within Hanoi's safe-vegetable chains (Ngo *et al.*, 2019) [19]. The full wording and standardized loadings are reported in Table 2.

Table 2: Measurement Items and Standardized Loadings

Construct	Code	Item wording	Loading
Logistics and warehousing management capability	LMC1	The chain has storage, preliminary-processing, preservation, or cold-storage facilities suitable for certified fruits and vegetables.	.782
	LMC2	Transportation means, including cold or specialized vehicles where needed, are appropriate for certified fruits and vegetables.	.811
	LMC3	Packaging, grading, lot identification, and traceability labeling are implemented effectively.	.842
	LMC4	Personnel responsible for logistics and warehousing have suitable skills and experience.	.782
	LMC5	Routing and delivery schedules can be adjusted flexibly to Hanoi's urban distribution conditions.	.725
Relationship commitment	RC1	Supply chain partners comply with agreed contracts and commitments.	.865
	RC2	Partners have mutual trust in their supply chain relationship.	.882
	RC3	Partners renegotiate fairly and share risks when circumstances change.	.883
	RC4	Local government and supply chain actors actively support linkage development.	.851
	RC5	Partners view one another as long-term strategic collaborators.	.777
Information sharing	IS1	Market and buyer quality requirements are shared accurately and promptly.	.771
	IS2	Production, planting, and harvest plans are shared among relevant actors.	.739
	IS3	Market feedback on prices, preferences, quality, and inspection is communicated effectively.	.785
	IS4	The chain uses shared communication channels, software, or records to exchange information.	.767
	IS5	Information transparency helps reduce supply–demand mismatch and price pressure.	.765
Risk management	RM1	The chain has measures to mitigate weather and technical production risks.	.852
	RM2	The chain has response scenarios for pest and disease events.	.866
	RM3	The chain has solutions for fluctuations in input prices.	.904

	RM4	Alternative markets are available when problems arise in the Hanoi market.	.870
	RM5	Supply chain actors receive training in risk identification and prevention.	.853
Information technology application	IT1	Electronic traceability, such as QR codes or electronic production records, is applied effectively.	.802
	IT2	Software is used to manage orders, inventory, warehousing, or transportation.	.789
	IT3	Smart devices are used to monitor production, storage, or logistics activities.	.763
	IT4	Cashless or electronic payments are used in supply chain transactions.	.807
Financial capability	FA1	The actor has sufficient working capital for inputs, greenhouses, and VietGAP-related production requirements.	.766
	FA2	The actor can access preferential or suitable credit for certified production and supply chain activities.	.817
	FA3	Buyers or partners provide advances, inputs, or other financial support when needed.	.831
	FA4	Relevant public financial support, subsidies, or trade-promotion assistance is accessible.	.811
Supply chain performance	SCP1	Harvesting, packaging, and transportation are completed on schedule.	.859
	SCP2	The rate of damage, loss, and quality deterioration is low.	.829
	SCP3	Logistics costs are optimized across the supply chain.	.830
	SCP4	Distributors evaluate product freshness and quality positively.	.808
	SCP5	The supply chain achieves good overall profit and economic efficiency.	.785

3.3 Analytical Procedure

The hypotheses were tested with partial least squares structural equation modeling in SmartPLS 4 (Ringle *et al.*, 2024) [21]. PLS-SEM was appropriate because the study estimates the predictive relationships between a set of capability constructs and a focal performance outcome while accommodating a model with multiple latent variables and indicators (Hair *et al.*, 2019, 2022) [14, 13]. All constructs were specified as reflective, consistent with the expectation that the indicators are manifestations of their underlying capability or performance domain.

The PLS algorithm used path weighting, a maximum of 3,000 iterations, and a stopping criterion of 10^{-7}. The algorithm converged after six iterations. Statistical inference was based on nonparametric bootstrapping with 5,000 subsamples, a fixed seed, two-tailed tests, a .05 significance level, and percentile confidence intervals.

Measurement-model assessment proceeded in four stages. First, standardized outer loadings were examined for indicator reliability. Second, Cronbach's alpha, rho_A, and composite reliability were used to assess internal consistency. Third, average variance extracted (AVE) was used to assess convergent validity (Fornell & Larcker, 1981) [9]. Fourth, discriminant validity was assessed primarily through the heterotrait–monotrait ratio (HTMT), using .85 as a conservative reference value (Henseler *et al.*, 2015) [15]. These criteria follow current PLS-SEM reporting guidance (Hair *et al.*, 2019, 2022) [14, 13].

The structural model was assessed using inner variance inflation factors (VIFs), path coefficients, bootstrap standard errors, *t*-statistics, *p*-values, 95% confidence intervals, effect sizes (f^2), and the coefficient of determination (R^2). An SRMR value was reported as an approximate fit diagnostic, but interpretation centered on measurement quality, explanatory power, and the estimated paths, consistent with PLS-SEM's prediction-oriented logic. Effect-size interpretation followed Cohen's (1988) [5] conventional reference points of .02, .15, and .35 for small, medium, and large effects, respectively, while recognizing that substantive importance is context-dependent.

4. Results

4.1 Reflective measurement model

All 33 standardized indicator loadings exceeded .70, ranging from .725 to .904. The lowest loading was LMC5 (.725), and the highest was RM3 (.904). No indicator deletion was therefore required. Retaining the full item set also preserved the content coverage of the context-specific constructs.

Internal consistency and convergent validity were satisfactory for every construct (Table 3). Cronbach's alpha ranged from .800 to .919, rho_A from .802 to .920, and composite reliability from .869 to .939. AVE values ranged from .586 to .756, exceeding the .50 criterion. These results indicate that the reflective blocks consistently represent their intended constructs and explain more than half of the variance in their indicators.

Table 3: Internal consistency and convergent validity

Construct	Cronbach's α	rho_A	Composite reliability	AVE	Loading range
LMC	.848	.849	.892	.623	.725–.842
IS	.826	.830	.876	.586	.739–.785
RC	.905	.909	.930	.727	.777–.883
RM	.919	.920	.939	.756	.852–.904
IT	.800	.802	.869	.625	.763–.807
FA	.822	.831	.881	.650	.766–.831
SCP	.880	.882	.913	.677	.785–.859

Discriminant validity was supported by HTMT (Table 4). All values were below .85; the largest was .794 between relationship commitment and IT application. This pair is conceptually related because durable collaboration can facilitate technology-enabled coordination, but the estimate remains below the conservative threshold. The remaining HTMT values ranged from .458 to .765. The results, therefore, support empirical distinctiveness among the seven constructs.

Table 4: Heterotrait–monotrait ratios

Construct	FA	IS	IT	LMC	RC	RM	SCP
FA							
IS	.492						
IT	.703	.564					
LMC	.765	.560	.750				
RC	.676	.531	.794	.732			
RM	.458	.524	.464	.468	.458		
SCP	.655	.710	.740	.707	.694	.624	

4.2 Structural Model

Collinearity did not threaten the interpretation of the structural coefficients. Inner VIF values ranged from 1.410 for risk management to 2.301 for relationship commitment, remaining below the conservative value of 3. The six capabilities jointly explained 62.3% of the variance in supply chain performance (R^2 = .623; adjusted R^2 = .618). The model's SRMR was .049, with dULS = 1.354, dG = .496, χ^2 = 1,503.661, and NFI = .858. SRMR suggests an acceptable approximate fit, while the other indices are reported transparently rather than used as stand-alone acceptance rules.

Table 5 reports the hypothesis tests. All confidence intervals excluded zero, and all six hypotheses were supported. Information sharing exerted the strongest positive effect on supply chain performance (H2: β = .269, SE = .032, t = 8.317, p < .001, 95% CI [.205, .333]). Risk management was the second-strongest predictor (H4: β = .211, SE = .032, t = 6.678, p < .001, 95% CI [.148, .272]), followed by IT application (H5: β = .180, SE = .044, t = 4.138, p < .001, 95% CI [.094, .262]). Relationship commitment (H3: β = .148, SE = .042, t = 3.485, p < .001), logistics and warehousing management capability (H1: β = .128, SE = .038, t = 3.365, p < .001), and financial capability (H6: β = .098, SE = .042, t = 2.349, p = .019) also had positive effects.

Table 5: Structural model estimates and hypothesis tests

Hypothesis	β	SE	t	p	95% percentile CI	Results
H1:LMC → SCP	.128	.038	3.365	< .001	[.054, .202]	Supported
H2:IS → SCP	.269	.032	8.317	< .001	[.205, .333]	Supported
H3:RC → SCP	.148	.042	3.485	< .001	[.062, .229]	Supported
H4: RM → SCP	.211	.032	6.678	< .001	[.148, .272]	Supported
H5: IT → SCP	.180	.044	4.138	< .001	[.094, .262]	Supported
H6:FA → SCP	.098	.042	2.349	.019	[.018, .180]	Supported

The effect-size results qualify the ranking of coefficients. Information sharing produced the largest incremental contribution (f^2 = .126), followed by risk management (f^2 = .084), IT application (f^2 = .040), and relationship commitment (f^2 = .025). Logistics and warehousing management (f^2 = .019) were near the conventional small-effect boundary, while financial capability (f^2 = .013) was below it. Thus, the model explains a substantial share of performance through the combined capability portfolio, but no single predictor dominates the outcome.

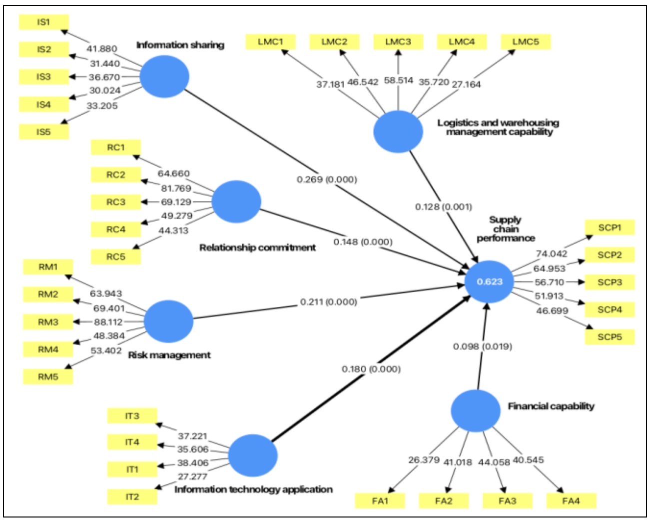

Fig 2: Estimated PLS-SEM structural model

5. Discussion

5.1 Interpretation of the Findings

The results support the central argument that certification-related performance depends on a complementary set of operational, relational, digital, risk, and financial capabilities. Together, the six antecedents explain 62.3% of the variance in supply chain performance, and all paths are positive. This breadth is theoretically meaningful: performance is not reducible to cold storage, software, trust, or working capital in isolation. Rather, certified fresh-produce chains perform when physical flows, information, relationships, risk responses, digital records, and financial resources reinforce one another.

Information sharing is the strongest driver. Its coefficient is more than twice that of financial capability and meaningfully larger than that of logistics capability. In a perishable chain, information has a high time value. Early notice of harvest volume, buyer specifications, delivery changes, or inspection feedback allows actors to adjust before a mismatch becomes waste. This finding is consistent with the proposition that shared information improves supply chain decisions and coordination (Cachon & Fisher, 2000; Li *et al*., 2005) [4, 17]. It is also highly context-relevant: earlier work in Hanoi identified limited information transparency as a barrier to stronger safe-vegetable relationships (Ngo *et al*., 2019) [19]. The present analysis goes beyond that diagnosis by showing that information sharing remains the strongest direct predictor even when five other capabilities are modeled simultaneously.

Risk management ranks second, and its low observed mean makes the result particularly consequential. Certified producers cannot standardize weather, disease, input markets, or urban demand. What they can standardize is preparedness: trigger points for technical intervention, protocols for product rejection, alternative outlets, rules for sharing losses, and rapid communication during disruption. The positive effect accords with risk-management frameworks that link proactive mitigation to operational continuity (Ritchie & Brindley, 2007) [22] and with agri-food evidence connecting risk practices to supply chain outcomes (Nyamah *et al*., 2017) [20]. Because risk management is less developed than the other capabilities in the sample, it represents a plausible source of unrealized performance.

The IT application is the third-strongest predictor. This result supports the view that technology creates value when embedded in operational processes rather than treated as a stand-alone visibility project. Electronic traceability, order and warehouse systems, smart monitoring devices, and cashless transactions can shorten cycle times and reduce record inconsistencies. Digital traceability can also strengthen the connection between certification claims and downstream verification (Bosona & Gebresenbet, 2023) [3]. The coefficient remains positive even after controlling for information sharing and relationship commitment, suggesting that IT contributes beyond the relational willingness to exchange information. At the same time, its effect is smaller than that of information sharing, indicating that installing a tool is not equivalent to establishing a high-quality information routine.

Relationship commitment also improves performance. Contract compliance, trust, fair renegotiation, institutional support, and a long-term orientation reduce the coordination costs that arise when partners fear opportunism or withdrawal. This result fits the relational view's emphasis on governance and joint value creation (Dyer & Singh, 1998) [7]. It also complements evidence that commitment may operate through customer integration (Ruzo-Sanmartín *et al*., 2023) [23]. In certified chains, the direct path may reflect the practical value of continuity: partners who expect to work together are more willing to align crop plans, preserve lot identity, share difficult information, and negotiate shocks rather than abandon transactions.

Logistics and warehousing capability have a positive but comparatively modest coefficient. Its descriptive mean is already high, which may indicate that basic handling, storage, packaging, and transport routines are more widely developed than coordination and risk routines. Marginal improvements still matter because physical integrity and delivery reliability are foundational in perishable chains. However, the result cautions against the idea that additional infrastructure alone will solve performance problems. A cold room cannot correct an inaccurate harvest forecast, and a specialized vehicle cannot compensate for delayed buyer information.

Financial capability has the smallest effect, although it remains statistically significant. This pattern is consistent with finance as an enabling resource. Working capital, credit, advances, and subsidies enable actors to invest and absorb timing gaps, but their contribution to performance depends on the processes they fund. Finance directed toward an isolated asset or short-term input purchase may have less leverage than finance tied to shared planning, contingency capacity, or interoperable traceability. The finding should therefore not be interpreted as an argument against access to credit; it is an argument for capability-linked finance.

5.2 Theoretical Contributions

First, the study extends capability-based reasoning to certified agri-food supply chains. Certification specifies a governance baseline, while the resource-based view explains heterogeneity in actors' ability to execute against that baseline (Barney, 1991) [1]. By jointly estimating logistics, IT, risk, and financial capabilities, the model shows that tangible and organizational resources make distinct contributions to performance.

Second, the study demonstrates that chain-level relational mechanisms add explanatory power beyond organization-centered resources. Information sharing and relationship commitment both remain significant in the full model, supporting the relational view's premise that interorganizational routines can generate value not owned by any single actor (Dyer & Singh, 1998) [7]. The dominant role of information sharing further suggests that relational value is realized through concrete decision routines, not merely through generalized goodwill.

Third, the integrated model clarifies complementarity without obscuring priorities. The sizeable R^2 arises from six positive paths, yet the effect-size profile is uneven. Information sharing and risk management have the greatest incremental relevance, while finance and logistics contribute more modestly at the margin. This reconciles two intuitions that are often treated as alternatives: certified chains need a portfolio of capabilities, but managers still need to sequence investment within that portfolio.

Fourth, the Hanoi evidence contributes to research on the development of safe food markets in emerging economies. Qualitative work has shown that certification can fail to produce market value when trust, transparency, and distribution governance are weak (Ngo *et al.*, 2019; Van Hoi *et al.*, 2009) [19, 26]. The present results identify which manageable capabilities are most closely associated with operational and economic outcomes within that context.

5.3 Managerial Implications

The priority is to create a shared operating cadence. Cooperatives and lead buyers should agree on a minimum data set, including expected harvest by grade, confirmed orders, rejection reasons, market prices, delivery status, and inspection findings, and specify who updates each field, when, and through which channel. A simple, disciplined routine can outperform a feature-rich platform with incomplete data. Weekly crop and demand planning should be supplemented by exception alerts when quantity, quality, or timing deviates from plan.

The second priority is to institutionalize joint risk protocols. Each chain should maintain a risk register that identifies weather, disease, input, logistics, quality, and market exposures; assigns an owner; defines early-warning indicators; and lists a response. High-impact scenarios should be rehearsed before the production cycle. Examples include approved alternatives for inputs, backup transport, prequalified secondary buyers, criteria for redirecting product, and rules for sharing the cost of buyer-requested changes. Public extension and plant-protection services can support the use of common templates and simulation exercises.

The third priority is to connect technology to workflow. QR codes and electronic records should use consistent lot identifiers from the farm through the buyer receipt. Order, warehouse, and transport data should be interoperable at the level needed for reconciliation, even if partners use different applications. Technology evaluation should focus on fewer errors, faster exception resolution, improved traceability completeness, and lower administrative effort, not simply the number of installed devices.

The fourth priority is to strengthen relational governance. Written agreements should clarify definitions of quality, acceptance procedures, payment timing, data responsibilities, and renegotiation rules in the event of material shocks. Periodic joint reviews should include both service outcomes and the fairness of value and risk allocation. This is especially important when cooperatives make relationship-specific investments that cannot be easily recovered through spot markets.

The fifth priority is to target logistics and finance at identified bottlenecks. Investment in cold storage, packaging, or vehicles should follow a product-flow diagnosis that specifies where time, temperature, handling, or capacity failures occur. Credit and public support should then be linked to measurable capability plans, for example, a financing package that combines a pre-cooling investment with staff training, shared harvest scheduling, and data capture. This approach uses finance as a multiplier of operational change rather than as an isolated input.

For policymakers, the results imply that certification support should extend beyond audit costs and physical infrastructure. Programs can fund shared data standards, risk-management training, contract templates, market diversification, and cooperative–buyer planning routines. The low mean and strong effect of risk management make it a particularly suitable target for extension services. Performance monitoring should include delivery reliability, rejected volume, product loss, traceability completeness, dispute resolution time, and partner profitability so that certification programs are evaluated by chain outcomes as well as the certified area.

6. Conclusion

This study examined six drivers of performance in VietGAP-certified fruit and vegetable supply chains serving Hanoi. Using PLS-SEM with 516 complete observations, the analysis obtained reliable and valid reflective measures, acceptable levels of collinearity, and positive support for all six hypotheses. Information sharing was the strongest predictor of supply chain performance, followed by risk management, information technology application, relationship commitment, logistics and warehousing management capability, and financial capability. Together, the six capabilities explained 62.3% of the variance in performance. The central conclusion is straightforward: certification creates an assurance architecture, but day-to-day performance is produced through capabilities. The most promising performance gains are likely to come from better information routines and stronger risk preparedness, supported by fit-for-purpose digital systems and durable relationships. At the same time, logistics and finance remain necessary, but their returns depend on how well they are connected to these coordinating capabilities.

These findings should nonetheless be interpreted in light of the study's limitations, each of which points to a productive direction for future research. Because the design is cross-sectional, the results support association and theory-consistent directional testing rather than definitive causal inference; longitudinal data would help establish whether capability improvements precede changes in product loss, delivery performance, and profitability. Because all constructs were measured from a single survey source, common-method bias cannot be fully ruled out from the supplied outputs, and future work should triangulate self-reports with buyer records, temperature and delivery logs, rejection rates, and audited traceability data. The supplied dataset also lacked respondent characteristics and sampling metadata, which are needed to assess representativeness and nonresponse and to compare actor types; multigroup analysis across farms, cooperatives, traders, distributors, and retailers, as well as between VietGAP-certified chains, would clarify where the six capabilities matter most.

Further opportunities follow from the model's scope. The present specification estimates only direct effects; therefore, future research should test complementarity more explicitly, for example, whether information technology strengthens the effect of information sharing, whether relationship commitment improves performance through customer integration, and whether financial capability contributes more when risk-management capability is high. Because performance was measured perceptually as a composite of operational and economic outcomes, subsequent studies could model freshness, loss, cost, service, and profitability as distinct outcomes or as a higher-order construct. Finally, predictive assessment on a holdout sample and out-of-sample procedures such as PLSpredict would strengthen claims about prediction beyond the explanatory evidence reported here.

7. References

1. Barney J. Firm resources and sustained competitive advantage. Journal of Management. 1991; 17(1):99-120. Doi: https://doi.org/10.1177/014920639101700108
2. Beck T, Demirgüç-Kunt A. Small and medium-sized enterprises: Access to finance as a growth constraint. Journal of Banking & Finance. 2006; 30(11):2931-2943. Doi: https://doi.org/10.1016/j.jbankfin.2006.05.009
3. Bosona T, Gebresenbet G. The role of blockchain technology in promoting traceability systems in agri-food production and supply chains. Sensors. 2023; 23(11):5342. Doi: https://doi.org/10.3390/s23115342
4. Cachon GP, Fisher M. Supply chain inventory management and the value of shared information. Management Science. 2000; 46(8):1032-1048. Doi: https://doi.org/10.1287/mnsc.46.8.1032.12029
5. Cohen J. Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates, 1988.
6. Dwyer FR, Schurr PH, Oh S. Developing buyer-seller relationships. Journal of Marketing. 1987; 51(2):11-27. Doi: https://doi.org/10.1177/002224298705100202
7. Dyer JH, Singh H. The relational view: Cooperative strategy and sources of interorganizational competitive advantage. Academy of Management Review. 1998; 23(4):660-679. Doi: https://doi.org/10.5465/amr.1998.1255632
8. Food and Agriculture Organization of the United Nations. Global food losses and food waste: Extent, causes and prevention, 2011. https://www.fao.org/4/mb060e/mb060e00.pdf
9. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research. 1981; 18(1):39-50. Doi: https://doi.org/10.1177/002224378101800104
10. Fugate BS, Mentzer JT, Stank TP. Logistics performance: Efficiency, effectiveness, and differentiation. Journal of Business Logistics. 2010; 31(1):43-62. Doi: https://doi.org/10.1002/j.2158-1592.2010.tb00127.x
11. Globalg AP. Integrated Farm Assurance for fruit and vegetables, n.d. Retrieved September 5, 2026, from https://globalgap.org/what-we-offer/solutions/ifa-fruit-and-vegetables/
12. Gunasekaran A, Ngai EWT. Information systems in supply chain integration and management. European Journal of Operational Research. 2004; 159(2):269-295. Doi: https://doi.org/10.1016/j.ejor.2003.08.016
13. Hair JF, Hult GTM, Ringle CM, Sarstedt M. A primer on partial least squares structural equation modeling (PLS-SEM) (3rd ed.). SAGE, 2022.
14. Hair JF, Risher JJ, Sarstedt M, Ringle CM. When to use and how to report the results of PLS-SEM. European Business Review. 2019; 31(1):2-24. Doi: https://doi.org/10.1108/EBR-11-2018-0203
15. Henseler J, Ringle CM, Sarstedt M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science. 2015; 43(1):115-135. Doi: https://doi.org/10.1007/s11747-014-0403-8
16. Huo B, Zhang C, Zhao X. The effect of IT and relationship commitment on supply chain coordination: A contingency and configuration approach. Information & Management. 2015; 52(6):728-740. Doi: https://doi.org/10.1016/j.im.2015.06.007
17. Li S, Rao SS, Ragu-Nathan TS, Ragu-Nathan B. Development and validation of a measurement instrument for studying supply chain management practices. Journal of Operations Management. 2005; 23(6):618-641. Doi: https://doi.org/10.1016/j.jom.2005.01.002

18. Ministry of Agriculture and Environment. Viet Nam has over 8,300 VietGAP-certified facilities and 2,000 safe agricultural supply chains, November 27, 2025. https://en.mae.gov.vn/viet-nam-has-over-8300-vietgapcertified-facilities-and-2000-safe-agricultural-supply-chains-9134.htm
19. Ngo HM, Vu HQ, Liu R, Moritaka M, Fukuda S. Challenges for the development of safe vegetables in Vietnam: An insight into the supply chains in Hanoi City. Journal of the Faculty of Agriculture, Kyushu University. 2019; 64(2):355-365. Doi: https://doi.org/10.5109/2339027
20. Nyamah EY, Jiang Y, Feng Y, Enchill E. Agri-food supply chain performance: An empirical impact of risk. Management Decision. 2017; 55(5):872-891. Doi: https://doi.org/10.1108/MD-01-2016-0049
21. Ringle CM, Wende S, Becker J-M. SmartPLS 4. SmartPLS GmbH, 2024.
22. Ritchie B, Brindley C. Supply chain risk management and performance: A guiding framework for future development. International Journal of Operations & Production Management. 2007; 27(3):303-322. Doi: https://doi.org/10.1108/01443570710725563
23. Ruzo-Sanmartín E, Abousamra AA, Otero-Neira C, Svensson G. The impact of the relationship commitment and customer integration on supply chain performance. Journal of Business & Industrial Marketing. 2023; 38(4):943-957. Doi: https://doi.org/10.1108/JBIM-07-2021-0349
24. Simatupang TM, Sridharan R. An integrative framework for supply chain collaboration. The International Journal of Logistics Management. 2005; 16(2):257-274. Doi: https://doi.org/10.1108/09574090510634548
25. Spekman RE, Kamauff JW Jr, Myhr N. An empirical investigation into supply chain management: A perspective on partnerships. Supply Chain Management: An International Journal. 1998; 3(2):53-67. Doi: https://doi.org/10.1108/13598549810215379
26. Van Hoi P, Mol APJ, Oosterveer PJM. Market governance for safe food in developing countries: The case of low-pesticide vegetables in Vietnam. Journal of Environmental Management. 2009; 91(2):380-388. Doi: https://doi.org/10.1016/j.jenvman.2009.09.008