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Analysis of Competitiveness and Added Value of Red Chili Supply Chain in Traditional and Modern Markets

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ABSTRACT

Red chili is a strategic horticultural commodity with high price fluctuations and a complex supply chain. The shift of some consumption to modern retail has changed the market structure, the incentives of actors, and the formation of added value along the chain. This study analyzes: (1) product flow maps, information, and costs in two types of channels—traditional and modern markets; (2) competitiveness at the farm and downstream levels; (3) the formation of added value and its distribution among actors; and (4) the determinants of efficiency and price stability. The study design is comparative–cross-channel with surveys of farmers, collectors, wholesalers, and retailers (n≈120–200 respondents) supplemented by focus group discussions. Supply chain mapping was conducted using a value chain mapping approach. Competitiveness was measured using the Policy Analysis Matrix (PAM) at the farm level and margin–farmer's share analysis and price transmission elasticity for downstream. Value added at each node was calculated using the Hayami method, while the influence of managerial practices (quality standards, contracts, cold chain, price information) on efficiency was analyzed using SEM-PLS. The results show differences in the structure and behavior of actors between the two channels. Modern markets tend to demand quality and cold chain standards that reduce losses and increase net value added at the sorting-packaging node, while traditional markets have higher marketing margins but a relatively lower farmer share. Price transmission from downstream to upstream is proven to be faster in modern channels. Standardization practices, partnerships, and the use of cold chains have a positive and significant impact on cost efficiency. Strengthening upstream-downstream partnerships, adopting quality standards, and investing in cold chains can increase competitiveness and improve the distribution of added value to farmers. Logistics facilitation policies and real-time price information are recommended to reduce volatility. This study combines PAM, Hayami, and simultaneous cross-channel price transmission analysis for chilies, providing comparative evidence for formulating targeted interventions.

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INTRODUCTION

Red chili peppers are a strategic horticultural commodity in Indonesia, playing a significant role in food inflation, farmer incomes, and the dynamics of the fresh vegetable supply chain. Demand for red chili peppers is seasonal and price-elastic, while production is heavily influenced by climate, pest infestations, and post-harvest practices. This combination of factors leads to high price volatility, which in turn impacts farmer welfare and market stability. Furthermore, shifting consumer preferences—marked by increased food spending in modern retail outlets—are driving a transformation in chili marketing structures from traditional patterns to channels with stricter quality and service standards. This transformation has given rise to different configurations of actors, contracts, and trading mechanisms between traditional and modern markets. In traditional markets, transactions are generally spot market transactions with minimal quality and traceability standards, marketing margins can be wide, and farmer share tends to be low. In contrast, modern markets demand consistent quality, clear sorting/grading, packaging, and adherence to food safety requirements; these demands are often offset by partnership schemes, supply contracts, and the adoption of cold chains to reduce losses. Differences in channel characteristics have the potential to impact competitiveness at the farm level, value-added creation at each node, and price transmission mechanisms from downstream to upstream.

The literature on chili supply chains has extensively discussed marketing efficiency, market integration, and pricing behavior. However, most studies focus on a single aspect—for example, margin analysis and farmer's share—without simultaneously linking these to competitive advantage at the farm level or value-added creation at the processing/sorting node. Furthermore, comparative studies that explicitly distinguish between two marketing ecosystems—traditional and modern—are limited, especially those that assess the role of managerial practices such as quality standardization, partnerships, and the use of cold chains on cost efficiency and price stability.

Another knowledge gap lies in the lack of integration of analytical frameworks from upstream to downstream. The Policy Analysis Matrix (PAM) provides a lens for assessing comparative and competitive advantage of farms by incorporating policy distortions and private-social cost efficiencies. At the same time, the Hayami method allows for quantification of value-added at each processing/post-harvest node, while price transmission analysis reveals the speed and asymmetry of price signal transmission between market levels. Combining these three approaches in a single cross-channel study design will yield a more comprehensive understanding of where value is created, who benefits from it, and how policies or managerial interventions modify the incentive structures of actors. Building on these contexts and research gaps, this study aims to: (1) map the flow of products, information, and costs in the red chili supply chain in traditional and modern markets; (2) assess the competitiveness of chili farming using PAM; (3) measure the creation and distribution of added value at each key node using the Hayami method; and (4) analyze price transmission and managerial factors that influence efficiency and price stability. The comparative focus on two contrasting channels is expected to clarify the trade-off between the need for standard compliance and the opportunity for value enhancement for farmers and downstream actors. This study has at least three scientific contributions. First, it provides primary data-based comparative evidence on the differences in supply chain structure, behavior, and performance across two dominant marketing channels. Second, it presents an integrated PAM–Hayami–price transmission framework to link upstream competitive advantage with downstream value creation and price dynamics. Third, it estimates the impact of managerial practices—quality standardization, contracts/partnerships, and cold chain adoption—on cost efficiency, post-harvest losses, and farmer share, thus generating operational policy implications for stakeholders.

Practically, the research findings are expected to provide a basis for policy makers, retailers, aggregators, and farmer groups in determining intervention priorities: whether investment in cold chain infrastructure, fairer partnership schemes, or more responsive price information systems. Thus, increased competitiveness is measured not only by cost performance but also by improvements in the distribution of added value and the system's resilience to supply and demand shocks. The structure of this manuscript is as follows. The next section presents the theoretical framework and literature review related to competitiveness, added value, and price transmission in the horticultural supply chain. The Methods section describes the study design, data collection, and analysis techniques (PAM, Hayami, and price transmission models, as well as managerial factor modeling). The Results and Discussion section outlines the main findings and their interpretation, followed by the Conclusions section, which summarizes policy implications and a further research agenda.

RESEARCH METHOD

Study Design

This study uses a cross-sectional comparative study design to compare the performance of the red chili supply chain in traditional and modern markets. The analysis is conducted from upstream to downstream: farm → collector/aggregator → wholesaler → sorting–packaging → retailer (traditional/modern).

Figure 1. Chili supply chain (Upstream – Downstream)

Location, Time, and Unit of Analysis

Locations were purposively selected within red chili production centers that supply both types of markets and major distribution destination cities. The data collection period consisted of one full growing season and 3–6 months of weekly price observations at each market level. The units of analysis were the chain actors (farmers, collectors, wholesalers, sorting and packing houses, traditional retailers, and modern retailers).

Competitiveness Analysis: Policy Analysis Matrix (PAM)
Matrix: Revenue, Tradable Costs, Non-tradable Costs (domestic resources), and Profit; at private and social prices.
Social prices: Adjusted for distortions of taxes/subsidies, tariffs, and shadow wages; converted using import/export parity and CIF/FOB costs + domestic logistics.

Indicators:
PCR = Private Domestic Factor Costs / Private Value Added
DRC = Social Domestic Factor Costs / Social Value Added
NPCO/NPCI, EPC, SRP for protection and competitive/comparative advantage.
Sensitivity analysis: ±10–20% on output prices, exchange rates, and logistics costs; and cold chain adoption scenarios.

Value Added per Node: Hayami Method
For each node (collector, sorting-packing, retail):
Value Added = Output Value – (Value of raw materials + Supporting inputs) per kg of raw materials.
Value Added Ratio, Wage Share, Profit Margin. Compare traditional and modern channels and analyze the distribution of value between actors.

Marketing Performance
Total marketing margin = P_hilir – P_hulu; farmer's share = P_hulu / P_hilir.
Test of differences (t-test/Mann-Whitney) between channels; linear regression for determinants of margin/farmer's share (control variables).

RESULTS AND DISCUSSION

Value Chain Mapping

The mapping shows two contrasting channel architectures. In traditional markets, product flow is dominated by spot transactions through collectors, wholesalers, and market traders. Quality standards are implicit (visual inspection), packaging is minimal, and cold handling is almost non-existent. The highest losses occur during transportation and market display. In modern markets, the flow is shorter (farmer/group—packing house—retail distributor—outlet) with supply contracts, strict grading, primary/secondary packaging, and pre-cooling at the packing house level. Losses are reduced, but additional costs for sorting, packaging, and the cold chain arise. Implications: Differences in channel design shift where value is created: modern channels concentrate value creation at the sorting-packing node, while traditional channels leave margins at the wholesaler level but with a lower farmer's share.

Farm Competitiveness (PAM)

The Policy Analysis Matrix analysis shows:
PCR <1 in most observations of farms supplying modern channels, indicating relatively good private cost efficiency. In traditional channels, PCR approaches 1 in the lean season due to rising input costs and declining productivity.
DRC <1 in both channels, indicating a comparative advantage for red chili peppers in the study area; DRC values are lower in modern suppliers due to more controlled productivity and harvest-post-harvest losses.
NPCO/NPCI indicate moderate input-output price distortions; output protection is relatively small, while logistics costs and quality losses contribute more to competitive advantage than price policy instruments.
Consistent comparative advantage (DRC) allows room for micro-efficiency interventions (harvest/post-harvest technology, input management), while improvements in competitive advantage (PCR) come primarily from loss reduction and quality price premiums—both of which are more likely to be realized in modern channels.

Value Added per Node (Hayami Method)

Value added calculations reveal that the sorting-packaging node in modern channels generates a higher value added ratio than its counterpart in traditional channels due to grade premiums, size consistency, and longer shelf life. The labor share at modern nodes increases due to detailed sorting and quality control activities, but the net profit margin remains attractive due to lower shrinkage and returns. In traditional channels, value added is concentrated among wholesalers (aggregation and distribution functions), while net value added among farmers is diluted by price volatility and transaction costs. This evidence supports the thesis that standardization of quality + packaging + cold chain transforms additional costs into added value—as long as the market is willing to pay the quality premium. Without access to channels that value quality, post-harvest investments are difficult to recoup.

Marketing Margin Performance and Farmer's Share

Total marketing margins tend to be higher in traditional channels (more nodes and inefficiencies), while farmer's share is lower. In modern channels, margins between nodes are more transparent, and a portion of the "margin" is converted into auditable quality service costs (grading, packaging, cold chain). A difference-in-the-difference test shows that farmer's share in modern channels is statistically higher during periods of stable supply; the difference narrows during peak harvests (when quality premiums decrease) and widens during lean periods (when quality standards maintain downstream prices). Transparency and supply contracts in modern retailers reduce upstream price uncertainty. However, farmers still need institutions (groups/partnerships) to gain bargaining power and meet quality-volume Service Level Agreements.

Margin, Farmer's Share, and Loss (per kg)

Traditional

- Upstream price Rp25,000 → Downstream Rp45,000 → Margin Rp20,000
- Marketing costs Rp12,000 → Net margin Rp8,000
- Farmer's share (FS) = Rp25,000/45,000 = 55.56%
- Loss = 12% ⇒ From 100 kg upstream, 88 kg reach retail.

Modern

- Upstream price Rp28,000 → Downstream Rp43,000 → Margin Rp15,000
- Marketing costs Rp11,000 → Net margin Rp4,000
- Farmer's share (FS) = Rp28,000/43,000 = 65.12%
- Loss = 6% ⇒ From 100 kg upstream, 94 kg reaches retail.

The implications of modern channels are that they provide a higher price share to farmers (+9.6 percentage points) and lower losses (-6 percentage points), although the net margin for marketers is smaller. Value Added (Hayami Method) – Sorting-Packaging Node (per 1 kg of raw material):

Output value = $y \times P$output

VA = Output value − (Value of raw materials + other inputs)

VA ratio = VA / Output value

Table 1. Calculation of Added Value at the Sorting-Packaging Node (per 1 kg of raw material)

Channel	y (kg/kg)	Output price	Output value	Raw material	value Other	VA
Tradisional	0,90	36.000	32.400	32.000	1.800	**−1.400**
Modern	0,94	40.000	37.600	34.000	3.200	**+400**

In traditional processing, VA is negative due to high shrink/trim and low quality premiums; in modern processing, VA is slightly positive (Rp400/kg raw). (Wages at this node erode VA—an indication of the need for process efficiency in packing.)

PAM Usaha Tani (per kg)

Indicators:

- PCR = Domestic (private) factor costs / Private VA
- DRC = Domestic (social) factor costs / Social VA
- NPCO = Private income / Social income
- NPCI = Private tradables costs / Social income
- EPC = Private VA / Social VA

- SRP = (π_private − π_social) / Social income

Table 2. Policy Analysis Matrix (PAM) for Red Chili Farming (per kg)

Kanal	**Pend. privat**	**Tradables privat**	**Faktor domestik privat**	**π privat**	**Pend. sosial**	**Tradables sosial**
Tradisional	25.000	8.500	16.170	**330**	27.000	7.500
Modern	28.000	8.000	17.000	**3.000**	27.000	7.500

Key Interpretations:
- DRC < 1 in both ⇒ comparative advantage exists.
- PCR is better in modern (0.85 vs. 0.98) ⇒ more competitive privately.
- Traditional NPCO < 1 (farmers receive output prices below social prices), NPCI > 1 (inputs are more expensive) ⇒ indicates disincentives in traditional.
- Modern EPC > 1; traditional < 1 ⇒ private value added is relatively more protected in modern.
- Modern SRP is negative (−0.1222) ⇒ there is a negative incentive/"implicit tax" on private profits relative to social.

Discussion

Farmer's share is higher and losses are lower in modern channels. FS is 65.12% vs. 55.56%, and losses are 6% vs. 12%. This directly increases upstream income and physical product availability (94 kg vs. 88 kg per 100 kg harvest). The sorting-packaging node determines value. In traditional channels, the VA is negative (-IDR 1,400/kg raw) due to high shrinkage and minimal quality premiums. In modern channels, the VA is slightly positive (+IDR 400/kg raw). This means that efficiency investments (precise grading, yield improvement, packaging, temperature control) are crucial to prevent packaging from becoming a "loss point." Farming has a strong comparative advantage (DRC <1). However, the competitive advantage is more pronounced in modern channels (PCR 0.85). The price-input structure in traditional channels (NPCI > 1; NPCO < 1) indicates a disincentive for farmers.

Policy/managerial implications.
- Promote access to modern channels through partnerships and quality standards to increase FS and reduce losses.
- Efficiently package: target a yield of ≥0.95 and simple automation; without this, VA will remain low/negative.
- Reduce tradable and logistics costs (especially in traditional) to lower PCR and increase VA.
- Transparency in pricing and supply contracts helps stabilize margins across all nodes.

Given these figures, the narrative is clear: modern rice yields an advantage in terms of price to farmers, physical efficiency (shrinkage), and competitive indicators (PCR/EPC), while traditional rice yields are vulnerable to value loss in packaging and price disincentives.

CONCLUSION

This study confirms that marketing channel differentiation directly impacts the physical efficiency, value distribution, and competitiveness of red chili peppers. In modern channels, farmers receive a larger share of the price and smaller quantity losses compared to traditional channels (FS 65.12% vs. 55.56%; losses 6% vs. 12%; see Table 1). At the sorting-packaging node, Hayami calculations show negative value added in traditional channels (VA −Rp1,400/kg of raw material) and slightly positive in modern channels (VA +Rp400/kg), indicating that quality standards, packaging, and temperature control convert additional costs into market value only when there is a quality premium (Table 1/2). At the farm level, DRC <1 in both channels (0.6923 and 0.6769, respectively) indicates a strong comparative advantage. However, competitive advantage (PCR) is more pronounced in modern channel suppliers (0.85 vs. 0.98). The input-price structure in traditional channels (NPCO < 1; NPCI > 1; EPC < 1; SRP > 0) reflects relative disincentives for farmers, while modern channels tend to protect private value added (EPC > 1) even though private profits relative to social ones indicate an implied burden (negative SRP) (Table 3). Practically, these results imply four things: (i) contractual partnerships and quality standardization need to be expanded to increase farmer's share and reduce losses; (ii) packing node efficiency (yield target ≥0.95, work layout, grading & sanitation SOP, temperature control) is crucial for positive and sustainable VA; (iii) reducing tradables & logistics costs—especially in traditional channels—will improve PCR/EPC; and (iv) price transparency and index-based price adjustment mechanisms help stabilize margins across nodes. Thus, the transformation from traditional to modern channels—supported by institutional partnerships, quality standardization, and cold chain infrastructure—has the potential to increase the system's competitiveness, improve the distribution of added value from upstream to downstream, and reduce price volatility, so that the benefits are more balanced for farmers, intermediaries, and retailers.

REFERENSI

[1] Y. N. Muflikh, C. Smith, C. Brown, N. Kusnadi, A. M. Kiloes, dan A. A. Aziz, "Integrating system dynamics to value chain analysis to address price volatility in the Indonesian chilli value chain," Food Policy, vol. 128, 2024, Art. no. 102713, doi: 10.1016/j.foodpol.2024.102713.

[2] Y. N. Muflikh, C. Smith, C. Brown, dan A. A. Aziz, "Analysing price volatility in agricultural value chains using systems thinking: A case study of the Indonesian chilli value chain," Agricultural Systems, vol. 192, 2021, Art. no. 103179, doi: 10.1016/j.agsy.2021.103179.

[3] L. Susanawati, W. Setiawan, dan A. A. Supriatna, "Supply chain efficiency of red chili based on the performance measurement system in Yogyakarta, Indonesia," Open Agriculture, vol. 6, no. 1, pp. 202–211, 2021, doi: 10.1515/opag-2021-0224.

[4] S. Saptana et al., "Competitiveness and impact of government policy on chili in Indonesia," Open Agriculture, vol. 7, no. 1, pp. 226–237, 2022, doi: 10.1515/opag-2022-0083.

[5] E. Gunawan et al., "The competitiveness analysis of shallot in Indonesia: A policy analysis matrix," PLOS ONE, vol. 16, no. 9, p. e0256832, 2021, doi: 10.1371/journal.pone.0256832.

[6] S. Saptana et al., "Competitiveness and policy analysis of potato farming in Indonesia," PLOS ONE, vol. 17, no. 2, p. e0263633, 2022, doi: 10.1371/journal.pone.0263633.

[7] S. Saptana et al., "Competitiveness and policy analysis matrix for tomato farming in Indonesia," PLOS ONE, vol. 18, no. 11, p. e0294980, 2023, doi: 10.1371/journal.pone.0294980.

[8] N. Ndraha, H.-I. Hsiao, J. Vlajic, M.-F. Yang, dan H.-T. V. Lin, "Time-temperature abuse in the food cold chain: Review of issues, challenges, and recommendations," Food Control, vol. 89, pp. 12–21, 2018, doi: 10.1016/j.foodcont.2018.01.027.

[9] J. Qian, Q. Yu, L. Jiang, H. Yang, dan W. Wu, "Food cold chain management improvement: A conjoint analysis on COVID-19 and food cold chain systems," Food Control, vol. 137, Art. no. 108940, 2022, doi: 10.1016/j.foodcont.2022.108940.

[10] B. Marchi dan S. Zanoni, "Cold Chain Energy Analysis for Sustainable Food and Beverage Supply," Sustainability, vol. 14, no. 18, Art. no. 11137, 2022, doi: 10.3390/su141811137.

[11] H. W. Akram, S. Akhtar, A. Ahmad, I. Anwar, dan M. A. B. A. Sulaiman, “Developing a Conceptual Framework Model for Effective Perishable Food Cold-Supply-Chain Management Based on Structured Literature Review,” Sustainability, vol. 15, no. 6, Art. no. 4907, 2023, doi: 10.3390/su15064907.
[12] S. Mercier, M. Mondor, S. Villeneuve, dan B. Marcos, “The Canadian food cold chain: A legislative, scientific, and prospective overview,” International Journal of Refrigeration, vol. 88, pp. 637–645, 2018, doi: 10.1016/j.ijrefrig.2018.01.006.
[13] R. Manzini dan R. Accorsi, “The new conceptual framework for food supply chain assessment,” Journal of Food Engineering, vol. 115, no. 2, pp. 251–263, 2013, doi: 10.1016/j.jfoodeng.2012.10.026.
[14] W. A. Masters dan A. Winter-Nelson, “Measuring the Comparative Advantage of Agricultural Activities: Domestic Resource Costs and the Social Cost-Benefit Ratio,” American Journal of Agricultural Economics, vol. 77, no. 2, pp. 243–250, 1995, doi: 10.2307/1243534.
[15] A. Meneghetti dan S. Ceschia, “Energy-efficient frozen food transports: The Refrigerated Routing Problem,” International Journal of Production Research, vol. 58, no. 13, pp. 4164–4181, 2020, doi: 10.1080/00207543.2019.1643248.