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Integrated Economic Efficiency and Vulnerability of Chu-Mango Value Chain in the Mekong Delta, Vietnam

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ABSTRACT

The main purpose of this study is to identify the allocation of cost, revenue, and net profit of stakeholders in marketing channels, identify vulnerable actors, and suggest policies for the sustainability of the Chu-mango value chain. This study employed value chain analysis to analyze the integrated economic efficiency of the Chu-mango value chain in the Mekong Delta, Vietnam. A total of 404 observations were collected from farmers, cooperatives, collectors, wholesalers, local retailers, export enterprises, processing firms, and supermarkets/fruit shops**.** The integrated economic efficiency of the Chu-mango value chain amounts to a revenue of USD 530.4 million and a net profit of USD 54.3 million. The export channels provide a revenue of USD 135.1 million and a net profit of USD 14.1 million while the domestic channels provide a revenue of USD 395.3 million and a net profit of USD 40.2 million. The findings show that farmers are the most vulnerable actors in the chain in terms of small-scale and low mango quality. This study suggests three policy initiatives: quality improvement, technological progress, and benefit re-distribution. The findings of this study contribute to the literature on value chain analysis for other tropical fruits and vegetables, and confirm the role of the value chain approach in policymaking.

Keywords: *Export channel; domestic channel; profit; integrated economic efficiency.*

1 Introduction

During the last decades, global agri-food systems have changed dramatically owing to the influences of internationalization, urbanization, income progression, dietary alteration, and technological advances (Pilar et al., 2021). Fruits and vegetables, which are important components of the food chain, do not stand outside the transformation. The global trade in fruits and vegetables is increasing to meet consumer demand for a regular supply of high-quality, safe, and nutritious fresh food products. Several factors contribute to this trend, including changing consumer lifestyles and eating habits, which promote a greater consumption of fruits and vegetables. This boosts high-value supply chains for developing nations to meet the requirements of foreign and domestic markets (Pilar et al., 2021) and provides a great opportunity for small-and medium-scale cultivators to reduce poverty (Reardon et al., 2012). Therefore, the FAO and WHO choose the year 2021 as the *International Year of Fruits and Vegetables* to confirm their vital role in health impacts, production, value chains, and consumption (FAO, 2021).

Value chain analysis (VCA) was used which is based on Porter's theory and has been developed by several researchers and policymakers. It is considered a diagnostic tool for researching the interactions between stakeholders in the chain (Trienekens, 2011), especially in the context of the impact of globalization. Value chain analysis helps identify key chain actors (mapping), evaluates institutional arrangements in the chain (governance), addresses the means of added value (chain upgrading), and analyzes the benefits to stakeholders

(Kaplinsky and Morris, 2003). In particular, VLC can guide policy interventions towards the reallocation of benefits for vulnerable actors within the chain and agri-food studies show ways to run the whole chain sustainably.

To develop the agricultural sector, the Vietnamese government emphasizes the idea of cooperation between producers, the state, companies and the research community, the "four houses" where all four actors have an essential role to play in agricultural development. There is an increasing recognition that traders, exporters, and processors are key actors in enhancing domestic and international markets. The policy also encourages the participation of all stakeholders in the value chain to achieve a more effective chain. Chu-mango is an important fruit in Vietnam and is popularly used as a source of vitamins. Chu-mango is a well-known variety in local and foreign markets (William, 2014). Chu-mango has a sweet taste, large amount of water, thick flesh, yellow color, and pleasant aroma. It is not only used as a fresh fruit but also in processed products.

In this study, VCA was applied to analyze the integrated economic efficiency of the domestic and export marketing channels of Chu-mango in Vietnam at market prices. The main purpose of this study is to identify the allocation of cost, revenue, net profit of stakeholders in marketing channels, and the value of the whole chain, and to identify vulnerable actors. This study helps to identify potential opportunities for the Chu-mango subsector in both international and domestic markets, to encourage quality improvement of vulnerable actors for participating in marketing channels, to increase their income, and to suggest policies for efficiently upgrading marketing channels.

2 Methodology

2.1 Sampling technique

A multi-stage sampling technique was used to select the study area. First, the Mekong Delta (MD) region was purposively selected because of its comparative advantage for mango production systems, accounting for 62.8% of the production volume and 48.2% of the production area of mango in Vietnam. Second, Dong Thap, An Giang, Tien Giang, and Vinh Long provinces were chosen (Figure 1) as the four provinces accounted for approximately 80.4% of the mango production volume and 68.8% of the production area in the MD (GSO, 2020) (Table 1).

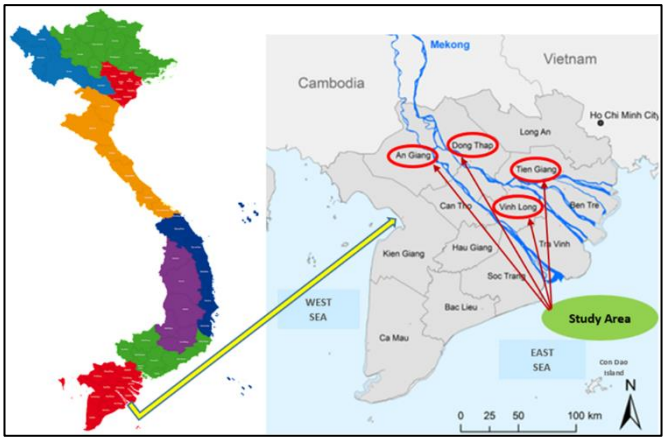

Figure 1. Study area in the Mekong Delta, Vietnam (Source: www.usssavage.org/MekongDelta.html).

Table 1.
Area, yield and productivity of mango in the study area and MD in 2019.

Province	Area (Thous.ha)	Percent. (%)	Yield (Thous.tons)	Percent. (%)	Productivity (ton/ha)
Dong Thap	11,500	23.9	130,102	25.4	11.3
An Giang	11,240	23.3	120,983	23.6	10.8
Tien Giang	4,282	8.9	95,898	18.7	22.4
Vinh Long	6,108	12.7	65,164	12.7	10.7
Mekong Delta	**48,154**		**511,854**		**10.6**

Source: GSO, 2020

Chu-mango, the most well-known mango variety in the MD and in Vietnam, accounts for about 20% of the production area and about 22,6% of the production volume of mango in the MD. In the study area, Dong Thap, An Giang, Tien Giang, and Vinh Long account for approximately 45% of the area and 55% of the volume of Chu-mango in the MD (GSO, 2020). A simple random technique was used to select 404 sampling observations for the Chu-mango value analysis (main actors). In 2018, 267 farmers were approached through a questionnaire, covering approximately 4.9% of the volume and 3.6% of the Chu-mango study area (Figure 2). The study did not classify farmer groups. However, the results of group discussions with agricultural extension centers in the study area showed that most farmers are smallholders, cultivating less than 2 ha of Chu-mango. In 2019, the study continued to sample additional 137 observations, including five cooperatives/farmer groups, 30 collectors, 30 wholesalers, 45 local retailers, seven export enterprises, five processing firms, and 15 supermarket/fruit shops.

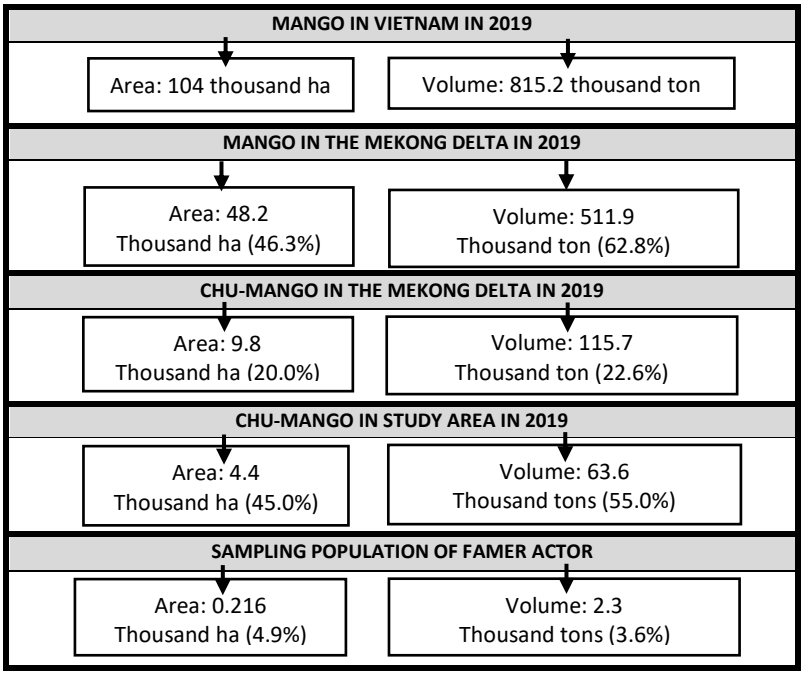

Figure 2. Procedures for selecting the farmer sample.
(Source: GSO 2020, group discussion 2018-2019, and calculation by author 2020).

Based on information from farmers, the study identified the downstream actors (traders) who handled mangoes (Figure 3). It selected representatives that either belonged to the 30% of the most popular ones or represented the largest operation.

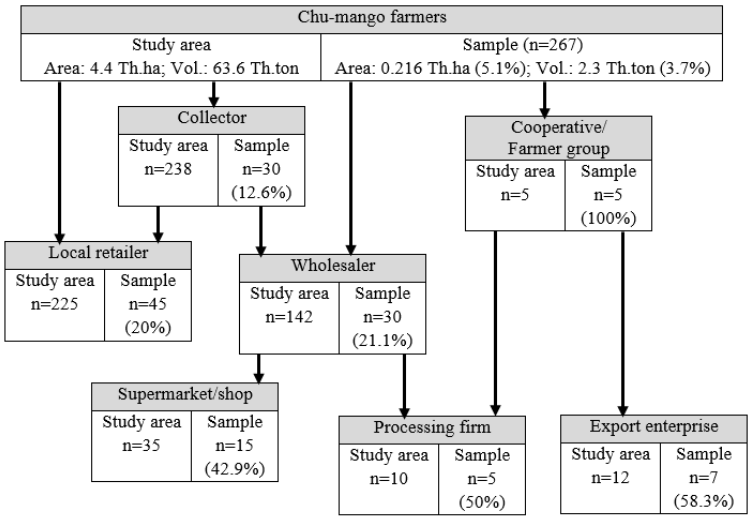

Figure 3. Sampling observation size of trade actors in the study area.
(Source: Group discussion and Calculation of author in 2020)

Using the flowering stimulation technique, farmers can harvest mangoes year-round (maximum three crops per year). However, they usually choose two crops per year or five crops in two years to help mango orchards recover well.

Table 2.
Seasonal schedule of Chu-mango in the Mekong Delta.

Months		1	2	3	4	5	6	7	8	9	10	11	12
Sunny season	Natural season	Flower			Harvest								
	Early season		Harvest									Flower	
Rainy season	Off-season					Flower			Harvest				
	Late season	Harvest							Flower			Harvest	

Source: Field Survey Data, 2018

2.2 Literature review

Many documents associated with the VCA approach for policy analysis have been published by FAO (Bockel and Tallec, 2005). These materials mentioned several aspects of VCA for policymaking (public and private agents, domestic and international markets, inputs-outputs, production factors, institutions, the environment, natural resources, etc.). It involves the following domains: socio-economic context of the value chain, demand for value chain outputs, analysis of the institutional set-up, analysis of input and output markets, functional analysis of the value chain, and economic analysis of the value chain.

Analysis of the value chain can guide policy interventions towards the reallocation of benefits for vulnerable actors within the chain and show how to run the whole chain sustainably, especially in agricultural product studies. Agri-supply chains are economic systems that distribute benefits and apportion risks among participants. Thus, supply chains enforce internal mechanisms and develop chain-wide incentives to ensure timely production and delivery commitment. They are linked and interconnected by virtue of shared information, reciprocal scheduling, product quality assurance, and transaction volume commitments. According to Lorenzo (2013), a VCA presents flows of marketing channels with a structure of cost and profit among actors in a chain. VCA is considered an accounting framework and not an econometric model to determine the factors influencing stakeholders' economic efficiency, especially socio-economic factors. Furthermore, VCA is limited in measuring trade-offs and impacts related to various policy options (Rich et al., 2011).

In agriculture, VCA implies managing the relationships between businesses responsible for the efficient production and supply of products from the farm level to consumers to meet consumers' requirements reliable in terms of quantity, quality, and price. In practice, this often includes the management of both horizontal and vertical alliances, and the relationships and processes between firms.

VCA not only helps understand interactions among stakeholders from production to consumption (Fernandez-Stark et al., 2012) but also identifies aspects of availability, accessibility, quality, and sustainability of collaboration (De Brauw et al., 2015; Hawkes and Popkins, 2015). Match's study (2011) showed that there are three types of mango chains serving different market segments (high-quality fresh mangoes for export, fresh mangoes for local markets, and processed products). Two important markets in the chain of fresh mango exports are the Middle East and Turkey. To increase competitiveness, the fresh mango export chain must improve postharvest facilities, farm management, and market linkages. Karina et al. (2017) studied a mango value chain in the Philippines. The findings indicated that the Philippines accounted for 4% of the global mango trade (fresh and processed mangoes). Mango is mainly consumed in the domestic market (98%). Eighty percent of export companies are small-and medium-scale, and 73% of farmers own mango farming areas of less than 3 ha. Philippines mainly export processed mango products to the United States, Hong Kong, South Korea, Japan, China, and Canada.

In Vietnam, William (2014) emphasized that the Chu-mango value chain exports about 63%, while the HoaLoc-mango value chain concentrates on the domestic market (77%). According to Kiet et al. (2015), the Chu-mango export channel comprises approximately 74.5% of the total fresh mango market. The proportion of processed mangoes in Vietnam is low, accounting for 10% of production (150 fruit processing factories in Vietnam). Processing companies focus primarily on exports (Anh et al., 2020) producing value-added products such as dry, frozen, bars, and ice cream mangoes. A few processing companies and exporters have storage and cooling systems. The findings indicate that the vast majority of Vietnamese mangoes were exported to the Chinese market. This means that Vietnamese mango production is at high risk because it relies heavily on one market.

Mango farmers are smallholders, with a farming area of 0.5-1.0 ha (William, 2014; Peter, 2020). Laura (2016) noted that small-scale growers' participation in the value chain in Dong Thap province is very limited. Farmers who are members of the cooperative play an important role. They share market information, access resources, and use advisable techniques. Currently, quality information is poorly understood, particularly in with regard to targeted markets, competitiveness, and market connections. This severely obstructs the actors' collaborates in the chain.

A study by Xuan et al. (2020) contended that the Vietnamese government is interested in expanding both mango production and consumption with priority policies to benefit smallholder mango cultivators and increase stakeholders' income in the value chain. It is expected that actors will become more competitive and efficient in the value chain.

2.3 Empirical model

The concept of collective economics reflects stakeholder collaboration and alliances becoming increasingly popular. This refers to the relationship between input providers, producers, collectors, distributors, wholesalers, retailers, and final customers. The marketing channel is defined as the expansion of supply chain management to understand the demands of each client and segment in every channel (Ayers and Odegaard, 2008). This creates delivery value networks, not only vertical alliance stakeholders but also horizontal collaboration of the same agents. This is known as a value chain. Value chain analysis (VCA), developed based on Porter's theory in 1985, has been considered a novel methodological tool since the 1990s. It is a systematic approach to evaluate competitive advantage in the context of international trade and globalization and to identify the value in each stage of the production process. The value chain includes the operating profit, which consumers are willing to pay above the cost of performing both groups of activities. Each activity creates costs and connections for certain activities. The VCA was based on Porter's theory and has been developed by several researchers and policymakers. It is considered a diagnostic tool for researching the interactions between stakeholders in the chain (Trienekens, 2011), especially in the context of the impact of globalization. Value chain analysis helps identify key chain actors (mapping), evaluates institutional arrangements in the chain (governance), addresses the means of added value (chain upgrading), and analyzes the benefits of stakeholders (Kaplinsky and Morris, 2003).

Researchers have applied value chain analysis in their studies for various purposes. Michael and Deigan (1989) emphasized cost objectives because the cost of performing one activity often affects other activities in the production process. Ramirez (1999) concentrated on a value co-production framework to gain a better understanding of business opportunities, management, and organizational practices. Kaplinsky and Morris (2003) add value to the value chain. Mau (2002) used value chain analysis to analyze inputs and outputs and demonstrate the allocation of resources with activity-based cost (ABC). Dekker (2003) contends that the provision of information plays a pivotal role in the value chain for the coordination and optimization of activities across firms. Bilateral and multilateral aid organizations are persuaded by the efficiency of value chain analysis in both the research and policy fields to guide some of their development interventions (Henriksen et al., 2010). A value chain is a sequence of coordinating and collaborating activities that can be integrated into the value of products or services by interacting with actors in the chain (Douglas et al., 2016). Mapping reflects stakeholders' characteristics, profit and cost structures, and flows in marketing channels (Dominic et al., 2020).

Andreas's (2018) value chain framework was applied. This is a well-known tool applied in the agri-food value chain in several developing countries that focus on agriculture. It is published by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). It has the following main components: production stages, stakeholders, final users, and supporters. The stages of production are input dealers, production, collectors, processing, trade, and consumption. Each stage has several different activities such as fertilizer, agrochemical, labor (input supplier), soil preparation, crop care, harvesting (cultivation), collection and transport (collector), packing and labeling (processing), merchandise and business (trade), and domestic and export (consumption). The main stakeholders participating in value are input material suppliers, farmers and cooperatives, middle-men, processors, wholesalers, retailers, export enterprises, and domestic and foreign consumers. In addition, other supporters such as local governments, NGOs, banks, agricultural extensions, university/institutes, and transporters support the operation of the value chain.

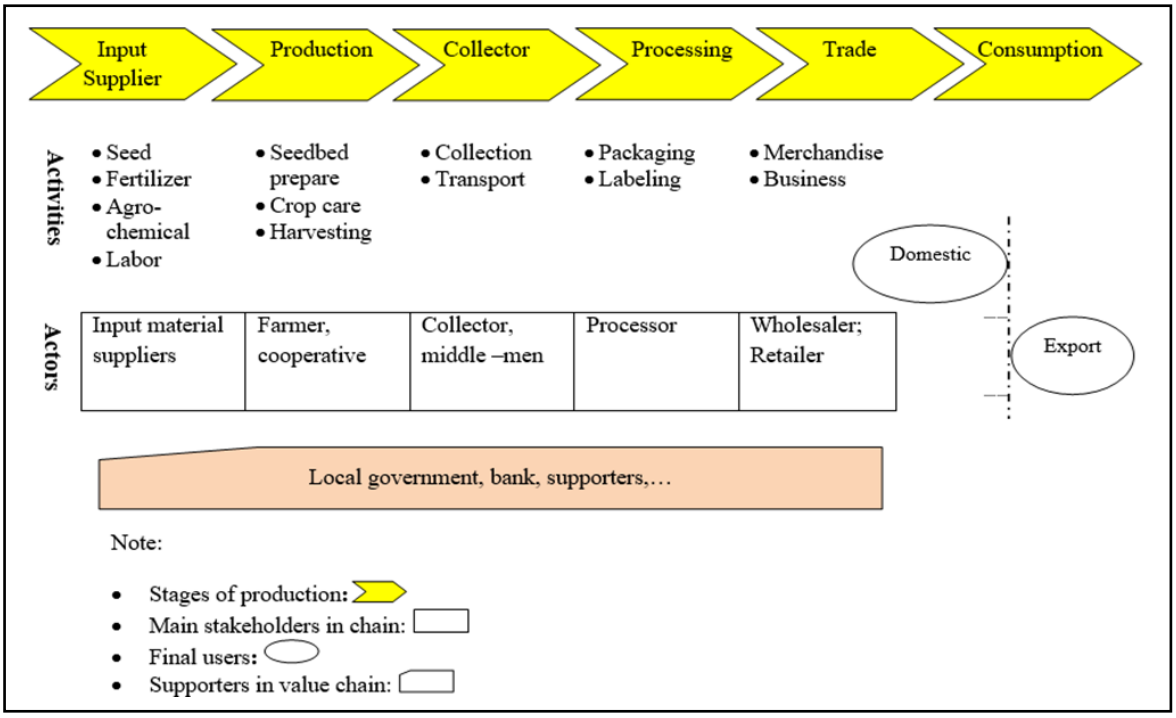

Figure 4. Conceptual framework of value chain (Source: Andreas, 2018).

2.3.1 Data analysis

This study used value chain mapping to illustrate the connections among actors in marketing channels in the Mekong Delta. The diagram reflects not only the main transaction flow of actors along the chain but also considers the value distribution and business services in each marketing channel. It is considered to be a helpful tool for measuring values (Nghi and Nam, 2016).

Financial indicators were applied to identify how cost, revenue, and profit were distributed among actors. The elimination of uneven distributions may support improvements in the efficiency of the chain.

Descriptive statistics were used to calculate quantitative information describing the entire chain. Descriptive statistics are reported in tables and graphs using percentages, mean values, averages, and frequency.

Method for calculating benefit-cost:

- Input cost = root fertilizer + leaf fertilizer + paclobutrazol + herbicide + insecticide + fungicide
- Marketing cost = energy + wrapping bag + transport + hired labor + family labor + fixed cost
- Fixed cost = machine depreciation + land rent + interest + tax
- Total cost = Input cost + Marketing cost
- Revenue = selling price of 1 ton mango.
- Added value = Revenue – Input cost.
- Net profit = Revenue – Total cost
- The marketing costs of traders and processors include the costs of packing, hired labor, transport, testing, and others.
- All indicators will be calculated based on the conversion into one mango ton.
- The general method for determining the rate of distributed products in the value chain diagram is as follows.

The number of output products of an actor is the number of input products for the next actor following the chain.

The total input products of the first actors are 100%, and the total output products of the last actors are 100%. The input and output of each actor must be equal.

2.3.2 Formulation of converting coefficient among Chu-mango categories

Before analyzing the benefit-cost of stakeholders in the Chu-mango value chain, the study converts the formulation from non-classified mango to classification grades 1, 2, 3, and 4 (classified mangoes before selling). The survey results for the study area were as follows:

- Classification of mango production: 23% mango grade 1, 35% mango grade 2, 35% mango grade 3, and 7% mango grade 4.
- Selling price: 1,416.32 USD/ton mango grade 1, 984.95 USD/ton mango grade 2, 524.27 USD/ton mango grade 3, and 263.02 USD/ton USD/ton mango grade 4.

Table 3.
Matrix of Chu-mango categories following prices.

	Grade 1	Grade 2	Grade 3	Grade 4
Selling price	1,416.32	984.95	524.27	263.02
Percentage (%)	0.23	0.35	0.35	0.07
Grade 1	1.00	0.71	0.37	0.19
Grade 2	1.41	1.00	0.52	0.26
Grade 3	2.70	1.91	1.00	0.50
Grade 4	5.38	3.82	1.99	1.00

Source: Calculation of author, 2020

2.3.3 Conversion coefficient for production cost of mango grades 1, 2, 3 and 4:

Grade 1 = 1/(0.23+0.35*0.71+0.35*0.37+0.07*0.19) = 1.61

Grade 2 = 1/(0.23*1.41+0.35+0.35*0.52+0.07*0.26) = 1.14

Grade 3 = 1/(0.23*2.70+0.35*1.91+0.35+0.07*0.50) = 0.60

Grade 4 = 1/(0.23*5.38+0.35*3.82+0.35*1.99+0.07) = 0.30

Chu-mango grades 3 and 4 are combined in the marketing channel of processed products and require only one conversion coefficient. The volume of mango grade 3 (736.18 tons) is five-fold that of mango grade 4 (147.24 tons).

Grades 3 and 4 = (0.60*736.24+0.30*147.24)/(736.24+147.24) = 0.55

In conclusion, unclassified mangoes represent the market segment of traditional markets. Grade 1 mangoes are exported to advanced markets by airplanes. Mango grade 2 is provided to the modern retail system in megacities in Vietnam and is exported to the Chinese market via heavy trucks with a cooling system at the border gate. Mango grades three and four enter processing firms for the production of value-added products.

3 Results and discussion

3.1 Integrated economic efficiency of Chu-mango value chain

The Chu-mango value chain map illustrates how Chu-mango products are channelled via various marketing channels from farms in the MD region to domestic and foreign consumers (Figure 5). The proportion of marketing channels is determined by the share of Chu-mango volume produced by farmers, with a total volume of Chu mango in the Mekong Delta region of approximately 115,700 tons.

The distribution system of the Chu-mango value chain can be allocated to two groups of channels. Export channels (marketing channels 1, 2, and 3) and domestic channels (marketing channels 4 and 5):

Channel 1	Farmer	→	Cooperative	→	Export Enterprise	
Channel 2	Farmer	→	Cooperative	→	Wholesaler	→ Processing Firm
Channel 3	Farmer	→	Collector	→	Wholesaler (China)	
Channel 4	Farmer	→	Collector	→	Wholesaler	→ Supermarket
Channel 5	Farmer	→	Collector	→	Local retailer	

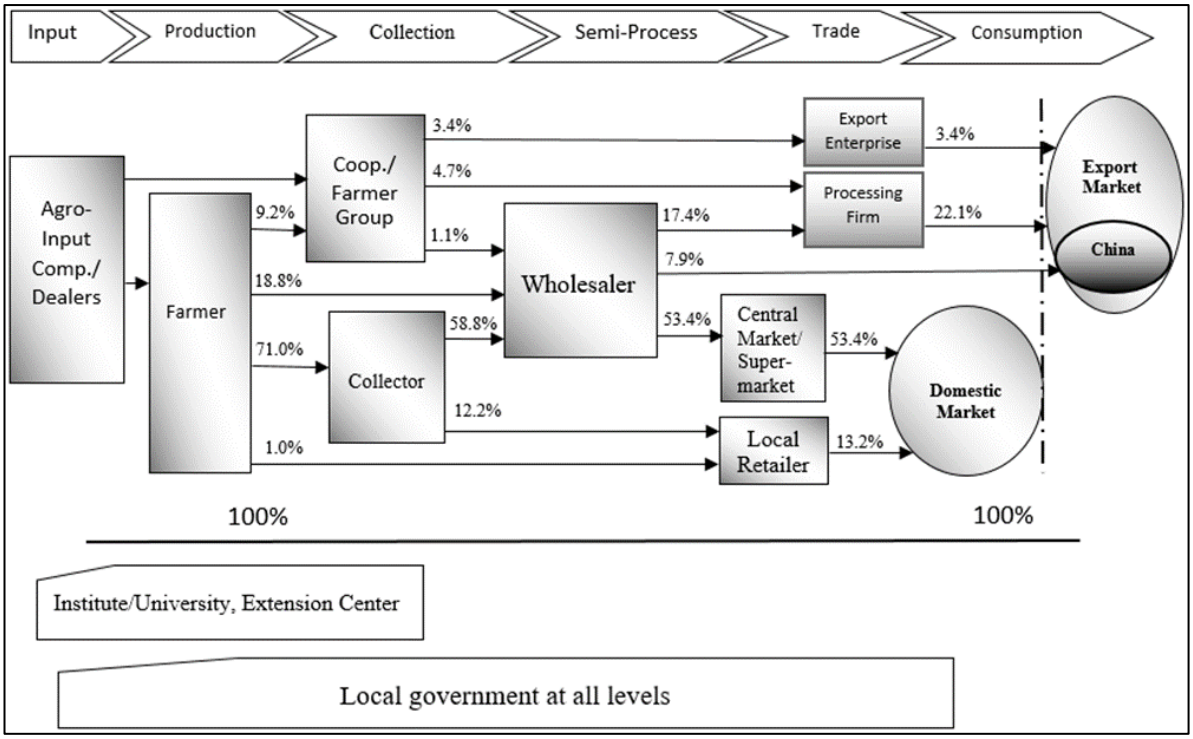

Figure 5. Chu –mango value chain in the Mekong Delta, Vietnam.

Marketing channel 1: It involves fresh fruits of grade 1. Most of Chu-mango grade 1 stems from cooperatives/farmer groups that have safety certificates (VietGAP, GlobalGAP), farming diary books, traceability codes, and strict pesticide residue control. The extrinsic attributes of Chu-mango grade 1 include attractive packaging and labeling, weight ≥ 280 g, wrapping bag, blemish-free, wrinkle-free, yellow, and bright skin color without abscission layers. Collaboration among farmers, cooperatives, and export enterprises in Channel 1 was regular and rigorous. Chu-mango in Channel 1 is distributed to advanced countries such as Europe, the U.S., Australia, Japan, Korea, and Canada by airplanes. It is a high-end market segment, with strict sanitary and phytosanitary requirements. The Chu-mango volume in Channel 1 accounted for only 3.4% of the entire chain.

Marketing Channel 2: Chu-mango in Channel 2 involves processed mangoes (juice, dried mango, frozen mango, jam, jellies, etc.). They travel to importing countries (Korea, Japan, Australia, the US, China, Europe, etc.) by shipping lines. It involves Chu-mango grades 3 and 4 with weights ≤ 200 g or 250 g, respectively, with poorer skin quality. Chu-mango has the highest processing share of Vietnamese mangoes, exporting approximately 22.1% of the total volume of the supply chain.

Marketing Channel 3: Chu-mango is mainly exported through border trade gates between Vietnam and China via heavy trucks. The Chu-mango in channel 3 involves fresh fruit grade 2 (exporting requirement: traceability code, weight 250-280 g, wrapping bag, partly blemish, wrinkle-free, and bright color). The Chu-mango volume exports to China is about 7.9% of the entire chain. Trucks are the main vehicles for transporting mangoes to the Chinese market. Heavy trucks have cooling systems installed with an electronic chip for controlling the temperature. In Channel 3, sales transactions take place either on Vietnamese or on Chinese territory.

Marketing Channel 4: Similar to Channel 3, Chu-mango in Channel 4 involves fresh fruit grade 2 (indicators: VietGAP, GlobalGAP certified or traceability code, weight 250–280 g, farming diary, wrapping bag, partly blemish, wrinkle-free, and bright color). This is a vital channel of the Chu-mango supply chain, accounting for 53.4% of the total Chu-mango volume. Wholesalers are key distributors transporting Chu-mango to central markets and supermarkets in big cities in Vietnam (Ho Chi Minh, Ha Noi, Hue, Dan Nang, and Hai Phong cities). Today, Chu-mango is consumed mainly in the domestic market.

Marketing channel 5: This is considered a traditional market channel (fresh fruit). Chu-mangoes are sold in local markets in the Mekong Delta. It is distributed via the collector and retail outlets to low-income consumers. The Chu-mango in Channel 5 is a non-classified mango that is sold in open-air markets and street vendors. This

accounts for approximately 13.2% of the total production. The relationships among stakeholders in Channel 5 are very weak, with characteristics of spot market relationships.

3.1.1 The integrated economic efficiency of the export channels

Table 4 presents selling price and net profit of actors in the export channels. Selling prices of export enterprises and processing firms are CIF prices, wholesale's selling prices in channel 3 are FOB prices. Generally, the average annual net profit of farms is decided by two factors comprising product quality and production scale.

Regarding product quality in various segmentations, the finding shows that selling prices of farms in channel 1 are approximately three times higher than prices in channel 3 and one and half times higher than prices in channels 2. Main reasons for the disparities are product grades with grade 1 in channel 1, grades 3 and 4 in channel 2, and grade 2 in channel 3.

Regarding production scale, farmers get the highest net profit per ton of production of all actors within the export channels. However, as the farming area of farm households is very small (about 0.4 ha), the production is only about 2.1 tons per year and the annual net profit is the lowest of all actors in the chain. In comparison, the average business scales of cooperatives and export enterprises in channel 1 are 72.6 and 92.3 tons per year, resulting in annual net profits which are 22 and 43 times higher than the net profit of farm households. Similar relationships are present in channels 2 and 3.

In the export channel, wholesalers deal with approximately 29.3 thousand tons (75.7%), and processing firms with about 25.5 thousand tons (66.2%) per year. Overall, the revenue is quite evenly distributed among the various groups of trading actors (wholesalers, export enterprises, and processing firms) and farms while the group of farms is the main beneficiary of the net profit (53.1%) earned within the export channel.

3.1.2 The integrated economic efficiency of the domestic channels

The results in Table 5 present the economic indicators of stakeholders in channels 4 and 5 with two obvious market segments and different fruit quality: Chu-mango grade 2 for the megalopolis retail system and non-classified Chu-mango for the local retail system. The selling price of farmers in Channel 4 is 1.2 times higher than the price in Channel 5.

In channel 4, the net profit of the farm group is 3.0, 5.4, and 2.4 times greater than that of collectors, wholesalers, and central markets/supermarkets, respectively. However, the annual net profit of individual farmers is 6.4, 20.7, and 15.4 times lower than the one of collectors, wholesalers and central markets/supermarkets, respectively. These differences are due to differences in enterprise size. The average annual sales volume of individual farms is 19.4, 112.2 and 36.7 times lower than the average annual volume dealt with by collectors, wholesalers, and central markets/supermarkets, respectively.

The local retailer obtains the highest net profit per ton in channel 5 (289.5 USD per ton), which is four times higher than the net profit per ton of collectors. Similarly, farmers realize a net profit per ton of 183.9 USD, which is nearly three times higher than the net profit per ton of collectors. However, due to the larger turn-over of collectors, their yearly net profit doubles and triples that of farmers and local retailers. The average yearly turn-over of collectors is 70.5 ton per year, which is approximately eight times the turn-over volume of farmers and six times the turn-over volume of local retailers.

Although the mango business scale of farmers and local retailers is quite similar, local retailers in contrast to farms do not rely heavily on Chu-mango sales but trade many kinds of fruits in traditional markets year-round, and revenue from them is a part of their business activities, while the main revenue of farmers is from Chu-mango production.

Turning to the integrated economic efficiency of the Chu-mango value chain, the MD serves the Vietnamese market with approximately over 77 thousand tons, generate a total revenue about 395.3 million USD, and reach a total net profit of approximately 40.2 million USD (Table 5).

The megalopolis retail system is vital in the integrated economic efficiency of the domestic channel, accounting for 80.2% (61,783.6 tons) of the total farmers' Chu-mango volume (77,055.9 tons). In the export channel, the Chu-mango value chain provides to the international market about 38.6 thousand tons, generates revenue of approximately 135.1 million USD (Table 4), and brings about a net profit of approximately 14.1 million USD through three main channels: fresh fruit to advanced markets by airplane, processed products by shipping line, and fresh fruit to the Chinese market by roadway. Overall, the findings of integrated economic efficiency show that the total revenue and total net profit of the domestic channel triples that of the export channel. The total revenue and net profit of the Chu-mango value chain (both domestic and export channels) in Vietnam are 530.3 and 54.3 million USD.

Table 4.
The integrated economic efficiency of actors in the export channels.

Indicators	Farmer	Cooperative	Collector	Wholesaler	Export Enterprise	Processing Firm	Total
The marketing channel 1							
Selling price (USD/ton)	1,416.3	1,863.2			7,268.6		
Input cost (USD/ton)	458.4	1,416.3			1,863.2		
Marketing cost (USD/ton)	554.3	185.2			5,011.9		
Net profit (USD/ton)	403.6	261.7			393.4		
Avg. volume/year (ton)	2.1	72.6			92.3		
Net profit/year (USD)	843.5	19,008.1			36,324.7		
The marketing channel 2							
Selling price (USD/ton)	480.7	705.1		705.1		1,295.6	
Input cost (USD/ton)	156.6	494.2		463.0		705.1	
Marketing cost (USD/ton)	189.4	147.4		151.6		563.2	
Net profit (USD/ton)	134.8	63.4		90.4		27.4	
Avg. volume/year (ton)	3.8	67.3		407.8		3,910.4	
Net profit/year (USD)	510.9	4,268.4		36,867.2		107,171.4	
The marketing channel 3							
Selling price (USD/ton)	984.95		1,156.8	1,423.8			
Input cost (USD/ton)	324.6		984.95	1,156.8			
Marketing cost (USD/ton)	392.5		83.2	209.8			
Net profit (USD/ton)	267.9		88.7	57.2			
Avg. volume/year (ton)	3.1		25.4	146.7			
Avg.net profit/year (USD)	841.2		2,249.8	8,398.8			
The integrated economic efficiency of export channels							
Volume (ton)	38,643.7	10,644.4	6,247.8	29,272.0	3,933.8	25,569.6	
Selling price (USD/ton)	695.4	1,133.1	1,156.8	929.5	7,268.6	1,295.6	
Net profit (USD/ton)	193.6	136.7	88.7	80.0	393.4	27.4	
Total revenue (Thous. USD)	26,871.8	12,060.9	7,227.7	27,208.4	28,593.1	33,129.0	**135,091.0**
Total net profit (Thous.USD)	7,483.1	1,455.3	554.2	2,343.1	1,547.6	700.8	**14,084.2**
% Total revenue	19.9	8.9	5.4	20.1	21.2	24.5	**100.0**
% Total net profit	53.1	10.3	3.9	16.6	11.0	5.0	**100.0**

Source: Field survey data in 2018 for farmer, in 2019 for other actors

Table 5.
The integrated economic efficiency of actors in the domestic channels.

Indicators	Farmer	Collector	Wholesaler	Central Market /Supermarket	Local Retailer	Total
The marketing channel 4						
Selling price (USD/ton)	984.95	1,156.8	1,367.7	2,145.7		
Input cost (USD/ton)	324.6	984.95	1156.8	1367.7		
Marketing cost (USD/ton)	392.5	83.2	161.3	665.7		
Net profit (USD/ton)	267.9	88.7	49.5	112.3		
Avg. volume/year (ton)	5.2	101.5	586.9	191.8		
Net profit/year (USD)	1,401.1	8,999.2	29,055.4	21,529.7		
The marketing channel 5						
Selling price (USD/ton)	812.9	963.8			1298.8	
Input cost (USD/ton)	284.7	792.9			963.8	
Marketing cost (USD/ton)	344.3	83.2			45.5	
Net profit (USD/ton)	183.9	67.6			289.5	
Avg. volume/year (ton)	9.0	70.5			10.9	
Net profit/year (USD)	1,658.8	4,766.0			3,156.0	
The integrated economic efficiency of domestic channel						
Volume (ton)	77,055.9	75,898.9	61,783.6	61,783.6	15,272.3	
Selling price (USD/ton)	950.8	1,120.9	1,367.7	2,145.7	1,298.8	
Profit (USD/ton)	251.3	84.8	49.5	112.3	289.5	
Total revenue (Thous. USD)	73,268.3	85,077.3	84,501.1	132,568.9	19,836.1	**395,251.8**
Total net profit (Thous.USD)	19,360.4	6,434.4	3,058.9	6,937.1	4,422.0	**40,212.7**
% Revenue	18.54	21.5	21.4	33.5	5.0	**100.0**
% Net profit	48.1	16.0	7.6	17.3	11.0	**100.0**

Source: Field survey data in 2018 for farmer, in 2019 for other actors

3.2 Vulnerability of stakeholders in Chu-mango value chain

The bar chart in Figure 6 illustrates the percentage of the actors' revenue distribution in the five marketing channels. Clearly, the revenue proportion of actors who supply products directly to consumers is the highest in every marketing channel. They account for 68.9%, 51.5%, 44.5%, 37.9%, and 43.2% of marketing channels 1 to 5. The export channels (channels 1, 2, and 3) obtain a proportion of revenue distribution higher than those of domestic channels (Channels 4 and 5). Farmers as producers are crucial partners in the chain. However, their revenue contribution in marketing channels is insignificant. Farmers rank the lowest in terms of revenue generation for channels 1, 4, and 5, and also take the penultimate rank for channels 3 and 4.

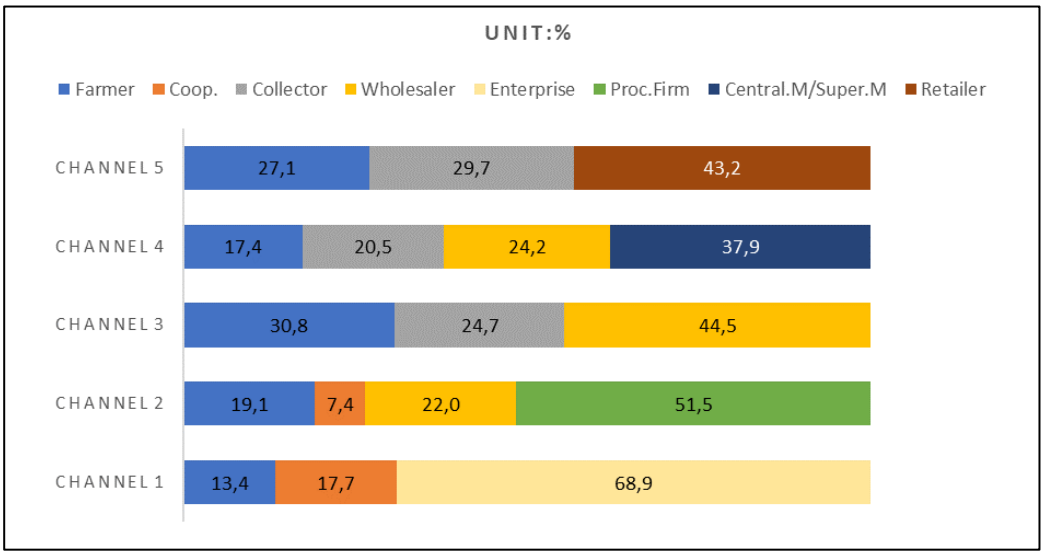

Figure 6. Distribution of stakeholders', revenue in marketing channels.

Figure 7 outlines the net profit distribution of stakeholders in the Chu-mango value chain through different channels. In general, farmers are the main drivers for creating net profits in each marketing channel. Specifically, farmers take the first place in terms of net profit distribution in channels 1, 2, 3, and 4, and rank second in Channel 5. This emphasises the role of farmers not only in supplying raw materials to traders, but also in contributing to the remarkable economic value of the Chu-mango chain in the Mekong Delta.

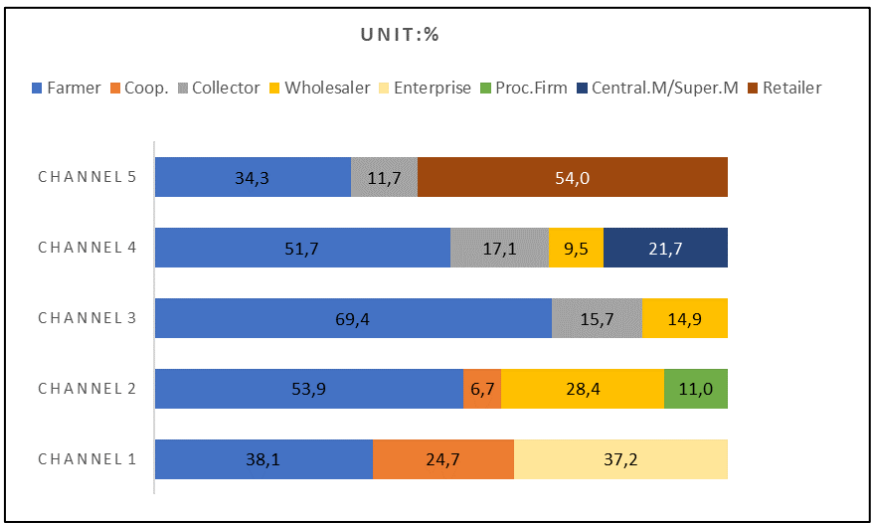

Figure 7. The distribution of stakeholders', net profit in marketing channel.

The average area of farm households in the MD is 0.42 ha while the productivity is 10.7 ton per ha. If they cultivate two crops per year, the average yield of farm households is nine tons of mangoes per year. According to the classification percentage from the survey, this includes 23% of mango grade 1, 35% of mango grade 2, 35% of mango grade 3, and 7% of mango grade 4. The annual net profit of individual farmers can therefore be expressed as follows:

Case 1: Mangoes of the farm do not meet the requirements of exporters and the farm can only provide them as non-classified mangoes to the traditional retail system (Marketing Channel 5). The farm's yearly net profit would account to 1,658.8 USD.

Case 2: Mangoes of the farm still do not have the quality standards for export, but they can be channelled into the megalopolis retail system (Marketing Channel 4) and provided to processing firms (Marketing Channel 2). They contribute to Channel 2 approximately 3.8 tons, and to channel 4 about 5.2 tons. In this case, farmers receive a yearly net profit of 1,912 USD, including 510.9 USD from channel 2, and 1,401.1 USD from channel 4.

Case 3: Mangoes of the farm are classified before sales into grades 1, 2, and 3, and provided to the marketing channels 1, 2 and 3, respectively. With providing e.g. 2.1 tons to channel 1 for an annual net profit of 843.5 USD, 3.8 tons to channel 2 for 510.9 USD, and 3.1 tons to channel 3 for 841.2 USD, a farmer's annual net profit would account to 2,195.6 USD.

The cases demonstrate the possibility of increases in the annual net profit of farmers through improvements in mango quality. However, the annual net profit of individual farmers is still the lowest of all actors in the Chu-mango value chain, mainly due to their small production scale and not to an unbalanced profit distribution among actors in the chain.

In summary, farmers are the most vulnerable actor in the chu-mango value chain for two main reasons.

1. Most farmers are small-scale which creates to challenges in technology application (production model, post-harvest technology, modern cool storing system), production organization, quality management, contract farming negotiation (verbal contract mostly), market information access, export requirements (certifications in good agriculture practice, traceability code, pesticide residue control), long-term agribusiness cooperation, etc.

2. The quality of fresh fruits is low (23% of mango grade 1 and 35% of mango grade 2), and 71% of mangoes are bought as non-classified mango by collectors at farm gates. It does not meet importer' demand. The fresh mango grade 1 in marketing channel 1 was modest (3.4%).

In addition, there is a lack of diversity in processed products and the export percentage is low (marketing channel 2: about 22.1%). Advanced technological investment is required to produce high value-added products. In particular, the processing activities focus only on the export market, ignoring the potential domestic market with 100 million people.

3.3 Policy proposals for upgrading Chu-mango value chain in the Mekong Delta

After determining the vulnerability of stakeholders in the Chu-mango value chain, an improvement in vertical and horizontal linkages is necessary to meet the quality requirements and regulations of the market, share market information, organize large-scale and safe production, and better collaborate among chain actors. A set of policies is recommended as follows.

3.3.1 Quality improvement

Production organization (horizontal linking): Farmers should participate in cooperative/farmer groups to establish large-scale mango farming areas following the production process of good agricultural practices with safety certifications and traceability codes. Cooperatives play an important role in connecting farmers to stakeholders and other networks. In particular, they need to support training in sustainable farming, harvesting, postharvest, market information, and agribusiness knowledge. This helps them make efficient financial decisions regarding production and business operations.

Collaboration (vertical linking): Trading contracts should encourage improved business interaction between farmers, cooperatives, and the processing enterprises for sharing responsibilities, benefits, and risks. Processing enterprises may open processing facilities in the local area facilitating access to large and high-quality farm mangoes while farmers could establish larger-scale production and get a stronger voice in negotiations. This could help stakeholders in developing an understanding of quality requirements, compliance, and demand-supply constraints.

Commercial support: The Vietnamese government is actively involved in bilateral and multilateral free trade agreements (FTAs). Vietnam has signed 13 FTAs and is negotiating with three other FTAs. This paves the way for Vietnamese agricultural exporters to participate in global value chains and attract foreign capital to this field. There are four striking FTAs that influence mango trade: the ASEAN Economic Community (AEC), the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), the Europe-Vietnam Free Trade Agreement (EVFTA), the United Kingdom (UK), and the UK-Vietnam Free Trade Agreement (UKVFTA). Most fresh mango and mango products from

Vietnam have a 0% import tax when exported to FTA member countries (Brian et al., 2021; Thang, 2018). The Department of Industry and Trade should disseminate information on FTAs regarding taxation, standards, quality, competition, and trade rules through conferences, workshops, and dialogue. This helps exporters increase export volumes, proactively expand markets, and reduce costs in market research. Moreover, trader actors need to understand each segment of the value chain to satisfy importers' standards and assure consistency with international regulations.

If the quality management policy is conducted successfully, it could help to increase the volume of quality mango eligible for export at a higher price which, in turn, would improve the income of chain actors and especially farmers (Figure 8).

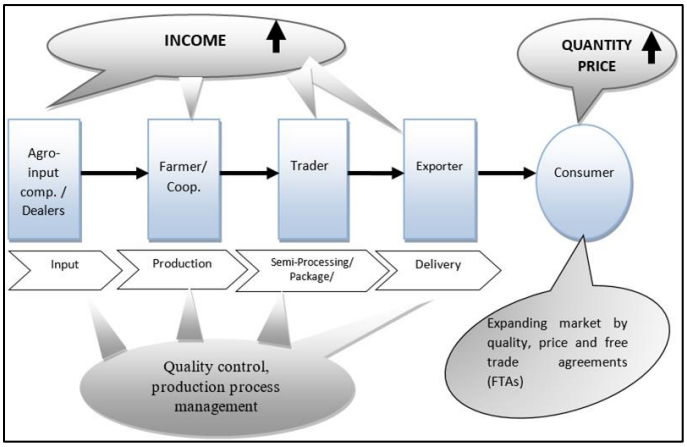

Figure 8. Quality improvement.

3.3.2 Technology development

Production organization (horizontal linking): The government should have a credit package with a preferential interest rate for cooperative/farmer groups investing in new technology such as drip irrigation systems, both water and fertilizer, and drone applications for spraying of pesticides.

Collaboration (vertical linking): Mango processing firms need special credit to invest in advanced production technology when moving factories into the local farm production regions. Technology and equipment include fruit classification systems, modern cool storage systems, vapor heat treatment factories for fresh fruits, standard packing factories, and intensive processing technologies.

Credit packaging is a macro policy that contributes to industrialization and modernization in the mango subsector, increasing productivity, value-added products, and diversity of products. It helps the Vietnamese mango subsector become more competitive in both domestic and international markets. Furthermore, technological developments boost new workforce for production and service suppliers. In particular, it will attract industry investors to expand their business and production scopes. This may significantly enhance mango quantity and diversity for better serving markets (Figure 9).

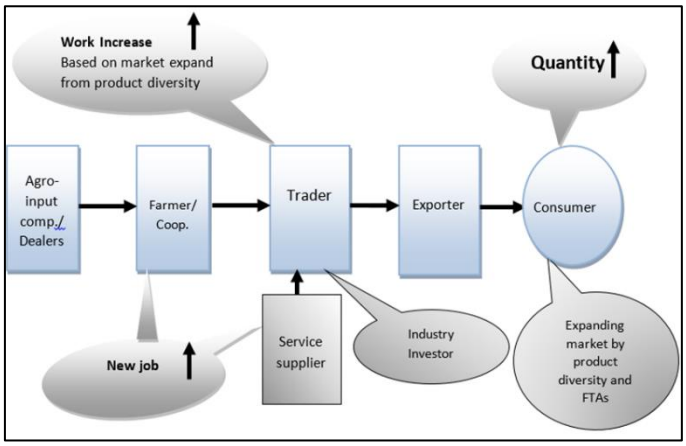

Figure 9. Technology development.

3.3.3 Benefit re-distribution

Farmers are an important factor in providing input to other actors in the chain but are are the most vulnerable actor. Re-distribution of benefits in support of farmers is essential for improving the efficiency and output quality of the chain. A pre-requisite would ask for more farmers to become members of cooperative/farmer groups which would represent farmers in transactions and negotiations allowing re-distribution of benefits through e.g. (Figure 10):

a) Cost savings in purchase of farm inputs,
b) Improvement in contract negotiations,
c) Better training in improving production processes and quality of mango production,
d) Assuring support for quality certification from receiving processing companies,
e) Assuring technology investments of processing companies in farms for allowing a reduction in labor costs,
f) Investing in digital marketing/e-commerce which could reduce costs for marketing, intermediaries, and delivery.

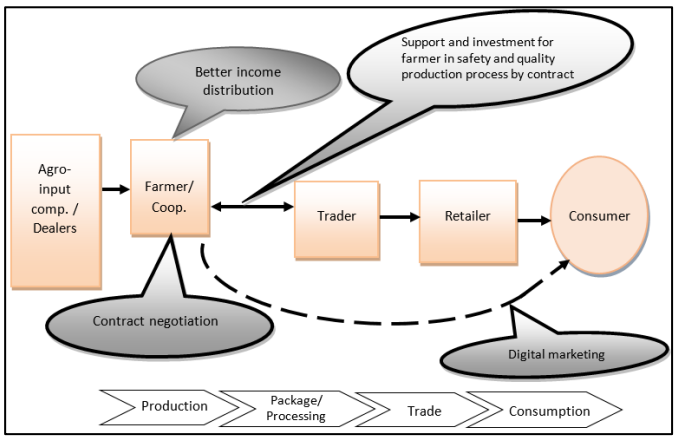

Figure 10. Benefit re-distribution.

4 Conclusion

The integrated economic efficiency of the Chu-mango value chain amounts to revenue of USD 530.4 million and net profit of USD 54.3 million. The export channels (marketing channels 1, 2, and 3) contribute revenues of USD 135.1 million and net profit of USD 14.1 million. Domestic channels (marketing channels 4 and 5) contribute revenues of USD 395.3 million and net profit of USD 40.2 million.

Farmers are the most vulnerable actor in the Chu-mango value chain. The annual net profit of individual farmers is the lowest of all the actors in the Chu-mango value chain, due to small scale production and low quality in products. In addition, the diversity of processed products is low, the marketing and distribution technology for serving international markets is not appropriate and the chains ignore the potential of the domestic market. Polices for upgrading the Chu-mango value chain include quality improvement, technology development, and benefit redistribution.

The main contribution of this study involves

a) the further development of traditional value chain analysis and its application in analyzing the Chu-mango value chain, an important production sector in the Mekong Delta and
b) the use of value chain analysis in support of developing policy opportunities for improving the selected Chu-mango sector.

The value chain analysis involved a cost-benefit analysis with economic indicators including opportunity cost (land rent, family labor cost, depreciation cost etc.). It provides a comprehensive picture of value chain analysis in agricultural sectors towards economic efficiency beyond the standard financial efficiency. In particular, the paper introduced a matrix of Chu-mango categories following prices and the formulation of conversion coefficients among Chu-mango categories for each market segment. This paves the way for future studies in value chain analysis of tropical fruits and vegetables. It demonstrates the use of a tool for analyzing the agri-food chains, identifying the production-trading account and the consolidated account of the chain.

Regarding the value of chain analysis for policy making, the study allowed the identification of the most vulnerable actors in the chain as well as its causes. It suggests policies towards quality improvement, technology development, and the reallocation of benefits for vulnerable actors within the chain. The paper helps to determine challenges of small-scale actors in these markets and the resulting benefits of cooperation related to effects of economies of scale and beyond.

Authors' contributions

The authors confirm the contribution to the paper as follows: study conception and design: Kiet Hong Vo Tuan Truong; data collection and data sheet entry: Kiet Hong Vo Tuan Truong; analysis and interpretation of results: Kiet Hong Vo Tuan Truong; draft manuscript preparation: Kiet Hong Vo Tuan Truong, Shaufique Fahmi Sidique. All authors reviewed the results and approved the final version of the manuscript.

Availability of data and materials

The data that support the findings of this study are available from the "Technology and science program for sustainable development in the Mekong Delta region", but restrictions apply to the availability of these data, which were used under license for the current study and are not publicly available. However, data are available from the authors upon reasonable request and with the permission of the Technology and Science Program for Sustainable Development in the Mekong Delta region.

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Conflict of interest

No potential conflict of interest was reported by the authors.

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