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Agri-Food Value Chain Performance during the COVID-19 Pandemic: An Empirical Study of Chu-mango Business Linkages in Dong Thap, Vietnam

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ABSTRACT

This study aims to identify important factors that directly influence value chain performance (quality, responsiveness, flexibility and efficiency), which are explained by value chain integration (collaboration, commitment, coordination and joint decision-making) in the case of unexpected risk (the COVID-19 pandemic). This study contributes to maintaining the business linkage model among farmers – cooperatives – enterprises in the case of the COVID-19 pandemic and quickly recovering after the COVID-19 pandemic. Structural equation modelling (SEM) was used for data analysis following an iterative process based on theoretical and empirical analyses to obtain a structural model fit and test the research hypothesis. The findings indicate that the VCI positively influenced the VCP of Chu-mango business linkages at the 1% significance level through coordination (Beta = 0.345; construct reliability (CR) = 3.272), collaboration (Beta = 0.289; CR = 3.128), and joint decision-making (Beta = 0.324; CR = 3.245). This study provides empirical data on the relationship between VCI and VCP through the Chu-mango value chain in Dong Thap Province during the COVID-19 pandemic to raise awareness from stakeholders and encourage value chain thinking to improve performance. This result may pave the way for relevant policymakers to look for policies and strategies for better inclusiveness of stakeholders to show the importance of the VCI in improving the performance. Moreover, the study is an empirical case contributing to the agribusiness value chain in a developing country; it applies the agribusiness value chain of the tropical fruit domain and can be used for other agricultural products in other cases of unexpected risks.

Keywords: *Chu-mango; business linkage; value chain performance*

1 Introduction

Stakeholders' coalition in the value chain has been a special concern from the Vietnamese government, especially regarding business linkages among farmers – cooperatives – enterprises. It is expected to benefit smallholder mango cultivators from strong assistance from enterprises. In fact, mango cultivation is small-scale (less than 1 hectare), and growers face several difficulties such as new technology approaches, production capital, quality requirements, market information, and dependence on middlemen. Enterprises with economic potential may help to address farmers' problems. However, mango export companies have confronted unexpected risk, i.e., the COVID-19 pandemic, which has significantly influenced enterprises and business operations. Thus, enterprises do not conduct mango purchases for farmers as given planning in signed contracts. In this context, the business linkage among farmers – cooperatives – enterprises is threatened and may make small farmers depend on middlemen and face new challenges. Therefore, important factors that influence the value chain performance of business linkages must be found to help policy makers suggest feasible solutions for sustainable collaboration among farmers – cooperatives – enterprises in the case of unexpected risk.

Mangoes are the second-most popular fruit in Vietnam (after banana) and are grown across many provinces. More than 80% of all fruit grown in Vietnam is consumed fresh, and 9% is processed. The fresh mango value chain has several points at which the fruit can be damaged and value can be lost; 15-25% of harvested mangoes are estimated to be damaged along the chain. Much of this damage is superficial, which often makes the fruit unsuitable for sale or export; however, in most cases, it is likely suitable for processing. Fresh mangoes play the largest role in exports, followed by dried mangoes. Frozen mangoes are also listed in the export category, while exports of mango juices are still under development. In terms of production area, the production area of mango sharply increased between 2015 (83.7 thousand hectares) and 2019 (104 thousand hectares). The Mekong Delta (MD) is the key region for tropical fruit production in Vietnam. MD has the largest share of mango production in Vietnam. It was the largest mango production region in the country, with 48,200 ha (46.3% of the national total) and 511,800 tons (62.8% of the national total) in 2019 (GSO, 2020). Within the region, the largest mango areas are Dong Thap, An Giang, Vinh Long and Tien Giang.

The Dong Thap province is the largest mango production area with the highest volume of any province in the Mekong Delta (MD), with 11,500 ha and 130,000 tons in 2019. This figure accounts for approximately 24% of the mango production area and 25.4% of the fresh mango production volume in the MD. The 2016-2019 period witnessed gradual growth in both area and volume of mango production; the mango production area increased by 8.0%, and the mango production volume increased by 9.2%. The main mango varieties in Dong Thap comprise Chu-mango (45%), Hoaloc-mango (21%), Green Tuong-mango (18%), and others (16%) (GSO, 2020). This area is considered a centre for mango production in the MD, especially for the Chu-mango variety.

This centrality also stems from several typical collaborations and effective alliances of stakeholders in the mango value chain. In the mango value chain, traders, processors, and exporters are better placed to understand the dynamics of the market – the requirements of domestic and global consumers, trends in prices, and activities of competitors. Support to smallholder farmers to improve production and raise their standard of living must be based on real market demand for their products. Thus, business linkage in the value chain is based on the idea of building cooperation and agreement among farmers, cooperatives and enterprises to jointly meet the demands of the market. Ultimately, the choice to form a cooperative must involve voluntary participation of both the company and the group based on mutual understanding of the requirements and capacity of each other. Cooperative groups may seek to link with different companies for different products to serve the export market (William, 2014).

In this study, we choose structural equation modelling (SEM) to analyse the value chain performance (VCP) of the business linkage among farmers – cooperatives – enterprises because it is more appropriate for testing the hypothesis than other methods via a system of linear equations (Karagöz, 2016). The VCP in SEM is called the endogenous variable (dependent variable) and is explained by four exogeneous variables (independent variables) of value chain integration (VCI): (1) collaboration among actors in terms of resource, capability and risk sharing (Lotfi et al., 2013; Wu et al., 2014); (2) commitment to long-term relationships (Cechin et al., 2013); (3) coordination of activities along the value chain (Van et al., 2008); (4) joint decision-making on important aspects such as the product quality, price and production process improvements (Malhotra et al., 2005). In addition, both VCP endogenous variable and four exogeneous variables are considered latent variables that are measured by the observed variables (research questionnaire use with the Likert-type ordinal scale).

The four main factors of VCP are: quality, responsiveness, flexibility and efficiency (Vickery et al., 2003; Gellynck et al., 2008; Zhao et al., 2008; Wu et al., 2014). These factors are also the observed variables of the latent variable (VCP). For the VCI, the observed variables are questions associated with collaboration, commitment, coordination and joint decision-making. Marcos et al. (2010) claim that interaction and collaboration play crucial roles among stakeholders in VCP, especially in the buyer-supplier interface. Interaction helps partners in business linkages feel connected to reciprocal businesses and secure in these uncertain times. Hence, stronger coordination and harmonisation of partners in the value chain are required to decrease the influence of the COVID-19 pandemic (flight cancellations, import and export controls, unstable prices and demand due to social distancing) and to strongly recover after the COVID-19 pandemic.

According to Chan et al. (2003), an analysis of the VCP can use either a quantitative method (finical indicator) or a qualitative method (respondents' satisfaction). The paper applied a qualitative method (respondents' satisfaction) instead of a quantitative method (finical indicator) because the business operations of enterprises and the profits of farmers have been negatively impacted by reduced mango consumption in both domestic and international markets during the COVID-19 pandemic. Thus, financial indicators are unavailable to share, while qualitative data on difficult shares of stakeholders are necessary to overcome challenges together in the COVID-19 pandemic context. A structural questionnaire is designed with a Likert scale of five levels (1 = totally disagree and 5 = completely disagree) to directly interview respondents in the business linkage among farmers – cooperatives – enterprises (questionnaire in Appendix 1).

2 Methodology

2.1 Sampling technique

In this study, we sampled the population in multiple stages. First, Dong Thap was chosen as a centre for mango production in the MD with typical business linkages among farmers – cooperatives – enterprises. Second, the respondents are members of two cooperatives (Tinh Thoi and Tan Thuan Tay) that directly participate in the business linkage model. The total farming area of cooperatives and members participating in business linkages was approximately 100 ha (equivalent to approximately 200 growers). Third, to obtain valid questionnaire items and reliability, we performed two field trials, and each trial used 10 cooperative respondents. Finally, a simple random technique was used to collect 194 respondents. Based on Santoso (2013), a structural equation model (SEM) with up to 5 latent variables, each of which has 3 or more indicators, requires a sample size of at least 100-150. All measurements for dependent and independent variables used a Likert scale (1 = totally disagree and 5 = completely disagree).

Figure 1. Study area in Dong Thap province

2.2 Empirical model

The VCP of the business linkage of Chu mango is evaluated by four key factors: quality, responsiveness, flexibility and efficiency (Vickery et al., 2003; Gellynck et al., 2008; Zhao et al., 2008; Wu et al., 2014).

Quality: In an interpretative review of perspectives and orientations of quality, product quality is often defined from a product or consumer orientation: the combinations of product attributes constitute quality, while the perception and response of the consumer to those attributes are referred to as acceptability. In the view of Cao and Zhang (2010), the quality of the product and service that end users receive is a combination of value chain actors in the production process to create reliable products with higher value. These products and services satisfy the demand of consumers (Lotfi et al., 2013). Moreover, the fitness of products and services is measured as attractiveness because its appearance is attractive to the eyes of consumers. In the area of food, both extrinsic and intrinsic attributes influence the perception of fruit quality (Aprile et al., 2016). The overall response of the consumers to quality results from both expected and experiential quality (Grunert, 2007).

Responsiveness: Responsiveness is the capacity of cooperation among actors along the value chain to supply products and services as soon as possible when there are orders from customers. Customer feedback associated with products and services is an important indicator of the responsiveness of value chain members (Molnar, 2010; Wu et al., 2014).

Flexibility: Flexibility is defined as the coordination and reinforcement of value chain actors to adapt alterations of customers' preferences in products and services and share unexpected risks (Cao and Zhang, 2010). According to Sezen (2008), key components of flexibility in the value chain include quantity flexibility, provision flexibility, product flexibility, and combination flexibility.

Efficiency: Efficiency refers to the comparison between observed and optimal values of its output and input. Furthermore, efficiency is the ability to produce at a given level of output at the lowest cost. In addition, Daraio and Simar (2007) emphasize that instead of defining efficiency as the ratio between outputs and inputs, we can describe it as the distance between the quantity of input and output and the quantity of input and output that defines a frontier, which results in the best possible frontier for a firm in its cluster (Jondrow et al., 1982).

In this study, the effectiveness of business linkages among farmers – cooperatives – enterprises is identified via the relationship between value chain integration (VCI) and value chain performance (VCP). Some policy implications are proposed to address the VCI- and VCP-related challenges in the business linkage of Chu-mango in particular and in the agribusiness value chains of developing countries in general.

According to Darroch and Mushayanyama (2006) and Wever et al. (2009), the VCI is the vertical linkage of the value chain from input suppliers to end users, where input materials are used to obtain products or services with higher value in each stage along the value chain. Thus, VCIs are alliances of actors that connect supply and demand for products or services. The main elements of the VCI are collaboration, commitment, coordination and joint decision-making.

Collaboration

Collaboration is constructed based on the share of resources (Cao and Zhang, 2010), capabilities (Vieira et al., 2009) and risks (Vereecke and Muylle, 2005) adopted by value chain actors to obtain higher VCP, which also helps value chain members share benefits based on the win-win principle. It is established as trustful, equitable cooperation among value chain actors to enhance the VCP. The findings of Stank et al. (2001) indicate that collaboration is positive for VCP by improving the product and service quality with a low-cost strategy. However, Wiengarten et al. (2010) show a different result from previous studies: a positive relationship between collaboration and VCP. We expect collaboration to be positively correlated with the VCP. From the above literature review, the following hypothesis was suggested.

H1: The collaboration of stakeholders in business linkages is positively associated with VCP.

Commitment

Commitment refers to an aspiration to maintain a long-term relationship among actors along the value chain. This relationship is established based on trust and mutual benefit share between value chain members towards the VCP (Zhao et al., 2008). In addition, Wu et al. (2004) define commitment as a combination of three aspects: affective, durable and normative commitments. The affective aspect is the awareness of the actors of belongingness and alignment along the value chain; the durable aspect leads to cost savings for actors who participate along the value chain; the normative aspect states clear

responsibilities and obligations of value chain members when they participate in the value chain. Past papers have shown that commitment to long-term relationships contributes to effective resource use and higher performance (Clarke, 2006).

H2: Commitment to long-term relationships among stakeholders in business linkages positively relates to VCP.

Coordination

Vickery et al. (2003) have reported that coordination refers to the participation of partners along the value chain in all activities to achieve a given purpose in the vertical linkage of the value chain. Coordination involves interactions of actors and requires rigorous management of procurement, production, and delivery activities along the value chain to attain VCP. Coordination helps actor alignment in the value chain reduce transaction costs and improve the VCP. In addition, it contributes to upgrading the capacity and capability of actors along the value chain by enhancing the responsiveness and flexibility of members of the value chain (Darroch and Mushayanyama, 2006).

H3: The coordination of stakeholders in business linkages positively relates to VCP.

Joint decision-making

According to Wiengarten et al. (2010), joint decision-making reflects the interaction level of value chain actors on important issues such as the product quality, price and production process and sharing essential market information. It is understood that joint decision-making plays a positive role in VCP and affects the VCI. From the above literature review, the following hypothesis was suggested.

H 4: Joint decision-making on critical issues such as product specifications and prices positively relates to VCP.

The SEM is a combination of factor analysis and regression analysis. However, unlike the regression model, the SEM is based on the covariance matrix and confirmatory approach to test research hypotheses in a single process by modelling complex relationships among many observed and latent variables. In addition, SEM measures the measurement errors and relationships between errors in the observed variable. If the regression model identifies only direct influences, the SEM detects direct and indirect influences.

The analytical process of SEM has several steps, beginning with a Cronbach's alpha test and ending with the SEM estimates. First, Cronbach's alpha index was used to evaluate the reliability of the emerging measurement scale. In the second step, EFA was performed to choose suitable items in the models and withdraw items with factor loadings below 0.5.

To evaluate the rationality of the fundamental multidimensional constructs, the outstanding feature of the third step was SEM estimation to follow an iterative process based on theoretical and empirical analyses to obtain a structural model fit. In SEM, both measurement model and structural model are tested. The measurement model is employed by a confirmatory factor analysis to determine the relationship between latent variables and observed variables. Hence, if the model fit indices are low, it will not ensure the testing of the structural model (Dursun and Kocagöz, 2010). This helps to reduce the disparity between a confirmatory approach (only one model tested) and an exploratory approach (Marco et al., 2009). The indicator to evaluate a model fit includes the following statistics: the chi-square fit test index (CMIN/DF), Tucker Lewis index (TLI), goodness-of-fit index (GFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). Finally, the structural model is measured to determine the relationship between the endogenous variable (VCP) and the exogenous variables (collaboration, commitment, coordination, joint decision-making). Collected data were processed using the SPSS 22.0 and AMOS 22.0 software.

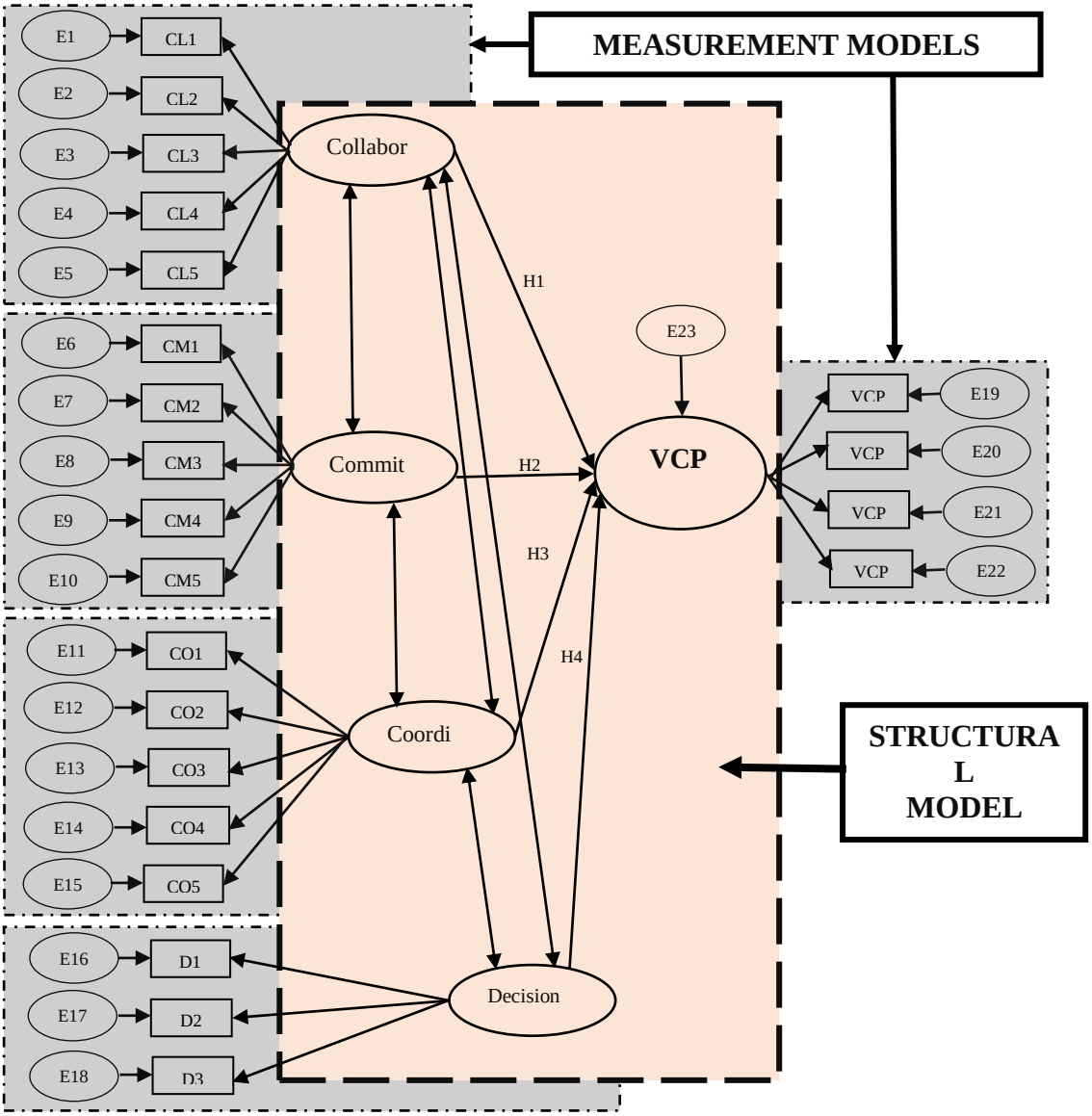

Figure 2. Hypothetical conceptual framework

3 Results and Discussions

Information about the demographic characteristics of the respondents is presented in Table 1, including the gender, age, educational qualification, farming experience, land area, density, number of cropping seasons per year, and production process. Males were the vast majority of labourers in Chu-mango farming (93.3%), and there is a small minority of females (6.7%). The largest group of respondents were more than 55 years old (44.8%), followed by 46-55 years (32%), 31-45 years (20.1%), and less than 31 years (3.1%). With regard to the farming experience of respondents, 67% had farmed for more than 15 12.9% for 11-15 years, 15.5% for 6-10 years, and 4.6% for less than 6 years. Most of the respondents attained primary school (34.0%) or secondary school (35.1) education, 23.1% of the respondents obtained a high school education, and a few respondents had a college or university education (7.7%).

The largest portion of farmers reported a land area of 0.2-0.4 ha (41.2%). A very small portion reported land area was less than 0.2 ha (6.7%). A small group reported land areas greater than 1.0 ha (10.3%). Noticeably, land area groups of 0.41-0.5 ha, 0.51-0.7 ha, and 0.71-1.0 ha had similar shares of 12.4-16.0%. For the density of mango trees per ha, most of the respondents had 200-400 mango trees/ha (56.2%), 33.5% of respondents had fewer than 200 mango trees/ha, and 10.3% of respondents had more than 400 mango trees/ha.

Table 1.
Demographic Profile of Respondents

Demographic variables	Frequency	Percentage
Gender distribution		
Male	181	93.3
Female	13	6.7
Age distribution		
≤ 30 years	6	3.1
31-45 years	39	20.1
46-55 years	62	32.0
≥ 56 years	87	44.8
Educational status		
Primary school	66	34.0
Secondary school	68	35.1
High school	45	23.2
College/university	15	7.7
Farming experience		
≤ 5 years	9	4.6
6-10 years	30	15.5
11-15 years	25	12.9
16-20 years	91	46.9
≥ 20 years	39	20.1
Land area		
< 0.2 ha	13	6.7
0.2 – 0.4 ha	80	41.2
0.41 – 0.5 ha	24	12.4
0.51 – 0.7 ha	31	16.0
0.71 – 1.0 ha	26	13.4
> 1.0 ha	20	10.3
Density		
< 200 mango trees/ha	65	33.5
200 – 400 mango trees/ha	109	56.2
> 400 mango trees/ha	20	10.3
Seasons		
One season per year	9	4.6
Two seasons per year	130	67.0
Three seasons per year	55	28.4
Production process		
Farming with wrapping fruit	150	77.3
VietGAP	39	20.1
GlobalGAP	5	2.6

Source: Field Survey Data, 2020

The largest disparity was found in the cropping seasons of Chu-mango (Table 1), which is well illustrated by the fact that 67.0% of growers reported cropping 2 seasons per year, whereas only 4.6% of growers cropped 1 season per year, and 28.4% cropped 3 seasons per year. Only a modest proportion (2.6%) of respondents produced following the GlobalGAP standard, most respondents performed conventional farming with wrapping fruit (77.3%), and 20.1% of respondents followed the VietGAP standard.

Table 2 presents the summary of loading ranges and reliability estimates for each construct in this study. The results show that Cronbach's α was 0.897 for the coordination questionnaire, 0.895 for the value chain performance, 0.829 for commitment, 0.803 for collaboration, and 0.741 for joint decision-making. All values of Cronbach's α were greater than 0.7, which confirms the reliability of the relationships among observed and latent variables.

To evaluate the appropriateness of the factor analysis for the scale, Kaiser-Meyer-Olkin (KMO) test was conducted to examine the relationship performance measurements, and all values were within the accepted region of greater than 0.5. The KMO value in the study required a significance greater than 0.5 (0.855). Moreover, all factors with eigenvalues above 1 (1.018) were extracted. The results in Table 2 show that the data satisfy the required level, and we can apply a factor analysis.

Table 2.
The Cronbach's α test factor loading in exploratory factor analysis (EFA)

Variables	Factor loading				
	F1	F2	F3	F4	F5
Coordination (Cronbach's α: 0.897)					
CO3: To share activity schedule	0.845				
CO4: To have clear guidelines for interactions	0.802				
CO2: To work closely for effective executions	0.767				
CO5: To strictly follow our interaction guidelines	0.754				
CO1: To jointly manage our activities	0.739				
VC performance (Cronbach's α: 0.895)					
VCP2: To improve our responsiveness to customers		0.866			
VCP 1: To improve product quality		0.858			
VCP 4: To improve our efficiency		0.834			
VCP 3: To enhanced our flexibility		0.734			
Commitment (Cronbach's α: 0.829)					
CM3: To maintain our association			0.855		
CM2: To continue for a long future			0.848		
CM4: To be ready to invest in the relationship			0.652		
Collaboration (Cronbach's α: 0.803)					
CL3: To share our knowledge with our partners				0.843	
CL4: To share their knowledge with us				0.822	
CL2: To combine resources on common projects				0.522	
Joint decision-making (Cronbach's α: 0.741)					
D1: To jointly decide on product type					0.917
D3: To jointly set product prices					0.579
Parameters of test					
Kaiser-Meyer-Olkin (KMO)		0.855			
Cumulative % (Initial Eigenvalues)		75.1%			
Bartlett's Test of Sphericity (Sig.)		0.000			
Initial Eigen values		1.018			

Source: Field Survey Data, 2020

Exploratory factor analysis (EFA) using principal component analysis with a promax rotation was applied to the relationship performance scales to determine the correlation factors. The factor loadings for all measurement indicators were greater than 0.70, which reveal the high reliability of the measurements. Overall, the factor loadings of the five factors were greater than 0.70 except for CM4 of commitment, CL2 of collaboration, and D3 of joint decision-making, which were 0.652, 0.522, and 0.579, respectively. In past studies, factor loadings equal to or higher than 0.50 were assumed to demonstrate sufficient validity (Yu et al., 2013). In the concluding section of measurement, the mean was taken for each multivariate construct. The EFA suggested that the items were loaded on the appropriate dimensions under investigation, which supports the specification of the SEM (Table 3).

Table 3.
Model fit indicators in SEM

Indicators	Threshold values	Calculated values	Conclusion
Chi-square	**≤ 2,793.800**	170.985	Fit
Df	**≤ 300.000**	108.00	Fit
Chi-square/df	**≤ 3.000**	1.583	Fit
CFI	**≥ 0.900**	0.965	Fit
TLI	**≥ 0.900**	0.956	Fit
GFI	**≥ 0.900**	0.903	Fit
RMSEA	**≤ 0.080**	0.055	Fit

Source: Field Survey Data, 2020
Note: Threshold values adopted from Yu et al., (2013)

The study performed confirmatory factor analysis (CFA) and SEM on the SPSS AMOS version 22.0 statistical software package to evaluate the goodness-of-fit model fit of the survey data sets. Using a modified index, we obtained the covariance relationship between E1 and E2 (Figure 3). The research produced a fit-generated structural model with a p-value of 0.000 (p-value < 0.01), a chi-square value of 170.985 (< 2,793.8), chi-square/degrees of freedom of 1.583 (< 3.0), a goodness-of-fit index (GFI) of 0.903 (> 0.900), Tucker-Lewis index (TLI) of 0.956 (> 0.900), a comparative fit index (CFI) of 0.965 (> 0.900), and a root mean square error of approximation (RMSEA) of 0.055 (< 0.080). According to these results, the test of the research model provides evidence that the model is fitted.

From the diagram of the SEM results (Figure 3), many observed variables of the measurement model were rejected by the confirmatory factor analysis, including D2 of the joint decision-making, CL1 and CL5 of the collaboration, and CM1 and CM5 of the commitment. In the structural model, the exogeneous variable (commitment) was rejected by the regression analysis. The findings indicate that when every factor of coordination, joint decision-making and collaboration increases by 1, VCP increases by 0.345, 0.324 and 0.289, respectively, at the significance 1% level, while the other elements remain unchanged. The equation of the VCP regression analysis is as follows:

$$VCP = 0.345*Coordination + 0.324*Joint\ decision\text{-}making + 0.289*Collaboration$$

The first hypothesis (H1) is collaboration, which has a positive significant effect on the VCP (Table 4). Collaboration directly influences the VCP with an estimated value of 0.289, a construct reliability (CR) of 3.128, and a p-value of 0.002 (accepted first hypothesis). More specifically, knowledge sharing and resource combinations among farmers, cooperatives and enterprises improved the VCP of Chu-mango business linkages. Therefore, the collaboration of stakeholders in business linkages (farmers-cooperatives-enterprises) has a direct and significant influence on the VCP. This finding corroborates the results of other studies (Vereecke and Muylle, 2005; Bagchi et al., 2005; Cao and Zhang, 2010).

The third hypothesis (H3) indicates positive and substantial improvements in performance as a result of the close coordination of stakeholders in the business linkage of the Chu-mango value chain (Beta = 0.345; CR = 3.272; p = 0.001). Thus, coordination among farmers, cooperatives, and enterprises will lead to better performance. The frequent schedule share, clear interaction guidelines, close cooperation, strict execution of interaction, and joint activity management play important roles in enhancing the VCP of the Chu-mango business linkage of farmers-cooperatives-enterprises. Hence, the third hypothesis (H3) is accepted. This result is consistent with previous studies by Simatupang et al. (2002) and Kim (2009), who found that coordination stemmed from performance by improving the flexibility and responsiveness factors. A similar finding was obtained by Stank et al. (2001) and Elmuti et al. (2008), who suggested that coordination saved costs to improve efficiency.

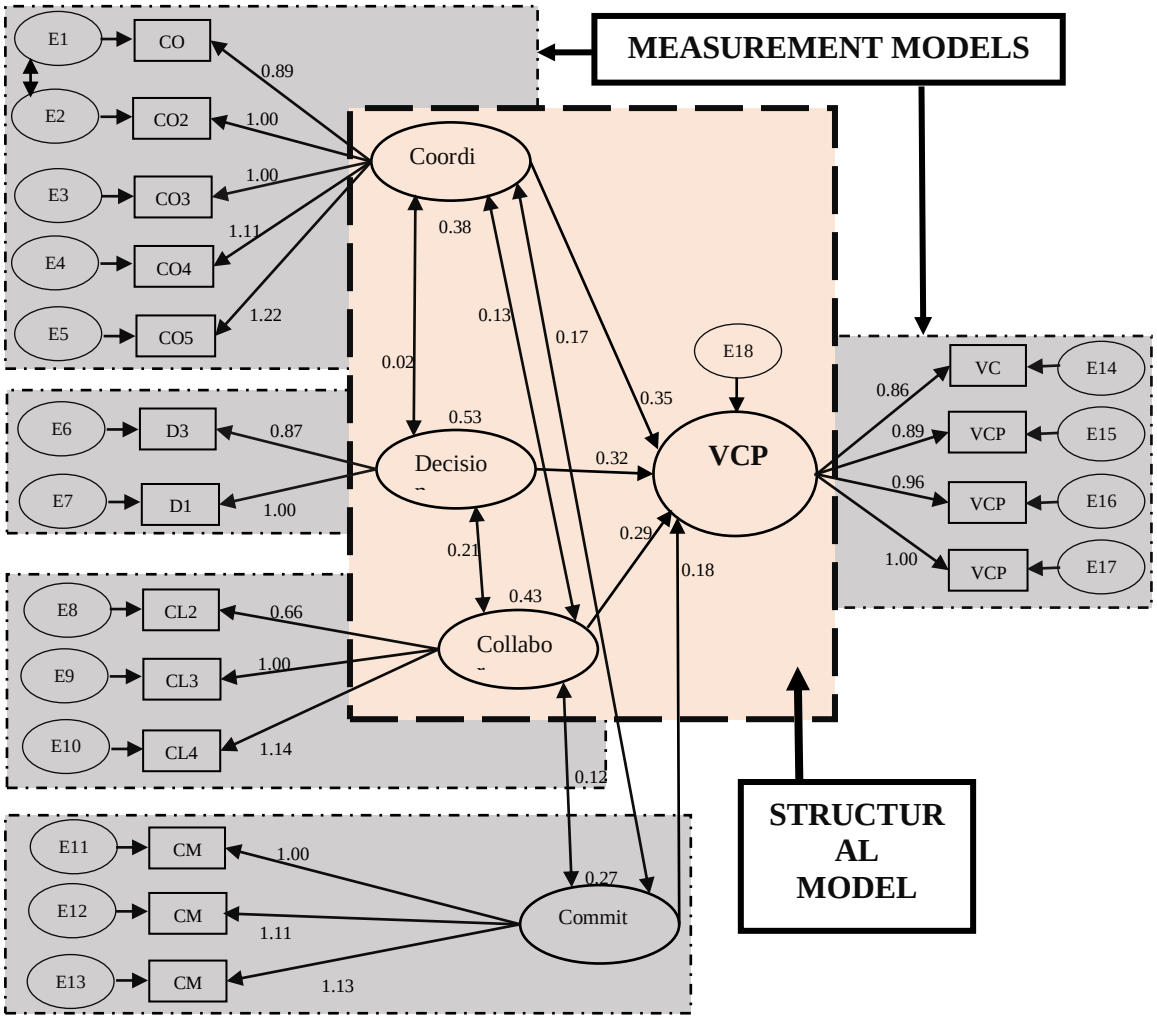

Figure 3. SEM map of the Chu-mango value chain performance

Table 4.
Estimates of the relationship between VCP and VCI factors

Relationship	Estimate	S.E.	C.R.	P – value
VCP ← Collaboration	0.289	0.092	3.128	0.002***
VCP ← Commitment	0.017	0.116	0.150	0.881
VCP ← Coordination	0.345	0.106	3.272	0.001***
VCP ← Joint Decision	0.324	0.100	3.245	0.001***
R^2 = 0.457				

Source: Field Survey Data, 2020
Note: *, **, and *** are levels of significance at $P < 0.01$, $P < 0.05$, and $P < 0.001$, respectively.

The fourth hypothesis (H4) states that VCP will improve as a result of joint decision-making in business linkage. Joint decision-making directly affects the VCP with an estimated value of 0.324, a CR of 3.245, and a p-value of 0.001 (Table 4). Thus, the VCP of Chu-mango business linkages can be increased by improving the joint decision-making based on the created model (joint decision of product type and prices). This result is consistent with those obtained from Van et al. (2008), who noted a positive relationship between joint decision-making and VCP, since it allowed extra flexibility to value chain members.

Additionally, there is a dearth of empirical studies on the VCI and VCP from developing countries (Vickery et al., 2003; Vereecke and Muylle, 2005; Sezen, 2008; Vanpoucke, 2009; Chin et al., 2014). Therefore, this study provides empirical data on the relationship between VCI and VCP through the Chu-mango value chain in Dong Thap Province during the COVID-19 pandemic.

4 Conclusion

This study provides evidence that the VCI significantly affects the VCP of Chu-mango business linkages through coordination, collaboration, and joint decision-making. The results show that the predictor provides support for performance. The findings will be of relevance to policy-makers, local governments, director boards of cooperatives, and company managers. In particular, stakeholders of business linkages will benefit from the study outcome, since it provides a framework for future reference, especially in the context of unexpected risks such as the COVID-19 pandemic. This framework will help partners in business linkages feel connected to reciprocal businesses in uncertain times and prepare businesses for the time after the crisis.

The findings of this study will help local governments by providing empirically tested results on several factors of VCP to better understand the influences of variables to enhance the VCP and sectorial allocation. This result may pave the way for relevant policymakers to look for policies and strategies that improve the inclusiveness of stakeholders to show them the importance of the VCI for better performance. In addition, policy makers should establish rules of alignment for Chu-mango business linkages to raise stakeholders' awareness and encourage value chain thinking to improve the performance. The study is an empirical case to contribute to the agribusiness value chain in a developing country; it applies the agribusiness value chain of the tropical fruit domain and is used for other agricultural products in other cases of unexpected risks.

Authors' contributions

The authors confirm the contribution to the paper as follows: study conception and design: Truong Hong Vo Tuan Kiet and Nguyen Thi Pham; data collection: Kiet Hong Vo Tuan Truong and Thoa Thi Kim Nguyen; analysis and interpretation of results: Kiet Hong Vo Tuan Truong; draft manuscript preparation: Kiet Hong Vo Tuan Truong and Thoa Thi Kim Thoa. 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 Mekong Delta region.

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No.:_____

Appendix 1

Questionnaire for The Mango Value Chain performance

Dear Sir / Madam,

My name is Tuan Kiet. I am doing research on mango value chain. The purpose of this research is to be more understanding relationship and collaboration between actors of mango value chain towards sustainable development.

In the next pages you will find a short questionnaire concerning mangoes. Firstly, there are some questions on basic information such as your age and gender. Most questions will obviously concern mangoes. Hopefully, you can spare 5 minutes to complete this questionnaire. Your help is necessary and will be very much appreciated!

Part 1: General Information

1. Actors in mango value chain:

☐Farmer ☐ Cooperative ☐ Middle men ☐ Wholesaler

☐ Enterprise ☐ Supporter

2. Sex: ☐ Male ☐ Female

3. Age_____, Email/phone number:_____

4. Years of experience: _____

5. Your level of education is:

☐ Primary school
☐ Secondary school
☐ College
☐ University
☐ Other (please specify):_____

Part 2: Value Chain Integration and Performance

Please mark **X** in the column that you have chosen for each statement

(1 = totally disagree 2 = disagree 3 = no idea 4 = agree 5 = completely agree)

Collaboration	**1**	**2**	**3**	**4**	**5**
We and our partners form joint teams to work on common projects	☐	☐	☐	☐	☐
We and our partners combine resources on common projects	☐	☐	☐	☐	☐
We unreservedly share our knowledge with our partners	☐	☐	☐	☐	☐
Our partners unreservedly share their knowledge with us	☐	☐	☐	☐	☐
We and our partners expend joint efforts to improve our relations.	☐	☐	☐	☐	☐
Commitment					
Our relations with our partners are based on mutual benefits	☐	☐	☐	☐	☐

Our relations with our partners continue for a long future	☐	☐	☐	☐	☐
We like to maintain our association with our partners	☐	☐	☐	☐	☐
We are ready to invest in the relationship with our partners	☐	☐	☐	☐	☐
We have stable relations with our partners	☐	☐	☐	☐	☐
Coordination					
We and our partners jointly manage our activities	☐	☐	☐	☐	☐
We work closely with our partners for effective executions of activities.	☐	☐	☐	☐	☐
We and our partners always share activity schedule	☐	☐	☐	☐	☐
We have clear guidelines for interactions with our partners	☐	☐	☐	☐	☐
Our partners strictly follow our interaction guidelines	☐	☐	☐	☐	☐
Joint decision-making					
We and our partners jointly decide on product type	☐	☐	☐	☐	☐
We and our partners jointly decide on process improvements	☐	☐	☐	☐	☐
We and our partners jointly set product prices	☐	☐	☐	☐	☐
Value chain performance					
We improved product quality by working closely with our partners	☐	☐	☐	☐	☐
We improved our responsiveness to customers by working closely with our partners	☐	☐	☐	☐	☐
We enhanced our flexibility by working closely with our partners	☐	☐	☐	☐	☐
We improved our efficiency by working closely with our partners	☐	☐	☐	☐	☐

Thank you for your answer!