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Alignment between vertical and horizontal coordination for food quality and safety in Indonesian vegetable chains

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Abstract

This study explores the alignment between vertical coordination (VC) and horizontal coordination (HC) in Indonesian vegetable value chains. This alignment helps buyers to design efficient coordination mechanisms with regard to the production of safe and high-quality vegetables. We use a qualitative approach and describe five vegetable value chains featuring VC and HC. Within-case and cross-case analyses have been performed to develop propositions. The empirical study finds that there is a diverse combination of VC and HC mechanisms in Indonesian vegetable value chains. Strong VC correlates with high food quality and safety standards that farmers have to meet. The presence of HC through a producer organisation (PO) reduces the need for strict VC mechanisms. When VC is combined with HC through a PO, efficiency of quality and safety control increases and coordination costs decrease, ensuring better compliance with food quality and safety requirements.

Keywords: Value chain, Producer organisation, Vertical coordination, Horizontal coordination, Food quality and safety

Introduction

The rise of modern retail markets¹ in developing countries has changed the nature of coordination between actors in agri-food chains (Reardon et al. 2009). Vegetable procurement in modern retail markets requires high levels of coordination to deliver vegetables while complying with the requisite quantity and quality standards (Reardon et al. 2012; Ruben et al. 2007). Moreover, the growing demand for food safety in developing countries implies that food chains are increasingly concerned about food safety requirements (Alita et al. 2020; Reardon et al. 2017). In their vegetable procurement processes, modern retailers often coordinate vertically with suppliers, which include smallholder farmers, often using contracts (Hueth et al. 1999; Michelson et al. 2012; Sahara and Gyau 2014).

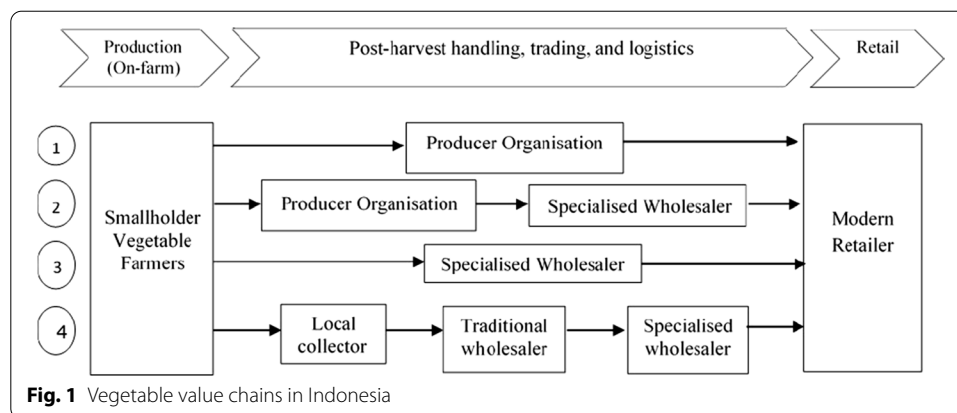
¹ Modern retail markets include hypermarkets, supermarkets and convenience stores.

When attempting to enter the modern retail market, smallholders in developing countries are often constrained by quality requirements (Jaffee and Henson 2005; Royer et al. 2016). However, contract farming arrangements including the provision of financial services, farming inputs, quality control measures, inspections and market information can improve the quality and safety of farmers' produce (Boselie et al. 2003; Dries et al. 2009; Key and Runsten 1999; Tefera and Bijman 2021). Alongside vertical coordination (VC) via contracts, other institutional arrangements, such as horizontal coordination (HC) through a producer organisation (PO), can help alleviate the concerns faced by smallholders who attempt to link up with modern food chains. The literature has shown evidence of POs being involved in quality control and providing services aimed at meeting product quality requirements (Dorward et al. 2004; Kaganzi et al. 2009; Kirezieva et al. 2016; Moustier et al. 2010).

Although there is ample literature that explains the role of vertical contracts or the role of POs in the improvement of food quality and safety in modern food chains (Adabe et al. 2019; Kirezieva et al. 2016; Moustier et al. 2010; Mwambi et al. 2020; Saenger et al. 2013), most of these studies analyse these VC and HC roles separately. In practice, however, VC and HC mechanisms are often combined, as POs may act as intermediary actors, providing coordination functions between buyers and the members of the PO (Fischer and Qaim 2012; Jia and Huang 2011; Mugwagwa et al. 2018; Widadie et al. 2021). The literature has shown that involving a PO in contract farming strengthens the efficiency and equity of the contracting arrangement (Jia and Huang 2011; Key and Runsten 1999). POs and contract farming may complement each other to overcome constraints relating to product quality. However, empirical studies that examine how VC (through contract farming) and HC (through a PO) combine to address quality and safety constraints faced by smallholders in value chains are lacking. Understanding how VC and HC mechanisms in value chains align may be extremely useful for planning effective coordination among actors and for lowering costs associated with such coordination. To fill this knowledge gap, this study explores how VC (in the form of contracting) and HC (in POs) interact in enhancing food quality and safety performance.

This study may help actors in modern retail chains design more efficient coordination processes concerning quality management. For policy makers, this study may help interventions that aim to improve the quality and safety of vegetables produced by smallholders. This study contributes to the academic literature on value chain coordination and food quality management, particularly how a combination of VC and HC structures can be used to improve food quality and safety performance at the farmer level. The study uses case studies from the Indonesian vegetable sector and modern retail markets. In addition, this study uses a cross-case analysis to compare value chains and develop propositions.

The paper is organised into five distinct sections. “**Background**” section provides background information on vegetable value chains and food quality and safety requirements in Indonesia's modern retail value chains. “**Research methodology**” section presents the theoretical framework and a literature review focussing on VC and HC in value chains and food quality and safety management. “**Conceptual framework and literature review**” describes the methodology of the empirical study. The results and discussions are



presented in “[Results and discussions](#)” section, which includes propositions. “[Conclusion and implications](#)” section contains conclusion, which includes policy and managerial recommendations, as well as suggestions for future research.

Background

Indonesian vegetable value chains in the modern retail market

Different types of institutional arrangements, including contracts and POs, exist in modern retail chains in Indonesia. According to our survey, modern retailers in Indonesia have formal vegetable procurement contracts with suppliers, including POs and specialised wholesalers. In these contracts, retailers establish the requirements for quantity, quality and delivery times that suppliers must comply with. These suppliers may then coordinate with other actors in the upstream part of the chain (Fig. 1).

We distinguish four different value chains. In Chain 1, the modern retailer has a formal contract with a PO that coordinates with its members. In Chain 2, the specialised wholesaler has a formal contract with a modern retailer and a verbal contract with a PO, which then coordinates with its members to meet the contractual requirements. In Chain 3, the specialised wholesaler has verbal contracts with individual farmers and has a formal contract with a modern retailer. In Chain 4, the modern retailer coordinates with a specialised wholesaler through a formal contract; in the upstream part of this chain, farmers sell their vegetables to a local collector, who sells to a traditional wholesaler who sells to the specialised wholesaler. Overall coordination between farmers and local collectors in chain 4 is weak, with spot market type of transactions. In all four value chains, retailers have contracts with their direct suppliers, who coordinate with actors upstream in the value chain.

Food quality and safety (organic) standards

The modern retail market in Indonesia is concerned about food quality and safety (David and Ardiansyah 2017; Minot et al. 2015; Slamet et al. 2017). To supply vegetables, suppliers have to meet quality and safety requirements determined by retailers. In general, modern retailers use quality standards based on intrinsic and extrinsic quality cues. Intrinsic quality cues relate to the physical properties of a product, such as its appearance, colour, shape and size; extrinsic quality cues relate to the production process (Luning and Marcelis 2007; Ophuis and Van Trijp 1995). Through our interviews, we learned

Table 1 Intrinsic and extrinsic vegetable quality attributes

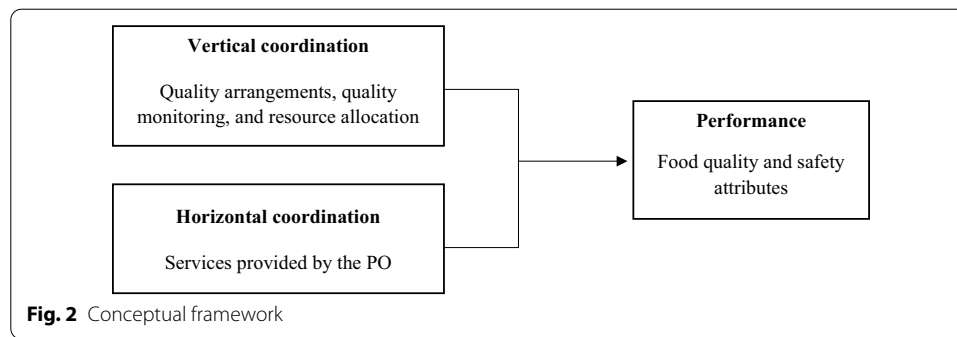
Intrinsic	Extrinsic
Appearance	Organic production practices (certified)
Colour	
Shape	
Size	

that intrinsic vegetable quality is gauged in terms of appearance, colour, shape and size, while extrinsic vegetables quality is judged in terms of organic production practices. The extrinsic quality is related to the safety of the product; for example, organic vegetables are free from pesticides and synthetic fertiliser residues. The retailers use organic certification as a cue for extrinsic quality (Table 1). To guarantee that vegetables have been produced according to organic standards, producers must obtain organic certification from an independent certification institution.

According to the Indonesian Agriculture Ministry's Regulation No. 64 established in 2013, organic agricultural products sold in Indonesia must meet the standards of the organic certification institutions. Indonesia has nine independent organic certification institutions that have the authority to assess agricultural production on organic practices. The standards for agricultural products in Indonesia are established in Indonesian National Standard (SNI) No. 6729: 2016, which acts as a guide for producers and for the organic certification institutions. According to SNI No. 6729: 2016, organic certification institutions inspect and assess the activities of producers and distributors, including farm inputs, cultivation, harvesting, storage, post-harvest handling and distribution. Producers are assessed through on-site inspections, interviews, the review of documentation and residue analysis. SNI No. 6729: 2016 is based on the minimal use of external input materials and the non-use of synthetic fertilisers and pesticides. Producers that meet organic standards are allowed to use an organic logo when labelling their products. In Indonesia, demand for food safety increases yearly due to the growing awareness of consumers of the importance of safe production and handling of food (David and Ardiansyah 2017; Minot et al. 2015). Organic certification guarantees that an agricultural product is free from pesticides and synthetic fertiliser residues.

Conceptual framework and literature review

Coordination is defined as managing interdependencies between activities performed to achieve a goal (Malone and Crowston 1994). Within a food supply chain, coordination has two key dimensions. The first is vertical coordination (VC), which includes collaboration between different actors in the chain from the primary producer up to the customers. The second is horizontal coordination (HC), which includes collaboration between actors in the same level of the chain, e.g. farmers collaborating with other farmers (Lazzarini et al. 2001; Lyne and Martin 2008). Contract farming is a type of VC that consists of a combination of coordination mechanisms between farmers and their buyers (Grandori 1997; Rehber 2007).



Previous studies have examined coordination mechanisms to better understand how governance structures work and to elaborate on the forms of governance that feature on the market-hierarchy continuum (Grandori 1997; Martins 2017; Wever 2012). Using the concept of coordination through governance structure, this study examines the VC mechanisms that are present in the relationship between farmers and buyers. The governance structure continuum stretches from spot market to hierarchical relationship. If the governance structure closely resembles a hierarchy, then a high degree of VC is implied.

The presence of POs in contract farming can be beneficial and can help to create more efficient VC mechanisms to comply with food quality and safety requirements (Moustier et al. 2010; Mwambi et al. 2020; Tefera and Bijman 2021). As POs are organisations that are formed by farmers, their key function is to provide goods and services to their members (Bijman 2016). Next to providing technical assistance and delivery of farm inputs, other services add value to vegetables through packaging and organic certification. In the context of chain coordination, providing all members of the PO with the same services and inputs is a form of HC.

This study explores the alignment between VC and HC, and how this affects food quality and safety performance. Based on the above-presented literature, we identify the following key concepts: *vertical coordination* mechanisms such as quality arrangements, quality monitoring and resource allocation; *horizontal coordination* via the services provided by POs to improve compliance with quality requirements; and *food quality and safety performance* measured by the intrinsic and extrinsic quality attributes achieved by coordination in the chain. Figure 2 illustrates our conceptual framework.

Governance structures and vertical coordination mechanisms

Transaction cost theory is often used as a fundamental theory to explain firms' and farmers' participation in contract farming. Transaction costs consist of information costs, negotiation costs, and monitoring or enforcement costs (Coase 1937). By selecting a suitable governance structure for a particular transaction, transaction costs can be minimised.

Governance structures can be placed on a continuum, ranging from spot market to hierarchy (Williamson, 1991). Between the spot market and hierarchy extremes on the continuum lie various hybrid governance structures. In the spot market, transactions have a low level of coordination and are mainly determined by the price mechanism. In

Table 2 Vertical coordination mechanisms regarding quality and resource allocation on the governance structure continuum

Vertical coordination mechanism	Variables	Spot market ← Hybrid → Hierarchy			
		Spot market	Intrinsic quality arrangements	Intrinsic and extrinsic (organic safety) quality arrangements	Hierarchy
Quality	Quality arrangements	No specific quality arrangements	Intrinsic quality arrangements	Intrinsic and extrinsic (organic safety) quality arrangements	Internal quality
	Quality monitoring	No monitoring of production	Monitoring by the transaction party (buyer)	Monitoring by the transaction party and a third party	Internal monitoring
Resource allocation	Buyer support: technical assistance	No buyer support regarding technical assistance and production knowledge	Buyer provides technical assistance and production knowledge in line with supplier requests	Buyer provides technical assistance and production knowledge	Internal technical assistance and production knowledge
	Buyer support: farming inputs	No farming inputs provided or approved	Farmers use farming inputs approved by the buyer	Farming inputs are allocated by the buyer	Farming inputs are used internally
	Buyer support: organic certification	No support	Buyer supports the process of organic certification and pays all expenses	Buyer supports the process of organic certification by paying expenses and applying to a third party	Internal support for organic certification

Source: Elaborated from Martins et al. (2017)

a hierarchical structure, there is a high level of coordination, with a single firm controlling all stages of production and distribution (Peterson et al. 2001). A hybrid form of governance is an intermediary form of control, where parties are mutually dependent but remain autonomous (Ménard and Klein 2004; Williamson 1991). Examples of hybrid forms of governance are contracts, networks, cooperatives, alliances and franchising.

Governance structures combine several coordination mechanisms (Grandori 1997). Williamson (1991) discussed different governance structures on the market to hierarchy continuum, however, without detailing the nature of coordination within these governance structures (Gellynck and Molnár 2009; Martins et al. 2017; Raynaud et al. 2005; Wever 2012). Even within one governance structure, different coordination mechanisms, such as agreements on price, quality and quantity may be located at different points on the continuum (Martins et al. 2017).

Based on our survey, VC mechanisms designed to address food quality and safety requirements in Indonesian vegetable value chains are depicted along the governance structure continuum (Table 2). Coordination mechanisms relating to food quality include quality arrangements, quality monitoring and the allocation of resources provided by specific buyers.

With regard to spot market governance, there are no specific quality arrangements; buyers do not monitor quality, buyers do not provide support or technical assistance, and there is no support regarding farming inputs. With regard to coordination on quality, farmers are free to use their resources independently and to produce vegetables with no specific quality requirements. Transactions between farmers and buyers are generally based on the price mechanism. When we move on to hybrid governance arrangements, which lie between the spot market and the hierarchy, VC becomes stronger. In terms of quality arrangements, buyers establish intrinsic and extrinsic (e.g. organic) requirements that contracted farmers must comply with. The buyer and a third party (an independent organic certification institution) evaluate farmers' quality and safety achievements. In such transactions, the role of the third party is to evaluate whether producers have met the organic standards. Regarding resource allocation, the vertical coordination mechanism consists of buyer support, such as the provision of technical assistance, production knowledge and farming inputs (seed, fertiliser and pesticide), as well as support for the organic certification process. The highest degree of coordination occurs in the hierarchy governance structure. Here, coordination comes through ownership and farmers become employees in a vertically integrated firm (Gereffi et al. 2005; Peterson et al. 2001). In a pure form of hierarchy governance, firms control all decisions regarding quality and resource allocation.

Producer organisations and food quality

The key function of a PO is to provide services and goods to its members (Bijman 2016). A PO supports quality and safety improvements and compliance with quality requirements. For instance, the services provided can support on-farm activities, e.g. by providing farming inputs or technical assistance, or can support vegetable sales by sorting, packaging, marketing, storage, delivery and organic certification. Farmers coordinate horizontally with other farmers to examine and meet food quality and safety requirements. The literature shows that the activities of POs and the services that they offer to members influence food quality and safety. For example, POs monitor their members' compliance with food safety requirements (Hueth et al. 1999) and they provide training and technical assistance to enhance food safety (Lindahl et al. 2018; Naziri et al. 2014). Value chain coordination, monitoring and technical advice provided by the PO supports members to adopt food safety measures (Mwambi et al. 2020).

Research methodology

We conducted this research on the slopes of Mount Merbabu and Mount Merapi in Central Java and Yogyakarta Provinces because these areas are large centres of vegetable production and they supply vegetables to modern retailers. To achieve our aims, a qualitative case study was conducted, as this was an appropriate way to obtain detailed information about the processes and actors (Yin 2003). Semi-structured interviews were conducted with chain actors and actors from the institutional environment (see Table 3). Interviewees were selected through a multistage sampling strategy. In the first stage, we interviewed the modern retailers to obtain the information about the suppliers of vegetables and mechanisms to supply the vegetables. In the second stage, based on the information received from the retailers, we selected the suppliers of vegetables (the

Table 3 Overview of interviewees

Type of organisation	n	Interviewees' function	States
Farm	13	Individual farmers selling to rural collectors (4), farmers contracted to specialised wholesalers (5), farmers contracted through a PO (4)	Magelang, Yogyakarta and Semarang
Producer organisation (PO1 and PO2)	4	Leaders (2), secretaries (2)	Boyolali, Semarang and Magelang
Specialised wholesaler (Wholesaler 1, 2, 3, 4)	4	Owners (4)	Yogyakarta and Magelang
Modern retailer (Retailer1 and Retailer2)	2	Purchasing staff members (2)	Yogyakarta and Surakarta
Institutional environment	2	OKKPD (local government) and Persada (an organic certification institution)	Semarang and Yogyakarta

Otoritas Kompeten Keamanan Pangan Daerah (OKKPD) translates as the Regional Food Safety Competent Authority. It is an institution within the Agriculture Department and Food Security Agency in Central Java and is tasked with ensuring food safety and the quality of fresh food of plant origin

specialised wholesalers). In the third stage, using the information provided by the specialised wholesalers, we selected the farmers who supplied the vegetables to the modern retailers. Snowball and convenience sampling method were conducted until the saturation point, that is, until we did not find any other VC and HC mechanisms. Five value chains were selected based on the VC mechanisms, the role of POs in the value chains and the food quality and safety performance in the value chain.

The interviews focused on quality arrangements, monitoring, resource allocation and organic certification. For POs, the interviews focused on the services provided by the PO, including meeting food quality and safety requirements and making improvements. In this study, food quality and safety performance were measured by the intrinsic and extrinsic attributes of vegetables produced by farmers. To analyse the interviews, we performed a within-case analysis (to describe each value chain) and a cross-case analysis (to explore differences in VC mechanisms, POs, and food quality and safety performance).

Results and discussions

The results and discussions of this study are presented in the within-case and cross-case analyses. In the within-case analysis ("[Within-case analysis](#)" section, five value chain cases are identified and described. In the cross-case analysis ("[Cross-case analysis](#)" section), the results highlight different levels of VC and HC (involving POs) in the five cases and their different quality and safety achievements.

Within-case analysis

Case A

Spot market transactions are present when farmers sell vegetables to rural collectors (see [Box 1](#)). In the spot market, the level of coordination between farmers and rural collectors is low, and coordination is primarily based on the price mechanism. Rural collectors do not have specific requirements regarding either intrinsic or extrinsic quality. *The farmer stated: 'I, along with most of the farmers nearby, sell the vegetable to the rural*

Box 1 Case A*Vertical coordination*

Farmers sell vegetables to rural collectors based near their homes and fields. There are no quality specification agreements. The farmers sell unsorted vegetables of heterogenous quality to the rural collectors. The rural collectors do not monitor quality or sort vegetables based on a specific quality standard. Rural collectors accept vegetables of any quality and then sell them to traditional (wet) markets. In addition, rural collectors do not allocate resources, such as farming inputs or technical assistance, that could help farmers address quality concerns.

Horizontal coordination

No PO is involved in this chain.

Quality performance

The vegetables produced are heterogenous and do not meet any specific quality requirements, either intrinsic or extrinsic (organic).

Box 2 Case B*Vertical coordination*

Specialised wholesaler 1 has contractual arrangements with local individual farmers regarding the supply of vegetables to modern retailers. In terms of contractual arrangements, wholesaler 1 sets out intrinsic quality product specifications. Farmers should meet the intrinsic quality requirements regarding size, appearance, colour and shape. Quality monitoring is carried out by wholesaler 1, as it sorts vegetables before delivering them to the modern retailers. Wholesaler 1 offers no technical assistance or farming inputs to contracted farmers to help them achieve quality standards.

Horizontal coordination

No PO is involved in this chain.

Quality performance

Vegetables delivered to wholesaler 1 by the farmers meet intrinsic quality requirements

collectors who come to our house and field at harvest time to buy vegetables. These rural collectors are willing to buy and accept all the vegetables produced without any specific grading and quality. Due to the absence of quality standards in this chain, rural collectors do not carry out quality monitoring activities and do not provide any resources to the farmers. Therefore, vegetables traded in this transactional context do not meet any quality or safety standards.

Case B

In Case B, the buyer (specialised wholesaler 1) has contracts with individual farmers to supply vegetables to modern retail markets (see Box 2). The specialised wholesaler sets specific requirements regarding the intrinsic quality of vegetables that the contracted farmers must comply with. Wholesaler 1 stated: *'Farmers have understood the quality of products that should be sold to us and to the traditional markets. For us, they select and deliver the vegetables having good quality. We accept the vegetables with the good quality and share the quality requirements with our farmers.'* Wholesaler 1 monitors quality by sorting the vegetables that have been delivered by the contracted farmers. Wholesaler 1 stated: *'Before we pack and deliver vegetables to the supermarkets, we sort them by selecting the ones that fulfil our standards in term of appearance, size, shape, and colour; like the supermarkets' quality requirements.'* Wholesaler 1 does not provide any farming inputs, technical assistance, knowledge or organic certification assistance. In this chain, the producer meets the intrinsic quality requirements set by the wholesaler.

Box 3 Case C*Vertical coordination*

Specialised wholesaler 2 has a contract with a PO1 regarding the supply of vegetables to modern retail markets. Wholesaler 2 sets the intrinsic quality requirements that PO1 must comply with. To achieve the quality standards, wholesaler 2 uses sorting to monitor vegetables on the basis of intrinsic requirements, such as appearance, size, colour and shape. Wholesaler 2 provides no support to PO1 in terms of farming inputs, knowledge or technical assistance.

Horizontal coordination

The PO1 provides services to its members by sharing knowledge and providing technical assistance regarding production. In addition, PO1 holds regular meetings with its members to share information about quality requirements and to arrange logistics and procurement processes that will help contractual requirements to be met.

Quality performance

Vegetables produced by smallholders meet intrinsic quality requirements

Box 4 Case D*Vertical coordination*

Specialised wholesaler 3 has a contract with PO2 to supply organic vegetables to modern retailers. Wholesaler 3 establishes the intrinsic and extrinsic (organic) requirements that PO2 must comply with. Wholesaler 3 monitors the intrinsic quality of vegetables, via sorting, and examines the produce in terms of size, appearance, colour and shape. The intrinsic quality standards stem from the requirements of modern retailers. Regarding the extrinsic (organic) standards, a third party (an organic certification institution) assesses the standard of farmers' production processes.

Horizontal coordination

PO2 coordinates with its farmer members to comply with the quality requirements set out by wholesaler 3 regarding intrinsic and extrinsic quality. PO2 provides services to its members to comply with quality requirements by providing organic farming inputs (organic fertiliser and phyto-pesticide), technical assistance and organic farming knowledge. In addition, PO2 holds regular meetings to share information with its members, including information on buyers' quality requirements. To achieve extrinsic quality (an organic standard), a third-party monitor and assesses vegetable production for PO2 members. The members cover the costs of PO2, including paying for the expenses associated with the organic certification process.

Quality performance

Vegetables produced at the farm level meet intrinsic and extrinsic (organic) safety standards.

Case C

In Case C, the specialised wholesaler 2 defines intrinsic quality requirements in the contract, which PO1 must comply with (see Box 3). PO1 coordinates the activities of its members for meeting the quality requirements. PO1 stated: *'For enhancing quality, we share pertinent information and provide technical assistance to our members. We share knowledge among our members that can also be received from an agricultural extension. We share the quality requirements from wholesaler 2 and arrange the logistics and procurement process to deliver the vegetables to wholesaler 2.'* Before delivering vegetables to the wholesaler 2, PO1 sorts the vegetables and selects produce that meets the intrinsic quality requirements. The wholesaler also carries out sorting activities and monitors quality to ensure that the vegetables meet the intrinsic quality requirements before delivering them to modern retailers. Wholesaler 2 stated: *"We inform PO1 about the quality specification that we want as per the requirements of supermarkets. We want good quality with grade A. We sort and monitor these vegetables and check whether they fulfil our specifications or not. Generally, we seek good appearance, fresh colour, specific size, and shape. We then pack these vegetables in our warehouse."*

Box 5 Case E*Vertical coordination*

Specialised wholesaler 4 has contracts with individual farmers for the supply of vegetables to modern retail markets. Wholesaler 4 has contractual arrangements with local farmers. In the contracts, wholesaler 4 establishes a strict rule that vegetables must meet intrinsic and extrinsic (organic) quality requirements. To achieve the quality required, wholesaler 4 shares information and knowledge and provides technical assistance regarding organic production to the contracted farmers. Wholesaler 4 also pays expenses associated with organic certification applications to a third party. Quality monitoring is carried out by wholesaler 4, which sorts vegetables and selects those that meet the intrinsic quality requirements before delivering them to modern retailers. For the extrinsic (organic) standard, a third party (an independent organic certification institution) inspects vegetable production to assess whether organic standards have been met by the contracted farmers. The third-party issues organic certifications for vegetables that have reached organic standards.

Horizontal coordination

No PO is involved in the chain.

Quality performance

The vegetables produced at farm level meet intrinsic quality and extrinsic (organic) safety standards.

Case D

In Case D, the buyer (a specialised wholesaler 3) has a contract with a PO2, rather than with individual farmers, regarding the supply of vegetables (see Box 4). Wholesaler 3 stated: *'We have a partnership with PO2 to deliver the organic vegetables to the supermarkets in Semarang. Our partner, PO2, has the capability to meet our quality specification and produce organic vegetables. We share information about the quality of vegetables that we need with the PO2.'* Wholesaler 3 establishes the intrinsic and extrinsic (organic) quality requirements that the PO2 must comply with. To monitor intrinsic quality, wholesaler 3 sorts vegetables before accepting them from PO2. Wholesaler 3 stated: *'We sort vegetables according to the quality. We select only those vegetables that meet supermarkets standards. For organic vegetables, the PO2 has an organic certification from INOFICE, an organic certification institution, which assesses the organic standard from the farmers' production.'*

PO2 coordinates member activities in order to comply with the quality requirements. PO2 facilitates quality achievement by providing farming inputs involving the use of pesticides and organic fertiliser and by providing knowledge and technical assistance for organic production. PO2 stated: *'Our group opts for organic vegetables because we find the soil structure to be more sustainable. Our group provides organic farming knowledge and technical assistance to our members to produce organic vegetables. The government and sometimes the experts as well come to share the knowledge with us. For supporting our members producing organic vegetables, we produce organic fertiliser and phyto-pesticide for the members.'* With regard to achieve the extrinsic quality, the farmers are assessed by the third party, an organic certification institution. As the statement of PO2: *'We use an organic certification institution, INOFICE, to ensure that our vegetables have meet with the Indonesian organic standard. We pay all the expenses for the certification and re-certification every three years. The label "organic" and the number of the organic standard are specified in the packaging.'*

Case E

In Case E, the buyer (specialised wholesaler 4) establishes intrinsic and extrinsic quality requirements that farmers must comply with (see Box 5). The intrinsic quality

Table 4 Overview of VC mechanisms and POs in the five value chain cases

Items	Variables	Case A Spot market	Case B	Case C Hybrid	Case D	Case E
Vertical coordination mechanisms	Quality arrangements	No specific quality arrangements	Intrinsic quality arrangements	Intrinsic quality arrangements	Intrinsic and extrinsic quality arrangements	Intrinsic and extrinsic quality arrangements
	Quality monitoring	No monitoring	Monitoring by buyer	Monitoring by buyer	Monitoring by buyer and third party	Monitoring by buyer and third party
	Resource allocations	No resource allocation	No resource allocation	No resource allocation	No resource allocation	Buyer provides technical assistance, knowledge and support for organic certification
PO	Services	No PO involved in the contract	No PO involved in the contract	PO shares knowledge and provides training	PO provides inputs, knowledge, training and support for organic certification	No PO involved in the contract
Quality and safety performance	Quality	No quality standards	Food quality	Food quality	Food quality and safety	Food quality and safety

requirements involve the appearance, colour, shape and size of the vegetables. In terms of extrinsic quality, the produce must meet organic standards. Wholesaler 4 stated: *'We have created a group of farmers around here who supply the organic vegetables to us. We regularly meet the farmers to share anything, such as knowledge of organic farming without any chemical input, arrange the schedule of delivery, logistics and information about the quality, quantity and kind of vegetables.'*

Quality monitoring is conducted by the wholesaler 4, which sorts vegetables delivered by contracted farmers based on intrinsic quality standards. Wholesaler 4 stated: *'Our staff in the warehouse sorts the vegetables that meet our quality standard. The vegetables are then cleaned, packaged and labelled. If these vegetables do not meet our quality, we reject them and return them to the farmers.'* In terms of the extrinsic requirements (organic production process), a third party (an independent organic certification institution) inspects the vegetables to assess whether organic standards have been met. Wholesaler 4 stated: *'To guarantee that our vegetables have been produced with the organic standard, we use PERSADA, an organic certification institution that inspects the vegetables to ascertain whether the organic standards have been met. Sometimes, we also inspect the farmers in the field, and if we find the farmers using chemical inputs, then we reject these products like our partners.'* In this chain, the transaction between the specialised wholesaler and farmers is based on a contractual arrangement.

Table 4 shows that the coordination mechanisms to address food quality and safety requirements, both vertically with the buyers and horizontally within POs, are diverse. The diversity of the vertical coordination is presented in the continuum of the governance structures, from less coordinated in Case A to more integrated in Case E, as well as within the models, which describe various VC mechanisms on quality agreements,

monitoring and resource allocation. These findings confirm previous studies that a diversity of governance structures and related coordination mechanisms exists in agri-food chains (Gellynck and Molnár 2009; Martins et al. 2017; Raynaud et al. 2005). At the same time, the HC in this study shows a diversity of services provided by the POs to meet quality and safety requirements. This finding confirms previous studies that different types of POs are involved in value chains, which differently influence food safety and quality performance (Kormelinck et al. 2019; Mwambi et al. 2020). It is the combination of VC mechanisms and HC mechanisms that determine the ability to meet food quality and safety standards.

Cross-case analysis

In this section, we present the cross-case analysis to illustrate the differences between VC mechanisms, PO services, and quality and safety standards in the five value chains. Based on the cross-case analysis, several propositions have been developed.

Vertical coordination mechanisms and food quality and safety requirements

The first difference between the five cases is the strength of VC. In case A, no quality standards were used; in cases B and C, vegetables were produced according to quality standards; while in cases D and E, quality and safety according to (organic) standards were produced. The level of vertical coordination was stronger in cases D and E than in cases A, B and C. The correlation between VC and quality performance shows that a strong vertical coordination goes together with strict requirements for production according to standards. To meet food quality and safety standards, actors in the upstream part of the value chain (farmers and buyers) must use strong VC mechanisms. Robust coordination is apparent in the efforts made by buyers to monitor intrinsic quality, involve third parties in the assessment of the organic standards, detail quality requirements in contracts and provide support such as technical assistance, knowledge sharing and the payment of organic certification expenses. Based on the findings about the relationship between vertical coordination and quality and safety standards, we have formulated the following proposition:

Proposition 1. *Strong vertical coordination correlates with strict requirements regarding the quality and safety of the vegetables produced.*

This finding is in line with previous studies that found that governance, in terms of VC in agri-food chains, correlates with food quality (Kataike et al. 2019; Raynaud et al. 2005; Wever et al. 2010). This result is also consistent with previous studies that showed that VC, through contracts, positively affects quality improvement by farmers (Boselie et al. 2003; Dries et al. 2009; Hueth et al. 1999). The proposition adds to the existing literature that strong VC not only correlates with food quality requirements but also with food safety requirements (such as organic).

The relationships between vertical and horizontal coordination

The second difference between cases is seen in the relationship between VC and HC (e.g. services of a PO) to comply with the food quality and safety requirements. These

relationships are both substitutable and complementary. The substitution dimension of the relationship can be seen in the role of POs in the value chains that may reduce the strength of VC and contribute to less hierarchical governance structures. In cases C and D, contracts between buyers and farmers are applied via the PO. The presence of a PO in the chain leads to weaker VC in comparison to chains without a PO (cases B and E). The POs in cases C and D provide services to members by sharing knowledge and providing training, farming inputs and even organic certification support (in case D) to help farmers improve quality and safety and meet requirements. In comparison, the buyer in cases B and E coordinates directly with individual farmers, with no mediation by a PO, to produce vegetables that meet food quality and safety standards. In addition, in case E, the VC strength is evident in the effort of buyers to provide technical assistance, share knowledge about organic farming and certification and monitor the vegetables being produced by farmers. The involvement of a PO in cases C and D partly substitutes VC mechanisms to meet the quality and safety standards. The POs in the chains play a role in providing services and replace some part of the buyer's function regarding monitoring compliance with the quality and safety requirements. This finding has led us to formulate the following proposition:

Proposition 2. *The presence of horizontal coordination (a PO) in a chain reduces the need for strict vertical coordination to comply with food quality and safety requirements.*

Considering VC and HC as substitute governance mechanisms is in line with Vroegindewey et al. (2018). These authors found that either a PO or a buyer takes control of specific coordination activities, depending on the relative costs of the competing structures. The substitution view is common among studies that categorise POs as a hybrid form of governance structure (Ménard 2007; Peterson 2001). In the extant literature, not much attention has been paid to the interaction between VC and HC in value chains. Proposition 2 contributes to the literature on transaction cost and governance structure; it posits that the presence of HC influences the level of VC and even influences the form of governance structure.

The relationships between VC and HC can also be seen as complementary. HC cannot completely replace VC in the chain because VC structures concern coordinating with the buyers downstream, while HC mainly concerns coordination among farmers in the PO. In cases C and D, HC is combined with VC to comply with quality and safety standards in modern retail chains. HC through POs providing services to its members complements VC structures in coordinating with buyers. In cases C and D, the POs provide inputs on farming, knowledge and training, and even on organic certification, as well as implement the marketing contracts in the VC structures. The pairing of HC structures (marketing POs) and VC structures (marketing contracts) in cases C and D is more effective than solely depending on VC (e.g. cases B and E). In cases B and E, the buyer assumes all the coordination responsibilities to comply with quality and safety requirements through resource-providing contracts (in a so-called buyer-led value chain (Gereffi et al., 2005)). The coordination costs in cases B and E are higher than the coordination costs in cases C and D. The coordination costs are associated with the costs of exchanging information and activities among partners to

the joint accomplishment (Grover and Malhotra 2003). In cases B and E, the coordination costs are high because of the efforts of the specialised wholesalers coordinating with the individual farmers to meet the quality requirements and arranging the logistics mechanism. With regard to meeting the quality requirements, the specialised wholesalers share information with individual farmers about the quality requirements, they monitor compliance and they provide resources to the farmers. Different from cases C and D, which involve a PO in the chains, the specialised wholesalers just share with the POs the quality requirements without interacting with the individual farmers. On the basis of this finding, we formulate that:

Proposition 3: *The combination of vertical and horizontal coordination in a value chain will increase efficiency when compliance with food quality and safety standards is needed.*

The literature has viewed HC and VC structures as a complementary relationship, in which each structure has specific advantages to help overcome coordination problems (Bijman and Wollni 2008; Royer et al. 2016; Sartorius and Kirsten 2007). With regard to meeting quality and safety standards, POs are often seen as more efficient at pooling agricultural products, delivering inputs such as training, extension and technology transfer, coordinating the logistics and communication among members, monitoring quality standards and enforcement of rules in the contract arrangements (Bijman 2008; Sartorius and Kirsten 2007; Ton et al. 2018). VC, through contract farming, is often seen as more efficient at reducing uncertainties through market guarantees, providing market information and providing protection from buyer hold-up (Kirsten and Sartorius 2002; Minot 2007). The combination of HC and VC in a value chain results in higher efficient in reducing transaction costs by minimising the coordination costs of complying with quality and safety standards. This finding confirms previous studies that VC and HC structures are often simultaneously present in agri-food chains and that they have a complementary and substitution relationship that is effective at reducing transaction costs (Vroegindewey et al. 2018). Proposition 3 adds to the existing literature on efficiency in chain coordination. The proposition can be tested by quantitative research that examines the efficiency in different forms of chain coordination.

Conclusion and implications

This paper explores the alignment and interaction of VC mechanisms, PO activity and production according to quality and safety standards. Qualitative case studies were conducted in five modern retail vegetable value chains in Indonesia. Within-case and cross-case analyses were performed to understand how the chain coordination structures, both vertically and horizontally, influence compliance with the quality and safety requirements of modern retail. Within-case analysis shows that different combinations of VC and HC can be used to comply with food quality and safety standards. Several propositions are derived from the cross-case analysis. First, the strength of VC is correlated with the quality and safety requirements of the vegetables

produced. The strength of VC can be seen in the efforts of buyers to monitor intrinsic quality, involve third parties in the assessment of extrinsic (organic) quality and provide resources. Second, in meeting quality and safety requirements, VC and HC can be substitutes or complements. In the substitution view, HC reduces the needed for strict VC, while in the complementary view, VC and HC together coordinate the compliance with food quality and safety requirements.

Policy and managerial implications

This study offers policy and managerial implications for government and buyers to improve efficiency in value chain coordination in order to meet the food quality and safety standards required by modern retail. This study found that VC mechanisms, combined with POs, improve compliance with food quality and safety and reduce transaction costs. To meet quality and safety requirements, buyers enter contracts with POs rather than with individual farmers. Specifically, partnerships of wholesalers and POs have the capability of complying with quality and safety (organic) requirements. Contracts that involve POs do not need strict VC, as POs can themselves coordinate farmer compliance with quality and safety standards.

The increase in consumer awareness of and demand for food safety assurances in Indonesia provides an opportunity for POs and smallholders to become more concerned about food safety (organic) standards. Therefore, policymakers should support the development of POs and encourage them to be increasingly concerned about food safety (organic) standards. For instance, local governments could impart knowledge and provide facilities to POs to help implement organic farming and help POs build internal control systems that assist in the monitoring of compliance with organic certification requirements.

Limitations and future research

Our study has several limitations. First, we focused on the upstream part of the value chain, which involved farmers and buyers. We suggest that future studies explore the entire value chain, from the upstream to the downstream level. By doing so, the whole process of chain coordination and the impact of coordination on quality and safety could be better understood. Second, in this study, HC was measured in terms of POs providing goods and services to its members. Future studies could also include other aspects of horizontal coordination, such as POs' internal governance and decision-making, member commitment and internal control systems that help to improve quality management. Third, this study used qualitative analysis to develop propositions. For testing the propositions, future studies should collect and analyse quantitative data; qualitative findings are often followed by a quantitative assessment (Harrison and Reilly 2011). Lastly, this study discusses the evidence of VC in a single form of governance structure in each case; however, in the field, the buyers (specialised wholesalers) use plural governance structures to coordinate with farmers. Future studies could also include such plural governance structures in line with research by Mugwagwa et al. (2018).

Abbreviations

VC: Vertical coordination; HC: Horizontal coordination; PO: Producer organisation.

Acknowledgements

We are grateful to the smallholders, producer organisations, specialised wholesalers and modern retailers in Indonesian vegetable value chains that have shares information and knowledge.

Authors' contributions

The first author conceived the study, conducted the survey, analysed the data and wrote the manuscript. Second and third authors read and edited the manuscript. All authors read and approved the final manuscript.

Funding

This research was financially supported by the Ministry of Education and Culture of The Republic of Indonesia.

Availability of data and materials

The datasets used and analysed in this study are available from the corresponding authors on reasonable request.

Declarations**Competing interests**

The authors declare that they have no competing interests.

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Received: 24 August 2021 Revised: 12 January 2022 Accepted: 1 March 2022

Published online: 14 March 2022

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