Interlinkages in Agro Supply Chains: An Empirical Investigation on Joint Socio-knowledge Development

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ABSTRACT

This paper examines the importance of information exchange in achieving efficient and collaborative supply chain best practices in Vietnamese agricultural industries. The study argues that joint knowledge development can be regarded as complementary assets to leverage supply chain information exchange (SCIE) and performance. This study used a resource-based view in its analysis. It employed statistical tests on a dataset consisting of 85 agricultural businesses in Vietnam, which was collected from a sample of 600 companies. The empirical results confirmed a strong association between a manufacturing firm’s information exchange and its joint knowledge development. Joint knowledge development has a mediating role in the supply chain such that SCIE can be attained. Accordingly, SCIE improves supply chain satisfaction and the operational and financial outcomes of SCIE characteristics. These findings are important for agricultural businesses that have to stretch their resources to accommodate their needs in executing sustainable agricultural strategies. In the future, researchers could conduct a longitudinal study and examine how SCIE evolves. A comparison of SCIEs between developed and developing economies could likewise be a noteworthy endeavor. This study opens up new research avenues in SCIE and suggests directions for future research and practice by exploring the conditions where SCIE can help to improve the performance of socio-knowledge development in agro supply chains.

Keywords: agriculture, joint knowledge development, supply chain information exchange, supply chain management, Vietnam

JEL Classification: O13, Q19
INTRODUCTION

Societies in Asia have always been plagued with developmental problems, primarily related to imported fossil fuel dependence, fresh water availability, municipal solid waste (MSW) management, transportation, and other related challenges associated with the agriculture and food security domain (Shankaranarayanan and Amaldas 2011). In agricultural industries, retail and food distributors are now increasingly requiring more information about their products and processes to satisfy the demands of end consumers on food safety and food hygiene. Food processing enterprises are then looking to farmers and cooperatives for the knowledge dissipation of the products and processes, which enhances the competitive position, both locally and globally, of their new products and services. This becomes more challenging with the rise of agricultural and food products in the global marketplace, the rise of off-shore sourcing, and the increasing rate of export-import across countries that poses problems in traceability of products and in food security (Fugate et al. 2012).

Traceability has been used as an indispensable tool for measuring food quality and assurance programs in many countries (Aung and Chang 2014). Many enterprises aim to benefit from the joint knowledge, skills, and resources of their suppliers by jointly creating new products (Thakur and Workman 2016). This strategy would then lead to improved quality and delivery (Primo and Amundson 2002) of goods and services, reduced product costs (Gardner, Cooper, and Noordewier 1994), and opportunities to gain first-mover advantages in product markets (Hartley and Choi 1996).

Supply chain joint knowledge (SCJK) development represents the ability of focal enterprises to obtain knowledge of market demand and know-how techniques (Baranson 2014) from supply chain partners in order to enhance the quality of the final product and to reduce fixed and variable costs. In many industries, best practices—such as involving a supplier early on in new product development processes—require significant information exchange and joint knowledge development to gain access to suppliers’ new technologies (Wagner, Grosse-Ruyken, and Erhun 2012) and to obtain permissions to use the patents and know-how (Schiele, Calvi, and Gibbert 2012). This process requires a close buyer-supplier relationship and exchanging socio-information and knowledge networks. However, this could prove to be challenging due to the risk of information leak to other parties (Hoecht and Trott 2006). Indeed, researchers have found that collaborative product development depends on exchanging information and knowledge (Hung et al. 2011; Rosell, Lakemond, and Wasti 2014; Wang et al. 2015), unlike in other supply chains in which very few agricultural actors possess all the required resources to enhance the knowledge development processes.

The Vietnamese agricultural industry is no different from these aforementioned processes. It is constantly changing its development strategies, shifting from supplier-driven to demand-driven approaches; that is, it is shifting from mass production to quality assurance in order to lead its production mechanisms from pro-growth to sustainable growth. However, interlinkages among farmers, producers, and businesses are weak, and thus prevent significant growth (Thang et al. 2014). As such, the Vietnamese government and other institutions have increasingly focused on supporting such missions.

The Vietnam Chamber of Commerce and Industry (VCCI) has started to implement a project that promotes business cluster development through developing the small and medium enterprises (SMEs) in the agriculture value chain. However, one of the main barriers that makes SMEs isolated from other actors is
the lack of trust and social capital of SMEs, which accordingly hinders them from gaining collective efficiency (UNIDO 2013).

According to a survey by the Food and Agriculture Organization (Rabobank 2016), Vietnam received a score of 55.7 (out of 100) in supply chain operations, 60.6 in product quality control, and 48.4 in farm produce trade. Compared with the Philippines, Vietnam excels in product quality control, but is inferior in the supply chain operation and trade. Vietnam’s scores in trade are even lower than those of Cambodia and Laos (World Bank Group 2016). Vietnam’s lack of investments in logistics services is reportedly the cause of the country’s big losses in agriculture. Farm produce is a major export item in Vietnam that makes up 18–20 percent of the total national product. However, most agribusinesses in the country are small- and medium scale, with the number of export products being insubstantial. Meanwhile, according to the Ministry of Industry and Trade, the expenses on logistics services in Vietnam are relatively high, weakening the competitiveness of Vietnamese products in the region.

This current study addresses the above issues pertaining to knowledge acquisition and dissipation in a Vietnamese agricultural context. It examines the relationship between information exchange and supply chain joint knowledge development and the corresponding impacts of this relationship on performance. Although literature agrees that lack of trust and social capital can deteriorate the focal point of the company’s long-term performance (Carter and Bélanger 2005; Liao and Barnes 2015), it is critical for supply chain managers to examine the effects of communication and joint knowledge development with its suppliers in designing their supply chain operations. Thus, this study investigates the following:

1. To what extent does supply chain information exchange (SCIE) affect joint knowledge development capability?

2. How do these value dimensions of supply chain joint knowledge (SCJK) development impact operational, relational, and financial outcomes?

The findings of this empirical study could help enterprises to have better understanding of how information exchange with agricultural partners (e.g., farmers and cooperatives) contributes to joint knowledge development and how this information exchange affects performance. For supply chain and operations management practitioners, the study demonstrates the importance of leveraging supply chain information in enhancing joint knowledge and performance. Having a deeper understanding of the performance outcomes associated with supply chain joint knowledge development would allow organizations, especially small manufacturing enterprises, to better decide when, how much, and where to invest their resources to improve performances. Furthermore, the current study contributes to existing literature as it investigates the aforementioned relationships in an emerging agricultural context; most studies involving this subject are done under the context of the manufacturing sector (Tomlinson 2010) and of developed economies (Oke and Kach 2012; Tomlinson 2010; Wagner and Hoegl 2006).

Socio-knowledge as a capital, in our context, is the application of social knowledge and its associated networks. It refers to the internal social and cultural coherence of a society, organization, and governance, and the norms and values that govern interactions amongst people and its institutions. Accordingly, these norms and values are embedded and embodied, and are likely to be mutually exclusive.

Socio-knowledge is the glue that holds societies together; without this glue, there can be no economic growth or human well-being (Rossing and Assaf 1999). This explains why many producers and exporters do not
want to use packaging and logistics services in countries like Vietnam and China as this results in big losses during the harvesting, processing, storage, and transportation phases of information dissipation and usage.

A World Bank survey, as reported in Dollar, Glewwe, and Litvack (1998), showed that Vietnam’s mechanization index is low with a score of 24.4 (from a scale of 1–100). This is equal to the scores of Laos, Cambodia, and Myanmar; it is far below the Philippine index. The transportation index of Vietnam’s agriculture sector is lower than that of Laos by 10–15 points. Experts pointed out that logistics play an important role in agricultural production; the longer it takes to transport farm produce, the higher the failure rate would be. If this problem is not addressed, Vietnam will soon find it hard to join the global production chain in the future (VSC 2017).

LITERATURE REVIEW

This section defines SCJK and its relationship to information exchange and other related performances. The theoretical framework and hypotheses are then derived from this literature review, particularly from the theory of socio-knowledge-based view.

Supply Chain Joint Knowledge Development

A firm’s joint knowledge development represents the ability of the firm to obtain information on market demand and know-how/techniques from supply chain partners in order to improve the quality of the final product and to reduce costs (Baranson 2014). From a knowledge-based view, farmers (suppliers) add a complementary knowledge that can be used or combined with the buyers’ knowledge (manufacturers). Supply chain joint knowledge development provides organizations with a “hidden” competitive advantage that cannot be easily imitated as it is exclusive. Furthermore, enterprises can combine farmers’ knowledge with the existing knowledge base as a strategic resource, thereby increasing entry barriers for competitors and protecting the firms’ competitive market advantage (Smagalla 2004).

Many Asian countries (e.g., Vietnam and Thailand) use the SCJK development strategy. The case of Vietnam may be taken as an example. According to the data from Vinh Long plant protection department, the Tan Thanh cooperation provides 200 metric tons (t) of fresh purple sweet potato to the daily market, whereas the Thanh Dong cooperation provides only 300 t each season. The Nhat Thanh Company, on the other hand, provides 6,000 t of the same product to the market each year. A total of 11 suppliers in Vinh Long provide sweet potatoes to the province’s market. All of these suppliers produce roughly 300,000 t of tubers each year, and their supplier bases are located in Tan Hung, Tan Thanh, Thanh Dong, and Thanh Trung. According to the value chain, 83 percent of the sweet potatoes produced are exported to China via brokers, while the remaining are transported to hub location candidates. Five distribution centers have also been identified as bases of operations, and these are located in the contiguous provinces and big cities of Vietnam, including Ha Noi, Hai Phong, Da Nang, Ho Chi Minh, and Can Tho regions.

Similarly, a Thai agri-supply chain project that began in 1998 was formed, and consists of a number of diverse participants. It is composed of CRC Ahold Ltd., PP Food Supply Co. Ltd., World Fresh Limited, Novartis, Rabobank International, and TNT Logistics, along with local and other international research institutes. These companies provide similar services as those in Vietnam.

In a joint knowledge development, asset specificity increases, such that there is an information asymmetry with and dependence on the suppliers (Eisenhardt 1989). This is particularly important when suppliers provide
specialized or unique resources to a buying firm that has limited knowledge about these technologies utilized. The socio-knowledge capital created from the collaborative activities between suppliers and manufacturers, from the joint knowledge development with suppliers (e.g., information exchange on demand), and from inventories and technological processes can effectively influence the innovation developers (e.g., R&D teams) (Ye and Kankanhalli 2013), which eventually enhances the teams’ innovation performance.

Frequent and intensive information exchange has been proven to facilitate knowledge exchanges and can help to overcome organizational conflict (Kim and Park 2015). The enterprises’ intention is to utilize the farmers’ specialized knowledge in their know-how projects. Enterprises engage their farmers in intensive communication in order to capture knowledge at the early stages of the development process. As such, this reduces the time to market or lead time (Zhao, Cavusgil, and Cavusgil 2014), improves responsiveness to market conditions, and enhances product characteristics (Morita et al. 2015).

Understanding Food Production and Consumption Patterns

Vietnam is still in the early stages of the food crop divergence process. It was only until recently that the government has begun to recognize that it needs to shift public resources to support the production capacity and marketing of other food crops (Figure 1).

Agricultural production in Vietnam consists of different types of production units, and is characterized by the following categories:

- **Agricultural households**: 8.9 million in 2011 down from 10.1 million in 2001
- **Farms**: 126,000 in 2011 up from 61,000 in 2001
- **Agricultural enterprises**: 2,536 in 2011 up from 2,136 in 2001
- **Production cooperatives**: 6,065 in 2011, down from 7,237 in 2001
- **Other entities including farms managed by the Commune People’s Committee**, other

Figure 1. Regional shares in commodity consumption growth, 2016–2026

Note: Demand growth compares 2026 to baseline (2014-16) average. Southeast Asia includes Indonesia, the Philippines, Malaysia, Thailand, Vietnam, Lao PDR, Myanmar, and Cambodia.

Source: OECD (2017)
domestic agencies, and foreign individuals/companies (World Bank Group 2016).

Nearly 90 percent of agricultural land is categorized under either agricultural households or farms. About 6 percent is under enterprises, and the balance is held by other stakeholders.

The agricultural household segment is dominated by very small farms and other family-oriented farmers. Figure 2, based on agricultural census data, suggests only minor changes over time in this agrarian structure. The smallest size category is less than 0.2 hectares (ha), and this applies to 26 percent of households in 2001 and 35 percent in 2011. The difference between the figures shows that there were significant changes in the production and consumption of agricultural resources within the 10-year period. This may be due to the further subdivision of holdings in the next category up, which indicates that those using 0.2–0.5 ha of agricultural land declined from 41 percent to 34 percent during the same period. Accordingly, this decline may have been brought about by some land owners being allowed to offer 20-year leases on ownership of agricultural lands as governed by the government of Vietnam. The share of the largest category of holdings include above 2 ha, which increased only slightly from 5 to 6 percent in 2013 (World Bank Group 2016).

In many aspects, researchers have found microlevel farms to be highly efficient in producing high-level outputs per unit of land and in other resource utilization. In some crops, studies have found either an inverse relationship between farm size and efficiency. On the other hand, other studies have determined some type of inverted U-curve relationship, in which efficiency improved over some farm-size increment and then declines thereafter. In Vietnam’s case, small farms are often rendered less efficient due to the fragmented nature of their landholdings, or in other words, the fact that they are often made up of non-contiguous plots (World Bank Group 2016).

Consequently, the Vietnamese government now aims to reduce land fragmentation by

**Figure 2. Comparative growth in agricultural production in Vietnam**

![Graph showing comparative growth in agricultural production in Vietnam]

Source: Rabobank (2016)
implementing land consolidation programs in many communes, and these programs have been somewhat successful. Such initiatives have generally tried to facilitate plot exchanges between households, although there have also been efforts to promote cooperative farming. In some cases, households have leased out their land to companies, and then arranged for certain household members to continue working on these professionally managed farms (World Bank Group 2016).

Vietnam has only 0.34 ha of arable land per member of its agriculturally active population. This is about half (0.6–0.8 times) of those in Cambodia, Myanmar, or the Philippines. The agrarian structure of Vietnam is most like that of Indonesia where about 30 percent of farm households have less than 0.2 ha, 26 percent have between 0.2 and 0.5 ha, 18 percent have 0.5–1 ha, 15 percent have 1–2 ha, and 12 percent have more than 2 ha. In the Red River Delta, for example, 97 percent of holdings in 2011 were under 0.5 ha. These holdings typically consisted of multiple plots around three to six of roughly similar sized plots under management (World Bank Group 2016). This leads to small-scale farming, in which local consumption is unmonitored and becomes hard for both researchers and governing census to keep track of and to aggregate data for.

METHODS

Based on the literature presented in the previous section, the following research hypotheses are tested to determine the validity of this study:

H1 A supply chain joint knowledge development exerts a direct positive effect on its operational performance.

H2 A supply chain joint knowledge development exerts a direct positive effect on its financial performance.

H3 A supply chain joint knowledge development exerts a direct positive effect on its relational performance.

H4 SCIE has a positive relationship with supply chain joint knowledge development.

A sample of 600 agricultural processing firms and cooperatives were pooled from databases and from Vietnam farmer clubs in the Northern Vietnamese territory. A total of 85 respondent companies were obtained, thereby comprising the survey sample. Figure 3 presents the research model, and draws the relationship between the various hypotheses proposed in this section.

The survey was conducted in Vietnamese; thus, a rigorous process of translation and back-translation were done to ensure the consistent use of the scales. A pilot test was conducted in December 2017, with three members from the Vietnam farmer clubs serving as the respondents. The enumerators gave particular attention to reliably translating the catch phrases and depictions to ensure that cultural and language nuances were recognized without misinterpretation.

Several elements have been adjusted in the implementation of the research design to better reflect local practices. The research team made telephone calls to potential agricultural companies and provided detailed email questionnaires to those who agreed to participate in the survey. Follow-up telephone calls were also made to improve the response rate. Overall, the researchers were able to collect usable responses from 85 companies. This represents a response rate of 14.17 percent. On the other hand, in the follow-up phone calls to the nonrespondents (those who refused to
answer the questionnaire), the research team discovered that most of them, especially foreign organizations like NGOs and other entities, tend to avoid external surveys.

Table 1 provides the company profiles of the sample respondents, with about 90 percent of them composed of small- and medium-sized companies. Seven major agricultural commodities (e.g., vegetable, fruits, cassava, meat), being produced by the companies, are included in the survey.

Meanwhile, Table 2 presents the section of the questionnaire that relates to the current research. A combination of perceptual and objective measures was used to capture the responses and to limit common method bias. The measurements had already been examined in previous operational studies, mostly in manufacturing industries. Therefore, this study examined the construct validity and reliability of the model, including supply chain information exchange, which focuses on the enterprises’ ability to exchange demand, promotional plans, inventory level, and lead time (Malhotra, Gosain, and El Sawy 2007; Menor, Kristal, and Rosenzweig 2007; Vanpoucke, Vereecke, and Muylle 2017).

Supply chain joint knowledge development focuses on the manufacturer’s joint partnerships in obtaining, acquiring, and applying new knowledge (Cao and Zhang 2011). Financial performance is measured objectively based on market share, revenue, and profit increase relative to those of the competitors (Choi et al. 2002).

The internal consistency reliability test reveals that Cronbach’s alphas range from 0.82 (operations performance) to 0.94 (joint knowledge development). This value exceeds 0.60, which is the threshold value (Hair et al. 2010). Table 2 provides the constructs’ means of measurement items, standard deviation, loading, and p-values.

Subsequently, the confirmatory factor analysis (CFA) measurement models confirm the presence of five unique constructs, and their CFA details are presented in Table 3. The model fit indices are $\chi^2/df = 1.28$, which lies in the recommended range of 1–3. Furthermore, the root mean square error of approximation (RMSEA) value of 0.057 suggests a moderate model fit.

The results in Table 3 show that all of the average square root values are higher than the correlations, again indicating acceptable discriminant validity. In addition, both the maximum shared variance and average shared variance values are smaller than the average variance extracted (Hair et al. 2010).
A structural equation model was used to test the hypotheses discussed in the methods section. Results show that the fit indices indicate a good model fit (Table 4). Table 4 also displays the directions and significance of the hypothesized relationships among the constructs. Accordingly, results confirm the positive impacts of information exchange to supply chain joint knowledge development (H4). Meanwhile, supply chain joint knowledge development has positive impact on all performance measures, including operational (H1), financial (H2) and relational performances (H3). These results therefore confirm the significant gains on supply chain joint knowledge development from information exchange, which eventually lead to better performances.

FINDINGS AND LIMITATIONS OF THE STUDY

This study examined the interlinkages between information exchange, supply chain joint knowledge development, and manufacturing performance within the domain of agricultural production relative to the socio-knowledge and information dissipation among the various identified stakeholders. Drawing
upon the knowledge-based view and the hypotheses of this study, the analysis confirms that supplier information exchange is a source of socio-knowledge capital based on supply chain joint knowledge development.

Information exchange among members may not be enough; supply chain managers should also pay more attention to how the knowledge created with their farmers and traders—both of whom are also good at knowledge acquisition and dissipation relative to the products offered—is applied. In addition, unpredictable supplier behavior and technological factors change frequently. Thus, intensive communication is very important to enhance the supply chain joint knowledge development. This would reduce uncertainty and increase innovative products and services.

Table 2. Construct means and reliability trials

<table>
<thead>
<tr>
<th>Research Constructs</th>
<th>Estimate</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply Chain Information Exchange</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Our customers share information with us regarding their promotional plans.</td>
<td>0.484</td>
<td>3.706</td>
<td>1.231</td>
</tr>
<tr>
<td>We gather information from various sources to understand overall market level demand.</td>
<td>0.665</td>
<td>4.741</td>
<td>1.216</td>
</tr>
<tr>
<td>Our suppliers share inventory availability with us.</td>
<td>0.666</td>
<td>4.376</td>
<td>1.154</td>
</tr>
<tr>
<td>We get information from various sources to understand the overall market-level supply.</td>
<td>0.798</td>
<td>4.776</td>
<td>1.322</td>
</tr>
<tr>
<td>Our suppliers provide us with finished goods location status in the distribution network.</td>
<td>0.821</td>
<td>4.188</td>
<td>1.484</td>
</tr>
<tr>
<td>Our suppliers share information with us about order lead times/delivery dates.</td>
<td>0.790</td>
<td>4.482</td>
<td>1.532</td>
</tr>
<tr>
<td><strong>Joint Knowledge Development: Our firm and supply chain partners...</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jointly assimilate and apply relevant knowledge.</td>
<td>0.888</td>
<td>4.247</td>
<td>1.527</td>
</tr>
<tr>
<td>Jointly identify customer needs.</td>
<td>0.924</td>
<td>4.341</td>
<td>1.622</td>
</tr>
<tr>
<td>Jointly discover new or emerging markets.</td>
<td>0.879</td>
<td>4.165</td>
<td>1.565</td>
</tr>
<tr>
<td>Jointly learn the intentions and capabilities of our competitors.</td>
<td>0.866</td>
<td>4.459</td>
<td>1.600</td>
</tr>
<tr>
<td><strong>Relational Performance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main customers are generally satisfied with our relationship.</td>
<td>0.847</td>
<td>5.200</td>
<td>1.121</td>
</tr>
<tr>
<td>The organization is highly regarded by main customers.</td>
<td>0.841</td>
<td>5.059</td>
<td>1.199</td>
</tr>
<tr>
<td>Main suppliers are generally satisfied with our relationship.</td>
<td>0.950</td>
<td>5.082</td>
<td>1.093</td>
</tr>
<tr>
<td>The organization is highly regarded by main suppliers.</td>
<td>0.910</td>
<td>5.176</td>
<td>1.197</td>
</tr>
<tr>
<td><strong>Operational Performance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product performance</td>
<td>0.415</td>
<td>4.494</td>
<td>1.250</td>
</tr>
<tr>
<td>Delivery speed</td>
<td>0.857</td>
<td>4.471</td>
<td>1.250</td>
</tr>
<tr>
<td>Delivery reliability</td>
<td>0.935</td>
<td>4.600</td>
<td>1.217</td>
</tr>
<tr>
<td>Production variety flexibility (increase/decrease product mix)</td>
<td>0.659</td>
<td>4.506</td>
<td>1.342</td>
</tr>
<tr>
<td><strong>Financial Performance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total revenues</td>
<td>0.898</td>
<td>4.376</td>
<td>1.354</td>
</tr>
<tr>
<td>Profitability</td>
<td>0.826</td>
<td>4.318</td>
<td>1.197</td>
</tr>
<tr>
<td>Market share</td>
<td>0.797</td>
<td>4.659</td>
<td>1.140</td>
</tr>
</tbody>
</table>
Table 3. Correlation matrix and construct rationality procedures

<table>
<thead>
<tr>
<th>Research Constructs</th>
<th>CR</th>
<th>AVE</th>
<th>MSV</th>
<th>ASV</th>
<th>OP</th>
<th>SCIE</th>
<th>JKD</th>
<th>RP</th>
<th>FP</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP</td>
<td>0.82</td>
<td>0.55</td>
<td>0.37</td>
<td>0.20</td>
<td><strong>0.744</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIE</td>
<td>0.86</td>
<td>0.51</td>
<td>0.36</td>
<td>0.28</td>
<td><strong>0.486</strong></td>
<td><strong>0.714</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JKD</td>
<td>0.94</td>
<td>0.79</td>
<td>0.36</td>
<td>0.17</td>
<td><strong>0.377</strong></td>
<td><strong>0.602</strong></td>
<td><strong>0.890</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RP</td>
<td>0.94</td>
<td>0.79</td>
<td>0.35</td>
<td>0.12</td>
<td><strong>0.178</strong></td>
<td><strong>0.591</strong></td>
<td><strong>0.314</strong></td>
<td><strong>0.888</strong></td>
<td></td>
</tr>
<tr>
<td>FP</td>
<td>0.88</td>
<td>0.71</td>
<td>0.37</td>
<td>0.15</td>
<td><strong>0.610</strong></td>
<td><strong>0.399</strong></td>
<td><strong>0.261</strong></td>
<td>0.057</td>
<td><strong>0.841</strong></td>
</tr>
</tbody>
</table>

Notes:

(1) ASV = average shared variance, MSV = maximum shared variance, AVE = average variance extracted, CR = correlation ratio, OP = operational performance, RP = relational performance, FV = financial performance, SCIE = supply chain information exchange, JKD = joint knowledge development.

(2) Diagonal elements (in bold) are the square root of the AVE between the constructs and their measures. Off-diagonal elements are correlations between constructs. For discriminate validity, AVE should be greater than the off-diagonal elements.

(3) ** Correlation is significant at 0.001.

Table 4. Results of the hypotheses testing

<table>
<thead>
<tr>
<th>Research Constructs–Impact Direction</th>
<th>Est.</th>
<th>SE</th>
<th>CR</th>
<th>P</th>
<th>Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP ← JKD</td>
<td>0.260</td>
<td>0.079</td>
<td>3.295</td>
<td>***</td>
<td>H1 – Accepted</td>
</tr>
<tr>
<td>FP ← JKD</td>
<td>0.234</td>
<td>0.101</td>
<td>2.317</td>
<td>0.021</td>
<td>H2 – Accepted</td>
</tr>
<tr>
<td>RP ← JKD</td>
<td>0.261</td>
<td>0.089</td>
<td>0.089</td>
<td>0.003</td>
<td>H3 – Accepted</td>
</tr>
<tr>
<td>JKD ← SCIE</td>
<td>0.673</td>
<td>0.122</td>
<td>0.122</td>
<td>***</td>
<td>H4 – Accepted</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 275.830 \]
\[ \text{df} = 194.000 \]
\[ \chi^2/\text{df} = 1.420 \]
\[ \text{CFI} = 0.920 \]
\[ \text{NFI} = 0.910 \]
\[ \text{RFI} = 0.760 \]
\[ \text{RMSEA} = 0.071 \]

Notes:

(1) CFI = confirmatory fit index, CR = correlation ratio, FV = financial performance, JKD = joint knowledge development, NFI = normed fit index, OP = operational performance, RFI = relative fit index, SCIE = supply chain information exchange, SE = standard error, RMSEA = root mean square error of approximation.

(2) *** Correlation is significant at 0.001
Collectively, the results of this study support the argument on the importance of information exchange to leverage joint knowledge such that agricultural processing performance can improve. From a theoretical perspective, these results confirm the existing research in other industries (mainly manufacturing), which cites that communication is a key variable in enhancing knowledge (Delbufalo 2015). These results are also consistent with those of previous studies (Jalkala and Salminen 2010; Liao and Barnes 2015), which concluded that supplier knowledge is a source of innovation strategies. Food security and cleaner food supply chains are the main drivers that compel firms to be innovative in this agricultural context (Bosona 2013).

This study also defines that a firm’s supply chain joint knowledge development is composed of the focal enterprises’ collaborative effort to jointly capture and apply knowledge in developing new products and services and in improving existing knowledge processes. Previous studies have shown that information exchange can lead to a high degree of trust that facilitates supplier joint knowledge development and interorganizational creativity (Wang et al. 2008). In turn, this allows manufacturing enterprises to capitalize on its collaborative ties by accessing suppliers’ knowledge bases (Koufteros et al. 2007). In essence, supply chain joint knowledge development plays the significant role of “business intelligence” to close the gaps in the organizational boundaries.

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