Influence of supply chain risk management and its mediating role on supply chain performance: perspectives from an agri-fresh produce

Umair Waqas1 · Azmawani Abd Rahman1 · Normaz Wana Ismail1 · Norazlyn Kamal Basha1 · Sonia Umair1

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Abstract
As agropreneurs of fresh fruits and vegetables are important contributors to the economy, supply chain risk management is vital for their survival and growth. Therefore, this study examined the mediating effect of supply chain risk management in reducing the impact of supply chain risks and increasing supply chain performance among small scale agropreneurs in Malaysia. It also evaluated the moderating role that knowledge management plays between supply chain risks and supply chain risk management. SmartPLS 3.0 (PLS-SEM), which uses partial least squares structural equation modelling, was utilised to test the framework. Data from 430 fresh fruit and vegetable agropreneurs in the five most productive Malaysian states were collected using a questionnaire. The results confirmed (1) a negative correlation between supply chain risks and supply chain performance (2) that supply chain risk management mediates the relationship between supply chain risks and supply chain performance, and (3) that knowledge management moderates the relationship between supply chain risks and supply chain performance. Therefore, these findings could help government institutes and agropreneurs associations better appreciate the value of supply chain risk management due to its positive effect on the overall performance of agropreneurships.

Keywords Supply chain risks · Transaction cost theory · Knowledge management · Knowledge-based view · Supply chain performance · Agri-fresh · Partial least square structural equation modelling

1 Introduction
In today’s business environment, companies strive for global competitiveness by implementing supply chain management (Sharma et al., 2021) as what happens in one part of the world has far-reaching consequences in other parts of the world. For instance, when one part of the world is struck by a disaster or crisis, their economic, social, and emotional implications are

1 School of Business and Economics, Universiti Putra Malaysia, 43400 Serdang, Malaysia
not limited to that specific region but their secondary and tertiary effects create ripples in supply chains the world over (Goli et al., 2017). Previous studies have concluded that disasters and emergencies give rise to all sorts of risks due to an increase in uncertainty. For instance, the COVID-19 pandemic that has impacted every corner of the globe has not only increased global risk in public health but has caused the global economy to plunge to devastating lows as there is a constant uptick in all sorts of risks. Schoenfeld (2020) reports that emergency situations; such as the COVID-19 pandemic; pose a financial risk as businesses are forced to close, manufacturing plants sit idle, and layoffs spike. Ashokka et al. (2020) highlights that health and safety risks, miscommunication, misinformation, and coordination risks also occurred during the outbreak.

Supply chain risks have been shown to cause up to a 6% variance in supply chain performance (Wagner & Bode, 2008). The correlation between the two is of profound importance as supply chain risks need to be minimised to improve supply chain performance (Fan & Stevenson, 2018a, 2018b; Hoffmann et al., 2013). Previous studies have posited that supply chain risk management is of paramount importance to mediate this correlation (Munir et al., 2020; Shenoi et al., 2016). Nevertheless, there is still a need for the further and more expansive use of theory to better understand supply chain risk management and to add external validity to the research (Fan & Stevenson, 2018a, 2018b). At present, supply chain risk management is considered a critical part of modern supply chain management (Hallikas & Lintukangas, 2016; Wiengarten et al., 2016) as it has profound value in reducing the occurrence and negative effects of risks (Jüttner et al., 2003; Miller, 1992).

Structural changes in industrialisation; such as outsourcing, just-in-time manufacturing, and shortened product life cycles; have increased exposure to supply chain risks (Duhadway et al., 2019; Fan & Stevenson, 2018a). The agri-fresh produce supply chain plays a critical role in the world economy as it is a source of food supply (Waqas et al., 2020). However, the agri-fresh produce supply chain is more complicated than the manufacturing supply chain due to unique characteristics (Behzadi et al., 2017a, 2017b); such as seasonality, supply spikes (bulkiness), and perishability.

Prakash et al. (2017) highlight that only a handful of studies have investigated the correlation between supply chain risks and supply chain risk management. There is also a gross lack of research on the correlation between supply chain risks and supply chain risk management in agri-fresh produce supply chains. Existing studies provide inconsistent results regarding the correlation between risk and risk management (Shenhar et al., 2002; Soin & Collier, 2013; Wong & Boon-Itt, 2008). As such, in light of these inconclusive results, the correlation between supply chain risk and supply chain risk management warrants further investigation. Due to inconsistencies in the results, this study introduced knowledge management as a moderator as Zhang et al. (2018) posit that knowledge management makes risk management more effective.

Although some scholars have found a positive correlation between risk management and performance (Gordon et al., 2009; Mohammed & Knapkova, 2016; Quon et al., 2012), only a handful have investigated the correlation between supply chain risk management and supply chain performance (Fan & Stevenson, 2018a, 2018b; Kumar et al., 2018; Sun et al., 2012). It is, therefore, evident that little attention has been paid to this correlation (Hallikas & Lintukangas, 2016; Thekdi & Aven, 2016), especially in terms of the agri-fresh produce supply chains. This calls for more empirical research with theoretical support. As such, the present study empirically examined the correlation between supply chain risk management and the performance of agri-fresh produce supply chains.

This study was limited to Malaysia and agri-fresh produce of fresh fruits and vegetables only as it is an important sector of food crops that faces a shortfall in production especially
during the festive seasons or because of the floods. This production shortfall could be the reason behind the trade deficit recorded in Malaysia in recent years which, unfortunately, is on an upward trend. At present, the Malaysian agri-fresh produce industry faces several challenges in meeting growing demands for affordable, healthy, and safe food. These challenges are mostly due to low productivity, high losses post-harvest, suboptimal land use, disorganised marketing, ineffective institutional support as well as inadequate and low-skilled workers (Baqutayan et al., 2017). In comparison to the industrial sector, the agriculture industry is exposed to far more unpredictable risks and uncertainties (Beber et al., 2019). However, although supply chain risk management is critical to the success of the agri-fresh produce industry, there is a lack of adoption and understanding of tools that can be used to manage risks. As such, thorough research on managing risk throughout the supply chain would provide useful insights which may help increase productivity and reduce the current deficit faced by the Malaysian agri-fresh produce industry. The Malaysian context of this study will enrich existing literature as it will be the first to holistically examine the correlation between risks and performance in the agri-fresh produce supply chain by introducing supply chain risk management as a mediator and knowledge management as a moderator between supply chain risk and supply chain risk management.

The objectives of this study are as follows: (1) to examine the correlation between supply chain risks and supply chain performance, (2) to examine the correlation between supply chain risks and supply chain risk management, (3) to determine the correlation between supply chain risk management and supply chain performance, (4) to investigate the mediating effect of supply chain risk management on the correlation between supply chain risks and supply chain performance, and (5) to assess the moderating effect of knowledge management on the correlation between supply chain risks and supply chain risk management.

The rest of the paper is structured as follows: Section two explains the research framework, theoretical background, and a hypothesised model linking supply chain risk, knowledge management, supply chain risk management, and the performance of the agri-fresh produce supply chain. Section three describes the research methodology such as the data collection process and the statistical analysis that was used to test the hypotheses. Section four provides the findings and discusses the theoretical and managerial implications. The limitations of this study and suggestions for future research are also provided.

2 Theoretical background and hypotheses

A conceptual framework represents the key concepts of research and the correlations between them. The present research framework is an extension of previous studies that tested new concepts (Fig. 1). The theory is used in research to support framework development as well as define and elaborate the relationships among the variables (Ahmed et al., 2020).

2.1 Overarching theory: transaction cost theory

According to Miller (1992), managers face different forms of risk which lead to supply chain risks. These risks can be connected to both the specificities of the industry in which the firm operates and to the economic environment in general. For instance, industry risks refer to risks in supply, demand, and process whereas general environmental risks may refer to political instability, macroeconomics, and natural risks.
Transaction cost theory explains the transaction cost of an exchange relationship to define the best governance (Coase, 1937). Previous studies have argued that in order to use transaction cost theory in operations management or, specifically, supply chain management, it needs to be extended (Williamson, 2008). Grover and Malhotra (2003) call on future transaction cost research to evaluate different supply chain management challenges; such as supply chain risks and problems coordinating the flows of information and material across organisations due to complex and global supply chains. This study answered this call by using the transaction cost theory on supply chain risks and the performance of the agri-fresh produce supply chain with the mediating effect of supply chain risk management.

2.2 Knowledge-based view

The knowledge-based view is often related to heightened learning capability that can enhance a firm’s value offering (Baker & Sinkula, 1999). As stated by Wowak et al. (2013), evaluating correlations between learning and supply chain-related value creation is not new. With regard to linking knowledge with supply chains, Drew and Smith (1995) posit that organisational knowledge helps supply chain managers develop systems for thinking, information sharing, and collaborative teamwork to improve the supply chain. Subsequent empirical studies have documented the positive influence of knowledge management on multiple aspects of the firm supply chain (Ellinger et al., 2015). Overall, this stream of literature indicates that organisational knowledge has a positive influence on supply chains.

The existing literature also suggests that knowledge management may help firms better establish new market information and business intelligence to create supply chain-related value. More specifically, knowledge management allows for the effective planning and development of contingency plans to mitigate the adverse influence of supply chain disruptions. According to Grant (1996) and Spekman et al. (2002), knowledge management could potentially bestow a competitive advantage on members of a supply chain because it is predicated on acquiring new insight that would improve a firm’s outcome.

Research indicates that organisational knowledge has a positive influence on supply chains as it helps firms exploit opportunities and/or neutralise threats (Baker & Sinkula, 1999). In the current context, the knowledge-based view suggests that knowledge is the foundation of an organisational knowledge process that involves the generation, dissemination, sharing, and application of the knowledge learned (Nonaka, 1994) about complex network operations that help identify, assess, and mitigate the likelihood, consequences, and severity of multiple potential sources of supply chain risk (Ellinger et al., 2015).

2.3 Hypotheses development

A research hypothesis is a tentative prediction of the correlation between two or more variables that are tested to obtain valuable insights (Prasad et al., 2001). Hypotheses are generated based on the research framework. The hypotheses of the present study were formulated based on correlations between variables found in the literature. Figure 1 shows the conceptual framework of the present study.

2.3.1 The relationship between supply chain risk and supply chain performance

Ritchie and Brindley (2007) indicate the likelihood of a significant degree of risk surrounding supply chains. Supply chain risks are variations in the distribution of possible supply chain
outcomes, their likelihoods, and their subjective values (Jüttner et al., 2003). High levels of uncertainty lead to high levels of risks in the supply chain. The more risks there are in an exchange relationship, the harder it is for a buyer to identify, assess, and mitigate possible supply chain risks (Hoffmann et al., 2013). This sentiment is corroborated by Paksoy et al. (2013) who found that uncertain customer demand and uncertain supply delivery greatly impact supply chain performance.

Wagner and Bode (2008) examined the influence of supply chain risk on supply chain performance in the automobile industry and found that supply chain performance was adversely affected by supply chain risks. Similar studies by Edmond et al. (2014) and Nyamah et al. (2017) support this finding while Prakash et al. (2017) found that risk factors heavily influenced the dairy supply chain. Despite the numerous inborn risks in the agri-fresh produce supply chain (Behzadi et al., 2017a, 2017b; Jaffe et al., 2010), studies on the nature of these risks and their effects on agri-fresh produce supply chain performance are limited. The following hypotheses were drawn based on the arguments above.

**H1** There is a relationship between supply chain risks and supply chain performance.

### 2.3.2 The relationship between supply chain risks and supply chain risk management

According to transaction cost theory, uncertainty and governance have a positive correlation. However, Miller and Folta (2002) and Stranieri et al. (2017) found an inconsistent correlation between uncertainty and governance. Previous studies have demanded effective supply chain risk management in the agri-fresh produce supply chain as it is prone to high risks related to the environment, demand, and supply (Behzadi et al., 2017a, 2017b; Edmond et al., 2014; Nyamah et al., 2017).

As very little attention has been paid to the correlation between supply chain risks and supply chain risk management in the agri-fresh produce supply chain, the present study analysed supply chain risk management in terms of aspects such as risk identification, risk...
assessment, and risk mitigation strategies in supply chain risks (Ho et al., 2015; Kern et al., 2012). As each of these aspects may be affected by risks, it is important to individually understand the effect of supply chain risks on them.

In the case of agri-fresh produce, the supply chain is sensitive due to the highly perishable nature and short shelf-life of the product. Therefore, supply chain risks may have unique effects on each of these aspects of supply chain risk management. To fully understand this correlation in the agri-fresh produce supply chain, the present study examined the influence of supply chain risks on these aspects of supply chain risk management. The following were hypothesised:

H2 The higher the supply chain risks, the more likely it is that a firm will engage in supply chain risk management.

H2a The higher the supply chain risks, the more likely it is that a firm will engage in supply chain risk identification.

H2b The higher the supply chain risks, the more likely it is that a firm will engage in supply chain risk assessment.

H2c The higher the supply chain risks, the more likely it is that a firm will engage in supply chain risk mitigation strategies.

2.3.3 The relationship between supply chain risk management and supply chain performance

Researchers contend that improved supply chain visibility in supply chain risk management is critical in anticipating, preparing for, and mitigating supply chain risks (Christopher & Lee, 2004; Ellinger et al., 2015). Existing studies recognise that supply chain risk management improves supply chain performance by reducing operational losses, increasing responsiveness, and preventing supply chain disruptions (Fan & Stevenson, 2018a, 2018b; Munir et al., 2020). From a transaction cost standpoint, governance structure affects firm performance (Williamson, 1979). Therefore, firms need supply chain risk management as a governance mechanism to reduce uncertainty and achieve superior performance. Hoffmann et al. (2013) found that the introduction of supply chain risk management as a governance mechanism significantly influenced performance. The present study argues that supply chain risk management, including risk identification, risk assessment, and risk mitigation strategy, enables firms to identify risks and disturbances in the supply chain, assess the severity of a risk, mitigate supply chain risks to enhance firm performance (Fan & Stevenson, 2018a, 2018b).

This study focused on four key performance indicators i.e. responsiveness, flexibility, quality, and efficiency (Aramyan et al., 2007; Beamon & Benita, 1998; Jie et al., 2013). Supply chain risk management helps identify, assess, and mitigate supply chain risks and improve supply chain performance (Munir et al., 2020). Supply chain risk management enables firms to detect potential threats (Wieland & Marcus Wallenburg, 2012) which can be acted upon resulting in more responsiveness and cost efficiency in filling orders on time, with short lead-times, and delivering on time. A firm can be more flexible through supply chain risk management from upstream to downstream (Talluri et al., 2013). Finally, supply chain risk management results in better quality measures and procedures to prevent substandard quality products (Jie et al., 2013). Hence, it was suggested that supply chain risk management helps reduce risk by avoiding disruptions in the supply chain that will eventually improve supply chain performance. This led to the following hypothesis:
H3 There is a relationship between supply chain risk management and supply chain performance.

H3a There is a relationship between risk identification and supply chain performance.

H3b There is a relationship between risk assessment and supply chain performance.

H3c There is a relationship between risk mitigation strategies and supply chain performance.

2.3.4 The mediating effect of supply chain risk management on the relationship between supply chain risk and supply chain performance

Supply chain risk management seeks to ensure profitability (Kumar et al., 2018), save cost (Manuj & Mentzer, 2008), and potentially generate value (Trkman et al., 2016), meaning companies need to strike a balance between the benefits of supply chain risk management and investing in these strategies. However, there are limited studies on the effect of supply chain risk management on the correlation between supply chain risk and supply chain performance (Prakash et al., 2017).

However, a few studies (Ellinger et al., 2015; Hoffmann et al., 2013; Munir et al., 2020; Shenoi et al., 2016) adopted different approaches and therefore, reported different results. For example, Hoffmann et al. (2013) explored the moderating effects of supply chain risk management on the correlation between uncertainty and supply risk management performance and found that supply chain risk management moderates the correlation between uncertainty and supply risk management performance. Although risk monitoring does not influence supply risk management performance, Munir et al. (2020) introduced supply chain risk management as a mediator and received significant results.

The conceptual framework of Shenoi et al. (2016) argued that the mediating role of supply chain risk management has a significantly positive effect on the correlation between supply chain risks and supply chain performance. Ellinger et al. (2015) found that effective supply chain risk management entails recognising that all risks are not equally created and helps to implement suitable approaches to fit specific contexts. It was further argued that supply chain risk management involves identifying and assessing a diverse portfolio of risks that may occur and implementing strategies that are most appropriate to mitigate each of them. The following hypothesis was developed based on the abovementioned arguments:

H4 Supply chain risk management mediates the relationship between supply chain risks and supply chain performance.

H4a Risk identification mediates the relationship between supply chain risks and supply chain performance.

H4b Risk assessment mediates the relationship between supply chain risks and supply chain performance.

H4c Risk mitigation strategies mediate the relationship between supply chain risks and supply chain performance.
2.3.5 The moderating effect of knowledge management on the relationship between supply chain risks and supply chain risk management

According to Samuel et al. (2011), knowledge adds value to an organisation as it contributes to products, processes, and people while knowledge management transforms information, data, and intellectual assets into enduring value by identifying useful knowledge for management actions. However, a review of existing literature found mixed results on this correlation. While many studies support a positive correlation between risk and risk management (Hamid, 2017; Lai & Chang, 2010; Wong & Boon-Itt, 2008), others reported a negative correlation (Billitteri et al., 2013; Krickx, 2000; Nyamah et al., 2017). As such, knowledge management might prove to be beneficial in this regard (Zhang et al., 2018). For instance, Cantor et al. (2014) found knowledge management as a moderator between risk mitigation strategies and stakeholder pressure.

The present study suggests that the development of a framework for knowledge management in supply chain management can help determine supply chain risk management measures. Jüttner and Maklan (2011) argued that the correlation between supply chain risks and supply chain risk management is affected by knowledge management. Thus, a contribution of the present study is to investigate the moderating effects of knowledge management on the correlation between supply chain risks and supply chain risk management. Zhang et al., (2018) posited that different types of risks and knowledge management should be matched to achieve effective risk management. Knowledge management calls on firms to acquire knowledge from partners and convert them into meaningful information with which to identify supply chain risks and apply effective supply chain risk management strategies. Based on the above arguments, the following hypothesis was proposed:

**H5** Knowledge management moderates the relationship between supply chain risks and supply chain risk management.

**H5a** Knowledge management moderates the relationship between supply chain risks and risk identification.

**H5b** Knowledge management moderates the relationship between supply chain risks and risk assessment.

**H5c** Knowledge management moderates the relationship between supply chain risks and risk mitigation strategies.

3 Research methodology

The methodological and general assumptions of this study were based on the positivism paradigm. According to Bryman and Bell (2015), positivism is a research philosophy wherein the researcher tries to work in an objective and neutral way. The present study fell under the positivism paradigm because it employed a quantitative research design wherein transaction cost theory and the knowledge-based view were tested. The primary data of this study was collected. A model of interrelationship was developed in which partial least squares structural equation modelling (PLS-SEM) was used to confirm the relationship modelling. PLS-SEM estimates the parameters of a set of equations in a structural equation model by combining principal components analysis with regression-based analysis (Belhadi et al., 2021; Sarstedt et al., 2017).
PLS-SEM enjoys widespread popularity in a wide range of disciplines; such as operations management (Peng & Lai, 2012), accounting (Lee et al., 2011; Nitzl & Chin, 2017), group and organisation management (Sosik et al., 2009), hospitality management (Ali et al., 2017), international management (Richter et al., 2016), management information system (Sarstedt et al., 2017), marketing and strategic management (Sarstedt et al., 2012), and supply chain management (Kaufmann & Gaecckler, 2015). One of the main reasons behind the popularity of PLS-SEM is that it allows researchers to estimate very complex models with many constructs and indicator variables, especially when prediction is the goal of the analysis (Hair et al., 2014; Sarstedt et al., 2017). Furthermore, PLS-SEM generally allows for much more flexibility in terms of data requirements and the specification of correlations between constructs and indicator variables (Sarstedt et al., 2012).

3.1 Population, sampling, and sampling technique

The target population for this study was fresh fruits and vegetable agropreneurs from Malaysia. Malaysia comprises of 13 states; Johor, Kedah, Kelantan, Malacca, Negeri Sembilan, Pahang, Penang, Perak, Perlis, Sabah, Sarawak, Selangor, and Terengganu; and three federal territories; Kuala Lumpur, Labuan, and Putrajaya. The latest data obtained from the Department of Agriculture was from 2018.

As it was not possible to obtain a full list of all the small-scale fresh fruit and vegetable agropreneurs in Malaysia, the present study used non-probability sampling, more specifically the snowball sampling technique. In snowball sampling, the researcher makes initial contact with a small group of people who are relevant to the research topic and then uses this small group to establish contact with others in the industry (Bryman & Bell, 2015). Based on these reports, the total number of agropreneurs in Malaysia was not available. Hence, the research survey was conducted in the five Malaysian states that produced the highest amounts of fresh fruits and vegetables (Department of Agriculture, 2016a, 2016b). These five states were Johor, Kelantan, Pahang, Perak, Selangor. Table 1 shows the breakdown of fresh fruits and vegetables produced in the selected states. Small scale agropreneurs in Malaysia each hold between one to 1.5 hectares of land (Dardak, 2015) while almost 90% of agropreneurs fall under small scale farming of fresh fruits and vegetables (Ng, 2016). As such, the total amount of land owned and planted by agropreneurs (see Table 1) divided by the hectarage per owner revealed that there was no less than 100,000 agropreneurs in the selected states. This figure was taken as the population size of the study.

According to Krejcie and Morgan (1970), the sample size for a population of 100,000 is 384 at a 0.05 standard error and 95% confidence level. Also, according to Hair et al. (2010),

| States | Vegetables (ha) | Fruits (ha) | Relative % | Estimated agropreneurs |
|--------|----------------|-------------|------------|------------------------|
| Johor  | 15,390         | 40,878.6    | 56,268.6   | 144                    |
| Kelantan | 4400         | 21,090.3    | 25,490.3   | 65                     |
| Pahang | 18,421         | 27,061      | 45,482     | 117                    |
| Perak  | 5651           | 12,071.1    | 17,722.1   | 45                     |
| Selangor | 2653         | 2413        | 5066       | 12                     |
| Total  | 46,515         | 103,514     | 150,029    | 384                    |

Table 1 Hectare-based production in the selected states. Source Department of Agriculture (2016a, 2016b)
structural equation modelling requires a minimum sample size of 200 per model. Therefore, the minimum number of usable responses needed was 384.

3.2 Data collection method

The questionnaire was first developed in English and then translated by language experts into Malay for the benefit of the respondents. After the introduction section, brief instructions and scale summaries were provided. The Likert scale’s invention is attributed to Likert (1932), who prescribed this technique for the assessment of attitudes.

The present study used a seven-point Likert scale comprising of 1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neutral, 5 = somewhat agree, 6 = agree, and 7 = strongly agree and 1 = extremely low, 2 = low, 3 = somewhat low, 4 = neutral, 5 = somewhat high, 6 = high, and 7 = extremely high. Details of the adapted construct and their sources can be found in Table 2.

4 Results and data analysis

4.1 Overview

The purpose of the analysis was to validate the reliability of the items, measurement model, and to test the hypotheses. Statistical package for social science (SPSS) and structural equation modelling (SEM) was used to analyse the data and answer the research questions. This section discusses the data preparation process, confirmatory analysis of the measurement model for construct reliability and validity, descriptive analysis for respondent characteristics, hypothesis testing as well as mediation and moderation tests to assess both effects.

4.1.1 Profile of respondents

This section discusses the demographic background of the study’s respondents. The demographic profile was presented using a frequency test in the SPSS software. Table 3 displays a summary of the respondents’ profile. As there were 332 male and 63 female respondents, more than 80% of the respondents were male. This concurs with the current trend among Malaysian agropreneurs as the percentage of male agropreneurs is approximately 77.20% in Malaysia (HRDF, 2019). Of the 395 respondents, 181 were of Malay ethnicity, 168 were Chinese, and 46 were Indian. In terms of age, 72 respondents were between 18 to 24 years old, 104 were between 25 and 30 years old, 45 were between 31 and 35 years old, 78 were between 36 and 40 years old, 59 were between 41 and 45 years old, 37 were between 45 and
| Category       | Types                  | Frequency | Percentage (%) |
|----------------|------------------------|-----------|----------------|
| Gender         | Male                   | 332       | 84.06          |
|                | Female                 | 63        | 15.94          |
|                | Total                  | 395       | 100            |
| Ethnicity      | Malay                  | 181       | 45.82          |
|                | Chinese                | 168       | 42.53          |
|                | Indian                 | 46        | 11.65          |
|                | Total                  | 395       | 100            |
| Age            | 18–24                  | 72        | 18.23          |
|                | 25–30                  | 104       | 26.33          |
|                | 31–35                  | 45        | 11.39          |
|                | 36–40                  | 78        | 19.75          |
|                | 41–45                  | 59        | 14.94          |
|                | 46–50                  | 37        | 9.36           |
|                | Total                  | 395       | 100            |
| Marital Status | Married                | 207       | 52.41          |
|                | Single                 | 188       | 47.59          |
|                | Total                  | 395       | 100            |
| Education      | No formal education    | 64        | 16.20          |
|                | SPM and below          | 66        | 16.71          |
|                | Certificate            | 9         | 2.28           |
|                | Advance certificate    | 9         | 2.28           |
|                | Diploma                | 132       | 33.42          |
|                | Bachelor               | 105       | 26.58          |
|                | Masters and above      | 10        | 2.53           |
|                | Total                  | 395       | 100            |
| Farming status | Full-time              | 292       | 73.92          |
|                | Part-time              | 103       | 26.08          |
|                | Total                  | 395       | 100            |
| States         | Johor                  | 144       | 36.46          |
|                | Pahang                 | 116       | 29.37          |
|                | Perak                  | 47        | 11.90          |
|                | Selangor               | 15        | 3.79           |
|                | Kelantan               | 73        | 18.48          |
|                | Total                  | 395       | 100            |
| Position       | Owner                  | 264       | 66.83          |
|                | Manager                | 92        | 23.30          |
|                | Assistant manager      | 39        | 9.87           |
|                | Total                  | 395       | 100            |
Table 3 (continued)

| Category       | Types       | Frequency | Percentage (%) |
|----------------|-------------|-----------|----------------|
| Training       | MOA         | 18        | 4.56           |
|                | FAMA        | 13        | 3.29           |
|                | MARDI       | 23        | 5.82           |
|                | LPP         | 26        | 6.58           |
|                | OTHER       | 9         | 2.28           |
|                | No training | 306       | 77.47          |
|                | Total       | 395       | 100            |

| Working experience |          |          |                |
|--------------------|----------|----------|----------------|
| Less than 1 year   | 66       | 16.71    |                |
| 1–5 years          | 139      | 35.19    |                |
| 6–10 years         | 96       | 24.30    |                |
| 11–15 years        | 56       | 14.18    |                |
| More than 15 years | 38       | 9.62     |                |
| Total              | 395      | 100      |                |

50 years, and 40 were more than 50 years old. In terms of marital status, 188 respondents were unmarried while 207 were married, therefore, more than 50% of the respondents were married. As seen in Table 3, 16.20% of the respondents had no formal education, 16.71% had a Malaysian Certificate of Education (SPM) or below, 2.28% had a certificate degree, and 2.28% had an advance certificate. More than 33.42% of the respondents had a diploma while 26.58% had a bachelor's degree and 2.53% had a master's degree or higher. Of the respondents, 73.92% were full-time farmers while the remaining 26.08% were part-time agropreneurs.

Table 3 also shows that a majority of the respondents (36.46%) were from Johor while 29.37% were from Pahang, 11.90% from Perak, 3.79% from Selangor, and 18.48% from Kelantan. 66.83% of the respondents were owners, 23.30% were managers, and 9.87% were assistant managers. Of the 395 participants, 4.56% had received training from the Ministry of Agriculture and Agro-Based Industry (MOA), 3.29% from the Federal Agricultural Marketing Authority (FAMA), 5.82% from the Malaysian Agricultural Research and Development Institute (MARDI), 6.58% from the Farmers’ Organisation Authority (LPP), and 2.28% from other institutes. A majority of the respondents (77.47%) had not received any formal training for the business. In terms of farming experience, 66 (16.71%) of the respondents had less than a year of experience, 139 (35.19%) had one to five years, 96 (24.30%) had six to ten years, 56 (14.18%) had 11 to 15 years while 38 (9.62%) had more than 15 years of farming experience.

4.1.2 Assessment of the measurement model

This section discusses the analysis of the measurement model as it needs to be assessed before the structural model can be analysed. As this study has both reflective and formative constructs, they were evaluated separately. The reflective measurement model is explained first followed by the formative measurement model.
4.1.3 Assessment of construct reliability and convergent validity

The reflective measurement items were assessed in terms of composite reliability for internal consistency, individual indicator reliability, and average variance extracted (AVE) to evaluate convergent validity (Hair et al., 2014).

The internal consistency of the model was first assessed. Generally, Cronbach’s alpha is used to estimate reliability based on the inter-correlations of the indicators and the reliability should be greater than 0.7 (Hair et al., 2014). This statistic is defined in its standardized form as follows, where $K$ represents the construct’s number of indicators and $-r$ the average nonredundant indicator correlation coefficient (i.e., the mean of the lower or upper triangular correlation matrix). Generally, in PLS-SEM Cronbach’s alpha is the lower bound, while composite reliability is the upper bound of internal consistency reliability when estimating reflective measurement models with PLS-SEM. Researchers should therefore consider both measures in their internal consistency reliability assessment. Alternatively, they may also consider assessing the reliability coefficient (Dijkstra & Henseler, 2015), which usually returns a value between Cronbach’s alpha and the composite reliability:

$$Cronbach’s\alpha = \frac{K\bar{r}}{1 + (K-1)\bar{r}}.$$  

In PLS-SEM, internal consistency is also assessed with composite reliability. Composite reliability for all the reflective constructs should be greater than 0.7 (Hair et al., 2014). As seen in Table 4, the composite reliability of all the reflective constructs was above 0.7 indicating high internal consistency. When using PLS-SEM, internal consistency reliability is generally evaluated using Jöreskog’s (1971) composite reliability, which is defined as follows (for standardized data):

$$\rho_C = \frac{\left(\sum_{k=1}^{K} l_k \right)^2}{\left(\sum_{k=1}^{K} l_k \right)^2 + \sum_{k=1}^{K} var(e_k)},$$

where $l_k$ symbolizes the standardized outer loading of the indicator variable $k$ of a specific construct measured with $K$ indicators, $e_k$ is the measurement error of indicator variable $k$, and $var(e_k)$ denotes the variance of the measurement error, which is defined as $1 - l^2_k$.

As convergent validity can only be assessed for reflective constructs, this was measured next. Convergent validity refers to the extent to which an item positively correlates with alternative items in the same construct. This is assessed using average variance extracted (AVE) and outer loadings (Sarstedt et al., 2017). The average variance extracted calculated as follows:

$$AVE = \frac{\left(\sum_{k=1}^{K} l_k^2 \right)}{K},$$

where $l_k$ and $K$ are defined as explained above. According to Hair et al. (2014), an AVE of more than 0.5 indicates that a construct explains half or more of the variance of its indicators. All loadings that exceeded the recommended values were retained. where $l_k$ and $K$ are defined as explained above. According to Hair et al. (2014), an AVE of more than 0.5 indicates that a construct explains half or more of the variance of its indicators. All loadings that exceeded the recommended values were retained.
### Table 4: Reflective measurement model

| Factor/item | Factor loading | C.A  | C.R  | AVE  |
|-------------|----------------|------|------|------|
| Cost efficiency | | | | |
| CE4 (waste cost) | 0.745 | 0.823 | 0.610 |
| CE5 (improved profits) | 0.867 |
| CE6 (transportation cost) | 0.708 | 0.759 |
| Demand risk | | | | |
| DR3 (consistency of our customers to place orders with their product specification) | 0.734 | 0.832 | 0.555 |
| DR4 (consistency of our customers to provide reliable forecasts on their demands) | 0.633 |
| DR5 (consistency of our customers to commit to their demand forecasts) | 0.832 |
| DR6 (consistency of our customers’ actual demands with our forecasts) | 0.763 |
| Environmental risk | | | | |
| ERa2 (tax policies) | 0.719 | 0.841 | 0.639 |
| ERb2 (extreme drought) | 0.780 |
| ERb3 (flooding) | 0.860 |
| Flexibility | | | | |
| FLEX1 (meet customer satisfaction) | 0.779 | 0.860 | 0.654 |
| FLEX2 (respond to a changing environment such as received customer order) | 0.832 |
| FLEX4 (flexible in the delivery system) | 0.738 |
| Financial risk | | | | |
| FR1 (inadequate financial support) | 0.786 | 0.848 | 0.609 |
| FR2 (delays in accessing financial support) | 0.784 |
| FR3 (uncertain financial support (credit)) | 0.761 |
| FR4 (periodic change/uncertain interest and exchange rate policies) | 0.843 |
| Knowledge acquisition | | | | |
| KACQ1 (generation of new knowledge from existing knowledge) | 0.795 | 0.864 | 0.614 |
| KACQ2 (distribution of Knowledge throughout the organisation) | 0.709 |
| KACQ4 (exchanging knowledge between employees) | 0.824 |
| KACQ5 (acquiring knowledge about new products/services within our industry) | 0.783 |
| Knowledge application | | | | |
| | 0.786 | 0.875 | 0.701 |
| Factor/item | Factor loading | C.A  | C.R  | AVE  |
|------------|---------------|------|------|------|
| KAPP3 (make knowledge accessible to those who need it) | 0.820 |      |      |      |
| KAPP4 (take advantage of new knowledge) | 0.804 |      |      |      |
| KAPP5 (existence of processes for using knowledge in the development of new products/services) | 0.886 |      |      |      |
| Knowledge conversion | | 0.759 | 0.861 | 0.675 |
| KC1 (filtering knowledge) | 0.753 |      |      |      |
| KC2 (transferring organisational knowledge to employees) | 0.864 |      |      |      |
| KC6 (replacing outdated knowledge) | 0.844 |      |      |      |
| Process risk | | 0.725 | 0.829 | 0.549 |
| PR4 (forecasting and planning error) | 0.752 |      |      |      |
| PR6 (dependence on transport conflicts) | 0.783 |      |      |      |
| PR8 (dependence on labour disputes affecting transport) | 0.746 |      |      |      |
| PR9 (lack of infrastructure and service units) | 0.679 |      |      |      |
| Quality | | 0.722 | 0.842 | 0.641 |
| QTY2 (Skilled and/or experienced employees) | 0.725 |      |      |      |
| QTY3 (good records on all inspections and test performed) | 0.847 |      |      |      |
| QTY4 (implementation of occupational health and safety regulations) | 0.825 |      |      |      |
| Risk assessment | | 0.829 | 0.887 | 0.670 |
| RA1 (look for the possible source of Supply chain risks) | 0.925 |      |      |      |
| RA2 (evaluate the probability of supply chain risks) | 0.869 |      |      |      |
| RA3 (analyse the possible impact of supply chain risks) | 0.883 |      |      |      |
| RA4 (analyse and prioritise our supply chain risks) | 0.538 |      |      |      |
| Responsiveness | | 0.831 | 0.900 | 0.752 |
| RES1 (fills order on time) | 0.934 |      |      |      |
| RES2 (short lead time (the time between the order is placed and when it received by the buyers)) | 0.770 |      |      |      |
| RES3 (customer response time) | 0.889 |      |      |      |
| Risk identification | | 0.859 | 0.910 | 0.774 |
### Table 4 (continued)

| Factor/item | Factor loading | C.A  | C.R  | AVE  |
|-------------|----------------|------|------|------|
| RI1 (informed about possible risk in our supply chain) | 0.927 |      |      |      |
| RI2 (constantly search for short-term risks in our supply chain) | 0.745 |      |      |      |
| RI3 (select relevant observation area for supply chain risk) | 0.953 |      |      |      |
| Risk mitigation strategy | 0.815 | 0.884 |      | 0.719 |
| RSM2 (utilises a strategy (e.g. cost/revenue sharing) of sharing supply chain risk with supply chain partners) | 0.890 |      |      |      |
| RSM3 (existence of risk management policies defining responsibilities for each party of the supply chain member) | 0.912 |      |      |      |
| RSM4 (clear risk and revenue sharing rules between the members of the supply chain) | 0.730 |      |      |      |
| Supply risk | 0.771 | 0.852 |      | 0.596 |
| SR1 (logistics performance of suppliers (delivery dependability, order fill capacity)) | 0.783 |      |      |      |
| SR2 (supplier quality) | 0.852 |      |      |      |
| SR3 (default of a supplier (e.g. due to bankruptcy)) | 0.839 |      |      |      |
| SR5 (capacity fluctuations or shortages in the supply markets) | 0.584 |      |      |      |

Criteria: Composite reliability ≥ 0.7 (Hair et al., 2014); AVE ≥ 0.5 (Hair et al., 2014)

### 4.1.4 Assessment of discriminant validity

Discriminant validity is used to determine that one construct is empirically distinct from another (Hair et al., 2010). To that end, the Fornell-Larcker criterion was first used (Fornell & Larcker, 1981). The reflective constructs exhibited discriminant validity as the square root of the AVEs was larger than their correlations. For further confirmation of discriminant validity, the heterotrait-monotrait ratio of correlations (HTMT) was also used, where it should be less than 0.90 (Henseler et al., 2016). All the HTMT values displayed sufficient discriminant validity. These results validated that all the reflective items were empirically distinct from each other.

### 4.1.5 Assessment of the formative measurement model

The supply chain risk and knowledge management constructs were formative. As suggested by Chin (1998), redundancy analysis was used to assess the convergent validity of the formative measurement model and validate it. As seen in Table 5, the values of both the constructs exceeded the threshold value of 0.7 indicating sufficient convergent validity.

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| Construct               | Code | Items                                      | Convergent validity | Weights | VIF  | t-value | P-values |
|------------------------|------|-------------------------------------------|---------------------|---------|------|---------|----------|
| Knowledge management   | KACQ1| Generation of new knowledge from existing knowledge | 0.998               | 0.214   | 1.607| 18.421 | 0.000    |
|                        | KACQ2| Distribution of knowledge throughout the organisation |                     | 0.395   | 1.644| 23.761 | 0.000    |
|                        | KACQ4| Exchanging knowledge between employees    |                     | 0.333   | 1.575| 25.625 | 0.000    |
|                        | KACQ5| Acquiring knowledge about new products/services within our industry |                     | 0.322   | 1.821| 22.180 | 0.000    |
|                        | KAPP3| Make knowledge accessible to those who need it |                     | 0.173   | 1.993| 43.731 | 0.000    |
|                        | KAPP4| Take advantage of new knowledge            |                     | 0.404   | 1.480| 26.997 | 0.000    |
|                        | KAPP5| Existence of processes for using knowledge in the development of new products/services |                     | 0.425   | 2.032| 31.664 | 0.000    |
|                        | KC1  | Filtering knowledge                        |                     | 0.342   | 1.390| 18.213 | 0.000    |
|                        | KC2  | Transferring organisational knowledge to employees |                     | 0.445   | 1.699| 27.925 | 0.000    |
|                        | KC6  | Replacing outdated knowledge               |                     | 0.424   | 1.633| 26.911 | 0.000    |
| Construct          | Code | Items                                                                 | Convergent validity | Weights | VIF  | t-value | P-values |
|--------------------|------|-----------------------------------------------------------------------|----------------------|---------|------|---------|----------|
| Supply chain risks |      | DR3 Consistency of our customers to place orders with their product specification | 1.000                | 0.632   | 1.480| 13.750  | 0.000    |
|                    |      | DR4 Consistency of our customers to provide reliable forecasts on their demands |                      | 0.834   | 2.250| 49.575  | 0.000    |
|                    |      | DR5 Consistency of our customers to commit to their demand forecasts   |                      | 0.758   | 1.623| 27.799  | 0.000    |
|                    |      | DR6 Consistency of our customers’ actual demands with our forecasts    |                      | 0.741   | 2.082| 21.882  | 0.000    |
|                    |      | ERa1 Government policies                                              |                      | 0.419   | 3.229| 8.138   | 0.000    |
|                    |      | ERa2 Tax policies                                                     |                      | 0.705   | 4.081| 29.895  | 0.000    |
|                    |      | ERb2 Extreme drought                                                  |                      | 0.597   | 3.674| 14.515  | 0.000    |
|                    |      | ERb3 Flooding                                                         |                      | 0.522   | 5.551| 13.802  | 0.000    |
|                    |      | FR1 Inadequate financial support                                       |                      | 0.429   | 3.372| 11.111  | 0.000    |
|                    |      | FR2 Delays in accessing financial support                             |                      | 0.759   | 1.560| 40.501  | 0.000    |
|                    |      | FR3 Uncertain financial support (credit)                              |                      | 0.840   | 2.520| 57.564  | 0.000    |
|                    |      | FR4 Periodic change/uncertain interest and exchange rate policies     |                      | 0.857   | 2.535| 70.817  | 0.000    |
|                    |      | PR1 Outdated seeds                                                    |                      | 0.286   | 3.519| 7.689   | 0.000    |
|                    |      | PR2 Management decisions                                              |                      | 0.577   | 5.022| 11.723  | 0.000    |
Table 5 (continued)

| Construct | Code | Items                                                                 | Convergent validity | Weights | VIF | t-value weight | P-values |
|-----------|------|----------------------------------------------------------------------|---------------------|---------|-----|----------------|----------|
| PR3       |      | Quality control                                                      |                     | 0.423   | 4.781 | 9.422          | 0.000    |
| PR4       |      | Forecasting and planning errors                                      |                     | 0.750   | 1.526 | 27.998         | 0.000    |
| PR6       |      | Dependence on transport conflicts                                    |                     | 0.781   | 1.626 | 25.194         | 0.000    |
| PR8       |      | Dependence on labour disputes affecting transport                    |                     | 0.631   | 5.487 | 16.483         | 0.000    |
| PR9       |      | Lack of infrastructure and service units                             |                     | 0.632   | 4.670 | 17.779         | 0.000    |
| SR1       |      | Logistics performance of suppliers (delivery dependability, order fill capacity) |                     | 0.778   | 1.892 | 34.088         | 0.000    |
| SR2       |      | Supplier quality                                                     |                     | 0.855   | 2.349 | 68.116         | 0.000    |
| SR3       |      | The default of a supplier (e.g. due to bankruptcy)                   |                     | 0.842   | 2.412 | 69.404         | 0.000    |
| SR5       |      | Capacity fluctuations or shortages in the supply markets             |                     | 0.579   | 1.539 | 12.123         | 0.000    |

Criteria: t-value ≥ 1.96; VIF ≤ 5

Table 5 also shows the multicollinearity between the indicators that were assessed to validate the formative model. As a variance inflation factor (VIF) above five indicates a potential collinearity issue, multicollinearity did not exist in the data of the present study as all the formative indicators were below five and significant. Significance and relevance of the outer weights were also assessed (Hair et al., 2014). The $R^2$ values of the $k$-th regression facilitate the computation of the VIF for the $k$-th indicator, using the following formula:

$$VIF_k = \frac{1}{1 - R^2_k}$$

Higher $R^2$ values in the $k$-th regression imply that the variance of the $k$-th item can be explained by the other items in the same measurement model, which indicates collinearity issues (Sarstedt & Ringle, 2017).
4.2 Assessment of the structural model

There are five steps in structural model assessment (Hair et al., 2014). Firstly, it is crucial to ensure that there are no lateral collinearity issues in the model before evaluating the structural model. This is because even if discriminant validity (vertical collinearity) criteria are met, lateral collinearity issues can still mislead findings (Kock, 2015). As the VIF score of each construct was below the cut-off value of five (Hair et al., 2014), there were no collinearity issues in the present study.

Secondly, the path coefficients of the seven direct hypotheses mentioned in the research framework (Fig. 1) were then assessed. The bootstrapping technique was used to examine the significance of the hypotheses for a sample size of 395 at a 95% confidence level. Based on the results (Table 6), six of the seven hypotheses were supported at the 95% confidence level. The hypotheses investigating the influence of the three dimensions of supply chain risk management; risk identification, risk assessment, and risk mitigation strategies; on supply chain performance was then assessed. While the risk assessment and risk mitigation hypotheses were supported, the risk identification hypothesis was not supported. The hypotheses investigating the influence of supply chain risks on the three dimensions of supply chain risk management; risk identification, risk assessment, risk mitigation; were all supported. The direct influence of supply chain risks on supply chain performance was also supported in the present study.

In the third step, the coefficient of determination ($R^2$); which represents the variance of an endogenous construct as explained by the exogenous constructs associated with it (Sarstedt et al., 2017); was evaluated. As risk assessment had an $R^2$ of 0.162, supply chain risks accounted for 16.2% of the variance in risk assessment. The $R^2$ of risk identification was 0.219 indicating that supply chain risks accounted for 21.9% of the variance in risk identification while supply chain risks accounted for 23.3% of the variance in risk mitigation strategies. Finally, 30.1% of the variance in supply chain performance was explained by risk mitigation strategies, risk identification, and risk assessment. According to Cohen and Lee (1988), as a rule of thumb, $R^2$ values of 0.26, 0.13, and 0.02 can be described as substantial, moderate, and weak, respectively.

In the fourth step, the effect sizes that the seven exogenous constructs had on the endogenous constructs were calculated. Of the seven effects, risk mitigation strategies had a medium effect (0.150) on supply chain performance while risk assessment had a small effect (0.037).

Table 6 Path coefficient assessment

| Hypothesis       | OS   | SM (Beta) | SD  | t-value | p value | Decision      |
|------------------|------|-----------|-----|---------|---------|---------------|
| RA → SCP         | 0.229| 0.228     | 0.060| 3.839   | 0.000** | Supported     |
| RI → SCP         | 0.118| 0.117     | 0.071| 1.667   | 0.096   | Not Supported |
| RMS → SCP        | 0.351| 0.343     | 0.061| 5.740   | 0.000** | Supported     |
| SCRs → RA        | −0.163| −0.165 | 0.051| 3.199   | 0.001** | Supported     |
| SCRs → RI        | −0.437| −0.442 | 0.047| 9.297   | 0.000** | Supported     |
| SCRs → RMS       | −0.194| −0.197 | 0.057| 3.391   | 0.001** | Supported     |
| SCRs → SCP       | −0.219| −0.221 | 0.057| 3.818   | 0.000** | Supported     |

RA risk assessment, RI risk identification, RMS risk mitigation strategies, SCP supply chain performance, SCRs supply chain risk, OS original sample, SM sample mean, SD standard deviation

**Significant at p ≤ 0.01
Meanwhile, supply chain risks had a medium effect (0.166) on risk identification, a small effect (0.033) on risk mitigation strategies, and a small effect (0.022) on risk assessment. However, risk identification and supply chain risks had trivial effects of 0.009 and 0.008, respectively, on supply chain performance. Many of the effect sizes in social science research is small because it depends on the complexity of the research model, the research discipline, and the present situation of the industry in question (Cohen & Lee, 1988; Sullivan & Feinn, 2012).

The fifth and final step of the structural model evaluation was predictive relevance ($Q^2$) assessment (Geisser, 1974; Stone, 1974) which can be calculated using the blindfolding technique (Stone, 1974). $Q^2$ is important to assess the predictive validity of a complex model (Chin et al., 1996), where a value greater than zero proves that the model has predictive relevance (Sarstedt et al., 2017). Risk assessment was found to have a $Q^2$ of 0.086, risk identification had 0.126, risk mitigation strategies had 0.145, and supply chain performance had 0.074. As all the endogenous constructs; risk assessment, risk identification, risk mitigation strategies, and supply chain performance; had $Q^2$ values above zero, the predictive relevance of the model was validated.

### 4.3 Assessment of the mediating effect of supply chain risk management

This section presents the bootstrapping assessment results of the mediating effect of supply chain risk management based on the three developed hypotheses. As seen in Table 7, the path-coefficients indicate that two of the three mediating correlations were significant. Risk assessment and risk mitigation strategies were found to mediate the correlation between supply chain risks and supply chain performance while risk identification failed to mediate the correlation between supply chain risks and supply chain performance.

### 5 Assessment of the moderating effect of knowledge management

This section presents the results of the moderating effect of knowledge management based on the three developed hypotheses. First, the interaction effect between the moderator and the predicting variable and its effect on the endogenous variable had to be determined. Knowledge management was found to have a small effect (0.042) on risk assessment and trivial effects of 0.019 and 0.005 on risk identification and risk mitigation strategy, respectively. However, although the effects were small and trivial, their impact cannot be ignored. This is because a low effect size does not reflect the negligible effect of a moderator as it may

| Hypothesis       | OS       | SM (Beta) | SD   | t-value | p Value | Decision     |
|------------------|----------|-----------|------|---------|---------|--------------|
| SCR→RA→SCP      | − 0.037  | − 0.037   | 0.013| 2.889   | 0.004   | Supported    |
| SCR→RI→SCP      | − 0.051  | − 0.052   | 0.033| 1.562   | 0.119   | Not Supported|
| SCR→RM→SCP      | − 0.068  | − 0.067   | 0.023| 2.978   | 0.003   | Supported    |

*SCR* supply chain risk, *RA* risk assessment, *RI* risk identification, *RM* risk mitigation, *SCP* supply chain performance, *OS* original sample, *SM* sample mean, *SD* standard deviation
become meaningful under certain conditions (Chin et al., 1996). Therefore, it can be concluded that the moderating effects of two hypotheses were supported while one was not supported. Knowledge management was found to moderate the correlation between supply chain risks and risk assessment and between supply chain risks and risk identification but did not moderate the correlation between supply chain risks and risk mitigation strategy. Table 8 shows the results of the bootstrapping analysis of the moderators and Fig. 2 depicts the interaction model of knowledge management. The moderator model is presented as follows:

\[ f^2 = \frac{R^2_{\text{included}} - R^2_{\text{excluded}}}{1 - R^2_{\text{included}}} \]

Table 8 Moderation effect assessment

| Hypothesis       | OS   | SM (Beta) | SD   | t-value | p Values | Decision   |
|------------------|------|-----------|------|---------|----------|------------|
| SCRs*KM → RA    | 0.194| -0.193    | 0.062| 3.129   | 0.002**  | Supported  |
| SCRs*KM → RI    | 0.270| -0.267    | 0.060| 4.520   | 0.000**  | Supported  |
| SCRs*KM → RMS   | 0.099| -0.091    | 0.063| 1.565   | 0.118    | Not Supported |

SCR supply chain risk, RA risk assessment, RI risk identification, RMS risk mitigation strategy, KM knowledge management, OS original sample, SM sample mean, SD standard deviation

**Significant at p ≤ 0.01

Fig. 2 Interaction model of knowledge management. Note: 0.35 = large, 0.15 = medium, 0.02 = small, < 0.02 = trivial (Cohen & Lee, 1988)
6 Implications of the study

6.1 Theoretical implications

The present study focused on the importance of fit of an integrated theoretical model. The results provided ample evidence that supply chain risk management and knowledge management play a significant role in reducing the negative impacts of supply chain risks on supply chain performance. This study endeavoured to enrich existing literature by integrating all these variables into a model for fresh fruit and vegetable agropreneurs in Malaysia. This research has made a significant number of theoretical contributions to the field.

The efficacy of using transaction cost theory as a base for the supply chain risk management model was examined with an understanding of supply chain risks and supply chain performance. This study also extended governance mechanisms in supply chain risk management in the form of risk identification, risk assessment, and risk mitigation strategies to improve the performance of Malaysian agropreneurs. As previous literature on supply chain risk management and supply chain performance ignores the role of combined theories; i.e., transaction cost theory and knowledge-based view theory; the findings of this study indicate that supply chain performance is affected by increased supply chain risks. It also confirmed the applicability of transaction cost theory in the context of the supply chain of fresh fruit and vegetable agropreneurs. This study has also validated the effectiveness of supply chain risk management as a governance mechanism with which to mitigate supply chain risks. Knowledge management was also introduced with the use of the knowledge-based view. The knowledge-based view regards knowledge as a key resource in emphasising a firm’s ability to create and sustain a competitive advantage (Samuel et al., 2011) as it transforms information, data, and intellectual assets into enduring value by identifying useful knowledge for management actions (Goh & Sung, 2006).

While previous studies have investigated the impact of supply chain risk management on supply chain performance (Fan & Stevenson, 2018a, 2018b; Hoffmann et al., 2013), the present study contributes to the existing literature by empirically proving that supply chain risk management significantly impacts the performance of agri-fresh produce supply chains. Our study found that every aspect of supply chain risk management had a significant impact on the supply chain performance of fresh fruit and vegetable agropreneurs.

The present study has also expanded the knowledge on how supply chain risk management can reduce the impact of supply chain risks and improve performance. This study went further and proposed three aspects of supply chain risk management as well. Of the three proposed aspects, risk assessment and risk mitigation strategy were found to mediate the correlation between supply chain risks and supply chain performance. As such, the use of these two aspects of supply chain risk management can act as an effective tool with which to manage the supply chain performance of agropreneurs. Although risk identification was found to be insignificant, the importance of timely risk identification should not be overlooked. This mediating effect highlights the value of supply chain risk management in improving the performance of supply chains, particularly in the context of the agri-fresh produce industry.

Finally, this research provides an understanding of how knowledge management relates to supply chain risks and supply chain risk management and can act as a moderator between the two. Our findings reveal that knowledge management can indirectly influence supply chain risk management by minimising the negative effects of supply chain risks. This study also shows that the use of appropriate information is critical not only to understand risks but
to manage them as well. To that end, knowledge management can be an effective way to strengthen relationships between supply chain members and trading partners.

6.2 Practical contributions

Agropreneurs, policymakers, and organisations involved in agribusiness can draw several practical contributions from this study as it depicts how proper supply chain risk management can improve the performance of the agri-fresh produce supply chains. Malaysian agropreneurs are, generally, divided into two types: i.e. independent and contract (Arshad, 2012). The contributions outlined in this section are useful for both types of agropreneurs. This study found that supply chain risk management influences agri-fresh produce supply chains. It also postulates that the identification, assessment, and mitigation of risks becomes easier when all supply chain partners work together and respond professionally (Behzadi et al., 2017a, 2017b). Furthermore, awareness of supply chain risk management in the upstream and downstream of the agri-fresh produce supply chains increases performance and enhances competitiveness. Therefore, this study helps supply chain partners generate appropriate mechanisms with which to improve supply chain risk management which will, in turn, improve the performance of agropreneurs and supply chain partners as well.

Malaysia introduced the youth agropreneur programme in a bid to improve the production of agriculture to fulfil local demand and reduce food imports (Yusoff et al., 2016). As such, awareness of supply chain risk management must be integrated into the training content of this programme so that participating youths can fully comprehend the complex agri-fresh produce supply chains, familiarise themselves with supply chain risk, and understand supply chain risk management aspects that can enhance performance. This is vital as youth are the essential catalysts for the economic development goals of a country (Bahaman et al., 2010). As this study provides an overall view of the supply chain performance of Malaysian fresh fruit and vegetable agropreneurs, agropreneurs can use it as a guideline to better understand their supply chains. Additionally, this study urges that agropreneurs develop an understanding with government institutions so as to learn and effectively apply supply chain risk management strategies.

The present study reveals that agropreneurs can engage in improved supply chain risk management practices with their supply chain members through knowledge management. By working closely with their supply chain partners, agropreneurs would better understand the limitations of their partners and rapidly develop strategies to cope with supply chain risks. After all, reducing risk will influence strategies and improve customer satisfaction which would then increase the efficiency of the agropreneur. Therefore, this study encourages agropreneurs to develop structured supply chain risk management processes by incorporating knowledge management, a factor that is often overlooked by smallholding agropreneurs.

6.3 Limitations and future suggestions

Although the results of the present study provided useful insight and contribute considerably to supply chain theories and practices, it is not without its limitations. As the present study is cross-sectional, longitudinal studies should be conducted as it is difficult to establish a causal relationship between the constructs. Secondly, as this study only examined the agri-fresh produce supply chains in Malaysia, the inclusion of small and medium agribusinesses would make the framework robust. Furthermore, as the quantitative method of the present study may not provide an in-depth understanding of the issues under investigation, a qualitative
approach or a mixed-method approach may enhance its validity. Finally, as only five states of the thirteen states were included in this study, future studies should include more states to provide the generalised trend of the country.

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