

From farm to China: A case study of Malaysian frozen whole durian export supply chain

(Dari ladang ke China: Kajian kes rantaian bekalan eksport durian sejuk beku Malaysia dan bentuk biji)

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Abstract

Malaysia has substantially enjoyed rapid export growth of durian pulp and paste since the country gained the market access to China in 2011. In 2018, a new export protocol for frozen whole durian was promulgated and signed between Malaysia and China. The new protocol enables a promising market avenue for frozen whole durian, thereby consolidating Malaysia as China's important trading nation. However, ambiguities have arisen among the Malaysian durian exporters in understanding the frozen whole durian export supply chain to China following the recently signed new protocol. Therefore, understanding the export supply chain is imperative for an informed decision making. A case study of frozen whole durian export supply chain from Malaysian farms to retailers in Shenzhen, China was therefore carried out and analyzed based on the Supply Chain and Cost Mapping Toolkit (SCCMT). The study revealed that processing and outbound logistics were highly important nodes in the frozen whole durian export supply chain. Both stages spent the most amount of time and constituted the highest cost fraction in the supply chain combined. All stages were integrated through the establishment of cross-functional working team with trust and full commitment. Overall, this real case study is expected to encourage the spike of Malaysian durian export in future.

Introduction

As the world's largest population, China represents a potentially attractive market for emerging exporters. The rapid economic growth combined with increasing disposable income in China allows Chinese consumers to spend more on household products. For example, food and beverage expenditure in 2018 accounted for around a quarter of the urban household expenditure (Textor 2020). Fruit and vegetable market represents

the largest segment in the entire retail and food and beverage category (Direct China Chamber of Commerce [DCCC] 2017). Growing transport networks and technologies enable the Chinese consumers to buy more fruits and vegetables as there are ample choices and varieties in the market. The increased value in money, awareness of a healthy diet, and the public concerns of food safety are the key factors to the enhanced market growth in

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China (Produce Marketing Association [PMA] 2016). In today's China's market, distribution does not only happen in the traditional market, but also increasingly become more diversified in virtual marketplaces (Fung Business Intelligence 2018). The changing consumers' needs and preferences have upgraded their taste experience to tropical fruits, which bring durians to the consumers.

Durian has become increasingly popular in southern and eastern China partly due to its high nutritional value and widespread popularity of its derivatives, for instance ice cream, moon cakes, and dumplings (ChinaAg 2017). According to the Ministry of Agriculture and Rural Affairs of the People's Republic of China (2019), the country imported USD 963 million or 358,000 tonnes of durian in the first half of 2019, more than doubling the values in the current and previous years combined. Within China, the cities of Guangzhou, Shenzhen, and Hong Kong have since emerged as the largest markets for selling durian while Beijing and Shanghai recorded the highest consumption in durian, highly focusing on supplying the durian to the high-end hotels and eateries (Oriental Daily 2016). Historically, Thailand has been the major durian supplier to the Chinese market and it currently holds a monopoly (90% of market share) on fresh exports to Mainland China. Thai durian has established a strong reputation in China's market for over 30 years (Yuhuan 2015). Durian export can be quantified in two ways: (1) trade in fruit form; and (2) durian-based end products (MK Durian Harvest n.d.).

Following a positive demand outlook for durian in China, Malaysia has negotiated with China to obtain durian export access into the country. On 12th May 2008, the export protocol of frozen durian pulp and paste was signed between the two trading nations. The export officially began on 11th May 2011 onwards (Federal Agricultural Marketing Authority [FAMA] 2014). Malaysia is the only country after Thailand

that can officially supply the frozen durian to the Mainland China market. Fresh whole durian is classified under the HS code of 081060 (fresh durian) while pulp and paste are classified under the HS code of 210690 (food preparations not elsewhere specified or included). However, the HS code is jointly grouped with a wide variety of food products including durian as an exotic processed fruit.

Malaysian durian export has increased significantly in value (*Figure 1*). From 2002 – 2011 to 2011 – 2019, durian export grew by 172% in constant dollar terms upon gaining market access to China, increasing by 151% from USD 8.8 million (2011) to USD 22.3 million (2019).

Export destinations of durian are mainly to the Asian and some non-Asian markets (e.g. Australia, United Kingdom and Canada) (Suhana et al. 2018). Singapore and Hong Kong remain as the main traditional export destinations prior to adding China to the list of export destinations for durian. In 2017, China and Hong Kong contributed 48% to the durian export market share, followed by Singapore (46%). Malaysia's most popular trade varieties are 'Cat Mountain King' or 'Mao Shan Wang' or 'Musang King' and 'D24' mainly grown in Peninsular Malaysia particularly in the states of Pahang, Perak, Johor, and Kelantan. In Thailand, the bulk of export-orientated fresh durian production takes place near the Gulf of Thailand in the south eastern provinces of Chanthaburi, Rayong, Trat, and Prachinburi. Other durian production zones include the northern province of Uttaradit, the southern provinces of Yala, Narathiwat, and Surat Thani. Thailand's most popular varieties are 'Golden Pillow' or Monthong and 'Chanee' (ChinaAg 2017). In terms of fruit taste and quality between Malaysian and Thai durian, industry players generally find the taste and quality remarkably different. Malaysian durian is at its best due to its harvesting technique, which is fully ripened at 100% maturity instead of early harvest as practiced in Thailand (Freshplaza 2019).



Source: International Trade Centre (2020)

Figure 1. Malaysia's export of durian, 2002 – 2019 (in USD '000 and Mt)

Traditionally, importation of durian into China is done by transiting in Hong Kong via legal, illegal or grey distribution channel, thus bypassing Hong Kong and exporting directly to the Mainland China (Malaysia External Trade Development Corporation [MATRADE] 2016). Durian trade is estimated to increase, particularly for Malaysian durian which has already established a foothold in Guangdong for the distribution at wholesale market further inland (ChinaAg 2017). On top of that, another export protocol for frozen whole fruit durian was promulgated and sealed on 20th August 2018 between Malaysia and China. The export activity later started in 2019 upon approval and premise auditing by the General Administration of Customs of the People's Republic of China (GACC). At present, five companies have fulfilled the criteria and qualified by GACC to export frozen whole durian to China by using a new technique known as cryogenic nitrogen freezing. The technique aims to retain its freshness for long shelf life up to 18 months.

Nevertheless, little is known and understood about the frozen whole durian export supply chain following the new

export protocol recently signed between the two countries. Thus, this study generally intended to identify frozen whole durian export supply chain from Malaysian farm to China market. Specifically, this study identified activities involved in the export supply chain, evaluated time taken to distribute the frozen whole durian from Malaysia to China, and estimated the cost enumerated from all activities throughout the supply chain. The rest of the paper is organised into several sections. The literature review briefly delves into the basics of agri-supply chain and cryogenic freezing technique, followed by agri-supply chain of fresh produce in China. Next, methodology briefly explains the sources of data and analytical tool to examine the frozen whole durian export supply chain. Results and discussions present and deliberate on the findings, challenges and opportunities, followed by recommendations and strategies. Finally, conclusion is presented at the end of the paper.

Literature review

Agri-Supply Chain

Aramyan (2007 p.5) cited Bijman (2002) to define agri-food supply chain as “a supply chain where an agricultural product goes through different stages of production and distribution before reaching the final consumers”. The agri-supply chain is subjected to more stringent regulations and closer monitoring related to human consumption (Ahumada and Villalobos 2009). Food and Agriculture Organization [FAO] (2007) adds that the supply chain not only includes the producer and its suppliers, but also depends on the logistics flows, transporters, warehouse, retailers, and consumers themselves. In a broader sense, supply chain includes new product development, marketing, operations, distribution, finance, and customer service.

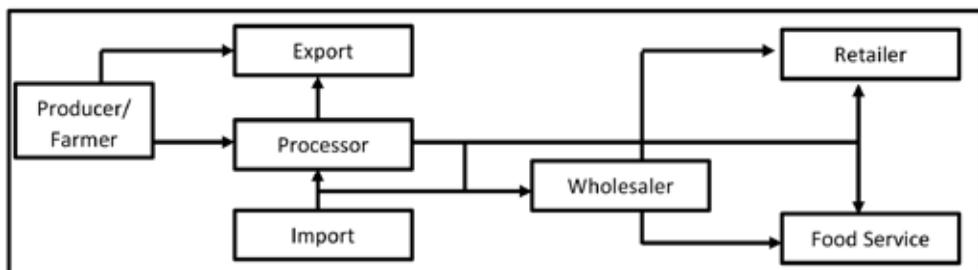
Supply chain principally exists in two forms: *viz.* domestic or cross-national borders (Rozhan 2015). The former refers to the flow of agricultural products from the stakeholders to the end users in the domestic market while the latter may extend to overseas markets via export. In addition to that, there are many stakeholders constituting an agricultural supply chain, ranging from producers to transport providers, sorting/processing facilities, wholesaler, distributors, retailers and consumers (Staples et al. 2017). For an international supply chain, there are additional stakeholders involved, such

as customs and biosecurity regulation at borders. *Figure 2* illustrates a simplified agri-supply chain.

Van der Most (2000) has observed that agri-food supply chain is complex to understand because it differs from other supply chains in such aspects as:

1. shelf life constraints for raw materials and perishability of products;
2. long production throughput time;
3. seasonality in production;
4. physical product features like sensory properties such as taste, odor, appearance, color, size, and image;
5. requires conditioned transportation and storage;
6. product safety issues; and
7. natural conditions affect the quantity and the quality of farm products.

Aramyan (2007 p.g 5) revealed that agri-supply chain was more challenging in distinguishing daily fresh products (vegetables and fruits), chilled products (salad, dairy products etc.), frozen products (fish, ice etc.) and non-perishables as sugar and coffee. For fresh fruits, uncertainties in supply and demand will lead to longer supply chain with relatively thin margin (Verdouw et al. 2010) apart from short product lifetimes (Ralf 2017). Furthermore, the quality of agricultural products is strongly determined by nature.



Source: Staples et al. (2017)

Figure 2. Stakeholders in a simple agricultural supply chain

Based on these facts, it is noteworthy to appreciate the crucial roles of food quality and environmental issues (e.g. weather condition) in determining agri-food supply chain performance. Thus, when developing a performance measurement system for an agri-food supply chain based on the specifications of agri-food production, it is crucial to consider the whole process of quality (e.g. freshness, food safety, environmental issues, etc.), and other financial and non-financial indicators for an effective measurement system (Aramyan, 2007; Van de Spiegel 2004).

Christopher (1998) described various performance indicators which could be deployed by an organization to measure success or failure in the market. Van der Vorst (2005) highlighted the main indicators on three main levels: (1) supply chain level (e.g. product availability, quality, responsiveness, delivery reliability, and total supply chain costs); (2) organizational level (e.g. inventory level, throughput time, responsiveness, delivery reliability, and total organizational costs); and (3) process level (e.g. responsiveness, throughput time, process yield, and process costs). However, failure to meet the logistical requirements for supply chains in the food sector would result in severe damage to the physical products and brand reputations (Tarek, 2006).

Aramyan (2007) developed a preliminary conceptual framework which focused on four main categories: *viz.* efficiency, flexibility, responsiveness, and food quality. Management and co-ordination of the fresh produce supply chain have become increasingly important as companies need to minimize distribution and inventory costs while maximizing market opportunities, resulting in fundamental changes in consumer preference and taste (Safari et al. 2019; Norsida et al. 2009).

Cryogenic freezing technique

Freezing is one of the best techniques to supply and preserve the quality of durians all year round. Through freezing, the excess of durian during peak season can be controlled and supplied during off season. Furthermore, the strong aroma of durian can be concealed along the supply chain.

Liquid nitrogen at $-196\text{ }^{\circ}\text{C}$ is a cryogenic fluid that can cause rapid freezing upon contact with living tissue. Pressurized liquid nitrogen is sprayed onto the product at high velocity to freeze it immediately. This method can extract heat at a faster rate. It permeates the food items' thermal resistance and creates an ice crust around them, locking in natural flavours, nutrients, and moisture (Linde 2020). Cryogenic freezing has five to ten times less dehydration than with conventional freezers. By limiting weight loss, this method improves product yield.

Besides that, freezing temperature reduces or inhibits the growth of microorganisms and decreases water activity, thereby maintaining the quality and extending shelf life of many food products, for example fruits (Heldman 2006; Fellows, 2009). Allan-Wojtas et al. (1999) found that rapid freezing by using liquid nitrogen provides better quality and enhances the blueberries' internal microstructure. In terms of food safety, frozen fruits are considered safer due to reduced water activity and retarded microbial growth under freezing storage environment (De Ancos et al. 2012).

Agri-supply chain of fresh produce in China

China has 34 major ports and over 2,000 minor ports. However, only seven ports are authorized by the Government to receive fresh produce from overseas. The ports are located in Ningbo, Xiamen, Nanjing, Qingdao, Guangzhou, Tianji and Shanghai (Wang et al. 2017) as indicated in *Figure 3*.



Source: Wang et al. (2017)
 Figure 3. Shipping ports in China

Guangzhou is the largest destination for imported fruits, accounting for approximately 70% of China’s imported fruit (MATRADE 2016). Guangzhou’s Jiangnan market is the biggest market for imported fruit, serving the whole Chinese market as well as to Shenzhen located in Guangdong Province (Shoufeng et al. 2019).

The two most common methods for fresh fruit exporters to gain access to the Chinese market are by exporting either indirectly to the Mainland China via Hong Kong or directly to the Mainland China (PMA 2016). The selected distribution channel may vary depending on the products and market segmentation. The primary advantage of using grey channel via Hong Kong is the tariff structure. However, one major disadvantage is the lack of robust cold storage facilities needed, especially for the exported frozen durian. Exporting directly to the Mainland China will be supported by improvements in China’s cold chain infrastructure (ChinaAg 2017). According

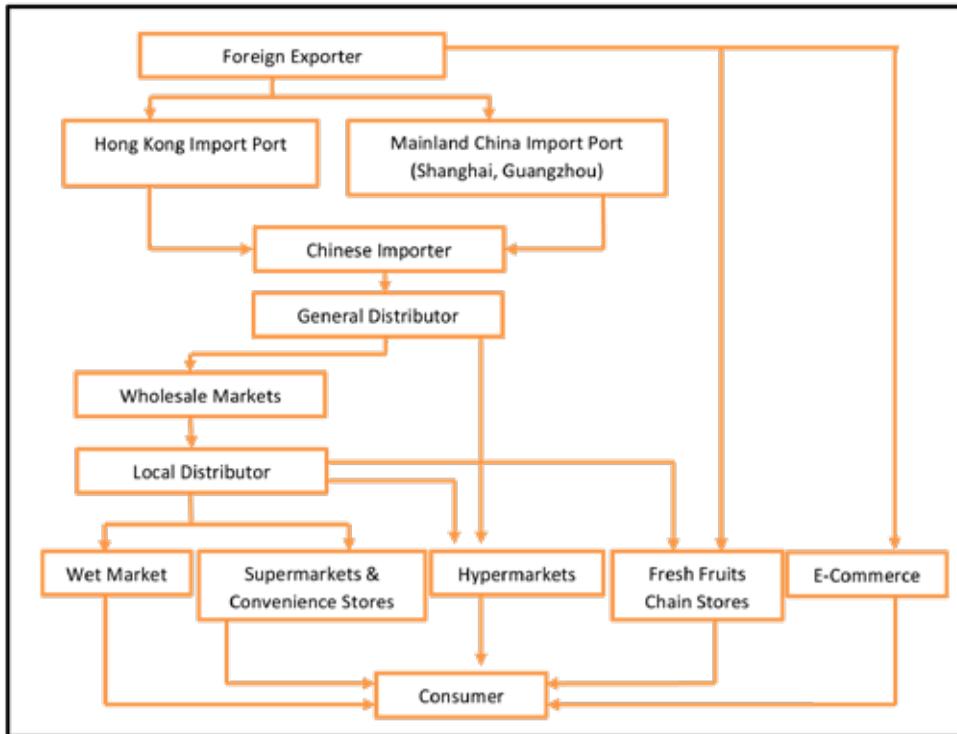
to Paul (2015), China now has 106 million m³ (cubic meters) of cold storage capacity and 89,000 refrigerated vehicles, upgraded from only 10 million m³ of storage and 12,000 refrigerated vehicles in 2007. This infrastructure development is centered around Shanghai, Guangzhou, Fujian and Tianjin.

Figure 4 shows fresh produce distribution model adopted by PMA (2016). The distribution in China involves local importers and wholesalers distributing fresh produce to wet supermarkets, supermarkets, and other wholesale markets in China. However, the fresh fruit supply model has evolved into direct importation from foreign exporters to fresh fruit chain store and through e-commerce.

Exporting fresh produce to the international market involves both technical and political issues. Pest and disease control, and quarantine procedures are the biggest technical concerns by Chinese authority in order to protect local agricultural industry. In obtaining technical market access criteria, foreign exporters should cooperate with the GACC and other related Chinese officials before exporting the products. The latter issue requires a good bilateral relation which is pivotal to gain market access in China. Nevertheless, it would turn to a rather delicate issue for exporters whose countries have a less-than-satisfactory relationship with the Chinese government (PMA 2016). Exporters whose countries have signed a Free Trade Agreement (FTA) with China enjoy a large competitive advantage in the form of tariff waivers (EU SME 2015).

Methodology

This paper generally aimed to understand the frozen whole durian export supply chain from Malaysia to China. A case study was conducted to profile supply chain activities involved in exporting frozen whole durian, to evaluate the time taken to distribute the frozen whole durian from Malaysia to China, and to estimate cost enumerated from all activities throughout the supply



Source: Produce Marketing Association (2016)

Figure 4. China's Imported fresh produce distribution model

chain. These were achieved by gathering information derived from primary and secondary data. Primary data were collected right from the first stage of supply chain i.e. farm harvesting to the end stage i.e. retail in China (in this case, retail shop in Shenzhen). Shenzhen has a relatively large demand for durian among the Chinese consumers. Apart from that, Shenzhen has some of the largest regional wholesale markets for imported tropical fruits (e.g. Buji Fruit) and Vegetable Wholesale Market. Secondary data, on the other hand, were retrieved from durian trade data pooled from various sources (e.g. Trade Map, UNCOMTRADE), annual reports published by the Department of Agriculture (DOA) Malaysia, Ministry of Agriculture and Food Industries (MAFI) or formerly known as Ministry of Agriculture and Agro-based Industry (MOA), Ministry of Agriculture of the Republic of China, and other publications.

The data collection began on 19th July 2019 and ended on 15th August 2019. In the beginning, farm and premise visits were conducted with growers, and five local exporters, who were predominantly approved for whole durian fruits export to China underwent a focused group discussion and in-depth interview. Another round of in-depth interview was subsequently conducted involving China's counterparts e.g. importers, wholesalers, and retailers. Additionally, in-store observation at various categories of grocery outlet (e.g. wet market, supermarket, hypermarket and fruits stores including Walmart, Ole, Pagoda, Aeon, Hema Fresh, Xin Fa Di market and Carrefour) were also carried out to obtain more relevant information of durian market in China.

Supply chain and cost mapping toolkit analysis

The frozen whole durian export supply chain was analyzed based on the Supply Chain and Cost Mapping Toolkit (SCCMT). The analysis has been developed by the Supply Chain Cost Effectiveness and Swift Service (SUCCESS) team and successfully used by leading global food manufacturers, including Masterfoods UK Ltd, Bernard Matthews Ltd and McCormick UK Ltd (Tarek 2006). The analysis provided visibility of time in the supply chain. It involved seven interlinked stages *viz.* (1) identifying project; (2) process mapping; (3) cost collection; (4) time-based analysis; (5) translation cost matrix; (6) cost-time analysis; and (7) scenario evaluation.

The Supply Chain and Cost Mapping Toolkit (SCCMT) began with process mapping which created an accurate visual activity and captured the use of time and resources. Next, activity-based cost was estimated in the cost collection stage. In this stage, accurate estimation or exact information was needed for calculation. Cost enumeration incentivized the local exporters to maneuver their businesses more aptly by monitoring their cost of doing business and strategizing an effective cost minimization. This strategy would benefit the exporters in mitigating business and financial risks across borders.

Next, time-based analysis, translation cost matrix, and cost-time analysis involved a process of identifying wastes and benefits in the supply chain. The process was useful for exporters to minimize or eliminate waste/slack resources in the supply chain and assessing the (un)intended impact of the supply chain on the organization.

Results and discussions

The export supply chain structure for Malaysian frozen whole durian

Description of a supply chain structure depicts the processes and activities involved from input (farm) to output (retail). In order to connect the chain, other processes like

inbound logistics, processing, and outbound logistics are integrated accordingly. *Figure 5* shows the process map of the frozen whole durian export supply chain. Fresh durians were harvested from drop-ripen fruit in the farm. The fresh durians were usually collected twice a day *i.e.* early in the morning and evening. The durian collection was done manually by farm workers. A mature durian tree (*i.e.* grafted cultivars start bearing at 4 – 6 years; seedlings start bearing at 7 – 10 years) could produce 100 – 200 durians per season (Shunyam 2019). Durian varies in size and shape depending on varieties and completeness of pollination. Its average weight ranges between 1.5 and 4.0 kg per fruit but occasionally 8.0 kg per fruit. For export purpose, durians weighing between 1.5 kg and 2.0 kg from Musang King, Mao Shan Wang or D197 cultivars were selected for freezing. The durians were subsequently loaded into the pickup truck and directly transported to packing house for processing, quality check, and other post-harvest export requirements.

According to Nur Azlin (2020), the post-harvest processing at the packing house was carried out in the processing area. The cleaning process of durian is done by using high-pressure air jet to remove any debris from the fruit. The optional sanitation of durian was conducted through automated washing system fitted with overhead sprayers to clean and wash the fruit. First, the workers gently placed the durians in the trays fitted onto the conveyor belt, which conveyed the fruits to the automated water spraying platform, wherein the fruits were showered with a clean water of potable quality mixed with 500 ppm sodium hypochlorite. The water was maintained at room temperature throughout washing.

Upon treatment, the fruits were passed through a drying section at the end of the conveyor to reduce moisture on the surface of the fruits. Prior to cryogenic freezing treatment, the fruits were transferred to the shelves. The shelves were subsequently

placed in the cryogenic chamber. The freezing treatment was set between -80°C to -110°C for not less than an hour.

Upon completion of freezing, the frozen durian must be immediately be packed in new and clean packaging whose materials conform to the phytosanitary requirements, and safety and hygiene standards. For the best quality, the frozen durian must be packed by using vacuum packaging. This would contain the gas and smell of the frozen durian and prevent it from high water loss.

If using netting to pack the frozen durian, the foam insulated box was recommended to be used as a retail box. All sides and edges of each package must be appropriately sealed with adhesives to prevent entry of target or non-target quarantine pests. Storage and transportation of packed frozen durian were conducted in at least -18°C environment.

At this point, frozen whole durian awaited customer orders and ready for discharge from the processing facility to be transported to China (outbound process) for export. From farm to port of discharge, it was estimated to take twelve days before it was ready for sea freight from Klang Port of Malaysia to Guangzhou Port of China. A 40-ft container fully loaded with frozen whole durians was ready to be transferred from the freight forwarding truck to the nominated vessel. The transfer might take a few hours depending on customs approvals i.e. documentation (e.g. packing list, import or export permit, export forms and others) and clearance by the Royal Malaysia Customs Department (RMCD) and port authorities. Sea freight voyage from Malaysia to southern China took approximately 10 – 11 days.

Upon arrival at the destination port, clearance and inspection process would be carried out by GACC and port authorities. Upon satisfying the requirements and getting approvals, the consignment was then unloaded from the vessel to the container loading bay. This process generally took one

to three days. Then, the consignment was transported to the importer's warehouse for subsequent distribution to the retail market.

In this case study, the frozen whole durian was kept in Demao Fruits and Vegetable Frozen Warehouse located in Donguan, Shenzhen. The process of filling the storage rack with the frozen whole durian took approximately 1 – 2 days in the warehouse. The frozen whole durian was subsequently distributed to fresh fruit chain stores known as 'Zhen Yin Yuen Xing Frozen Shop' in Shenzhen. The frozen whole durian was able to extend the shelf life up to 18 months without deteriorating its quality e.g. original flavor, taste, golden flesh color, and texture. Consumers were still able to enjoy its aroma and taste after 6 hours of defrosting in room temperature or microwave heating accordingly.

Cost collection

Cost estimation for each stage of the supply chain is shown in *Table 1*. Farming cost was estimated based on farm price, transport and workers' salary, RM8.00/kg, combined. The cost for inbound logistics could be calculated by taking the cost of operating a pickup truck (e.g. fuel, maintenance, etc.) plus the driver's salary, RM0.50/kg. The pickup truck could be fully loaded with approximately 90 kg of durian, equivalent to 60 fruits with an average weight of 1.50 kg/fruit. The processing cost included wage, post-harvest and cryogenic treatment, utility (e.g. water and electricity), and packaging. A fully loaded 40-ft container for export would hold approximately 1,140 frozen whole durians. Thus, the processing cost for the same container was estimated at RM10.50/kg or RM17,850/container.

Next, the cost of outbound logistics was estimated at RM8.50/kg or RM14,535 per load. The cost included cold storage warehousing, damage, transportation, insurance, taxes, and administrative charges for both exporter and importer. The retail cost for the two-tier supply (inclusive wholesalers and retailers) was

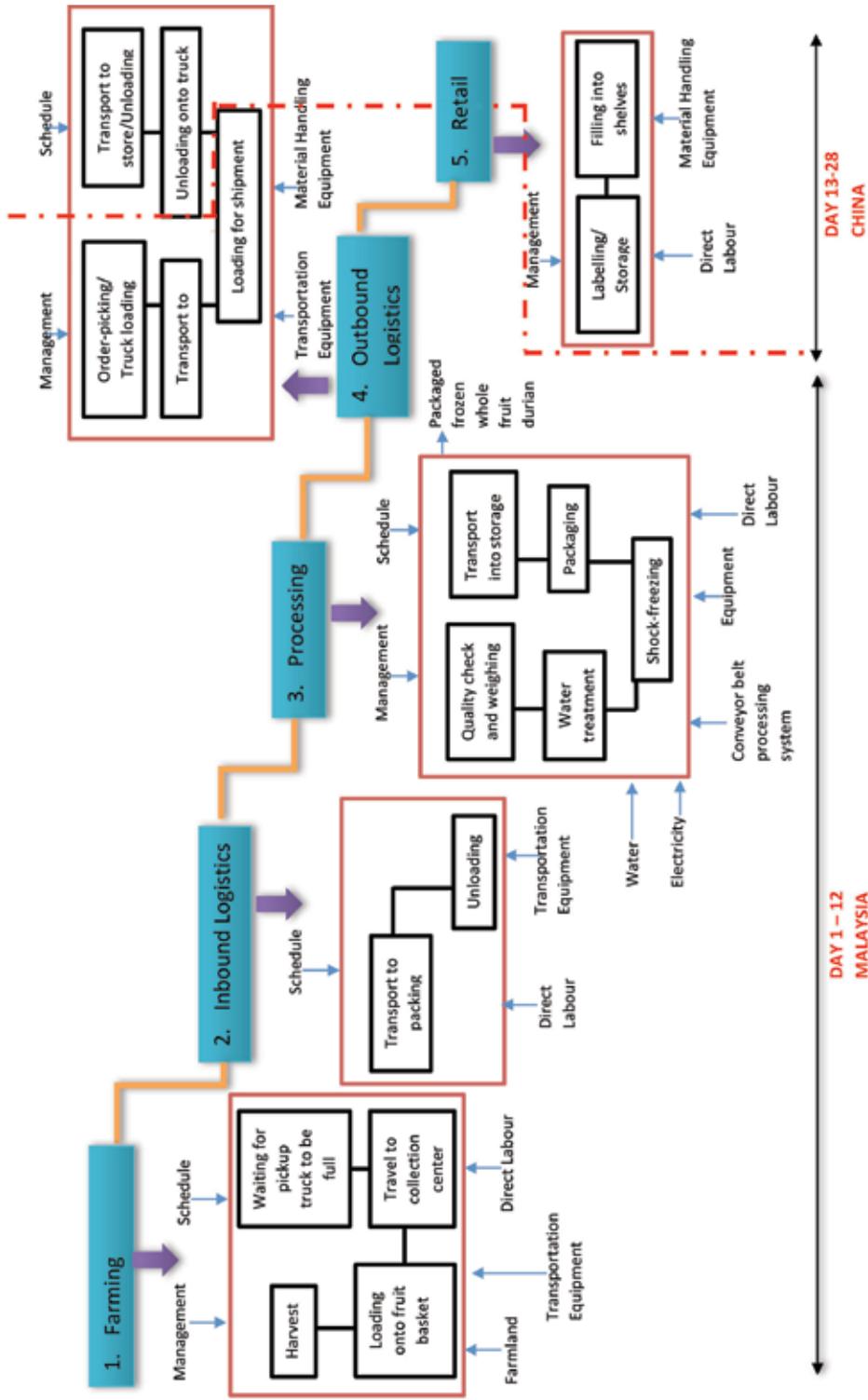


Figure 5. Process map of frozen whole durian from farm to retail

Table 1. Cost estimation (RM) for exporting frozen whole durian from Malaysia to China

Activity	Cost (RM)	Percentage (%)
1 Farming	RM8.00/kg	24.2
2 Inbound Logistics	RM0.50/kg @ RM45/load *A fully-loaded pickup contains 90 kg or 60 durians. **Average weight of fruit is 1.5 kg.	1.5
3 Processing Packaging Cold Storage	RM10.50/kg @ RM17,850/load *A fully-loaded 40-ft container contains 1,140 frozen whole durians.	31.8
4 Outbound Logistics	RM8.50/kg @ RM14,535 per load *Inclusive transport to port, export charge, export logistics, Delivered Duty Charge and VAT (9%)	25.8
5 Retail (Wholesaler and Retailer)	RM5/kg (Wholesaler) and RM6 (Retailer)	16.7
TOTAL	RM33.00	100.0

Note: VAT – Value-Added Tax; kg – kilograms; RM – Ringgit Malaysia; ft - foot

purely an estimation of resources (e.g. labor and electricity) and indirect cost (e.g. management and equipment maintenance) which was approximately RM5.00/kg at wholesaler level and RM6.00/kg at retail level. It is noteworthy to recognize that these estimated figures were contributed and jointly validated by the individuals who were involved in the entire supply chain activities. Despite the estimation, the figures relatively provide a fair baseline and useful insights for determining supply chain costing in exporting frozen whole durian from Malaysia to China.

Time-based analysis

Figure 6 shows the amount of time taken on all activities as indicated in the process map. This study found that the entire supply chain of frozen whole durian export took almost 26 days i.e. 12 days in Malaysia and another 14 days in China. In other words, the Malaysian durian sold for export market in China would possibly arrive at the Chinese fresh fruit markets after 28 days of farming, inbound logistics, processing, freezing, packaging, cold storage, outbound logistics, and retail (inclusive wholesalers and retailers) combined. Of these, farming and inbound logistics took a shorter time as

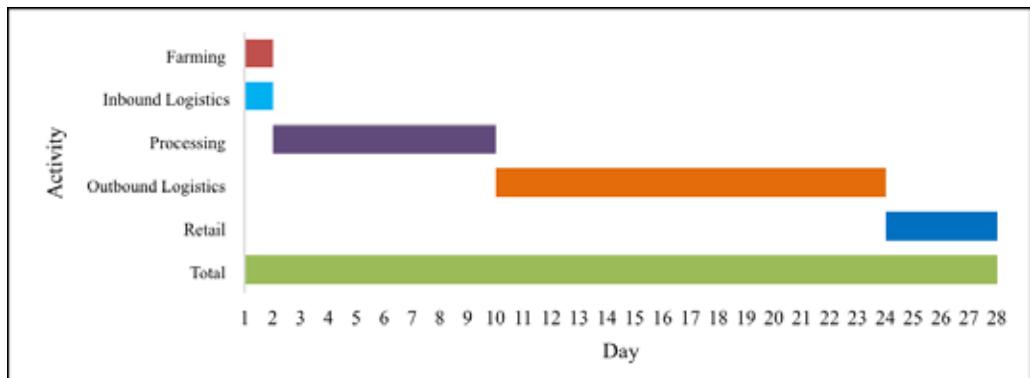


Figure 6. Amount of time taken by all activities for exporting frozen whole durian from Malaysia to China

both activities occurred at the same place starting from the fruit collection in the farm on the first day. For quality and safety reasons, the fruits must be sourced from the durian farms registered with the Department of Agriculture (DOA) Malaysia, accredited with Malaysian Good Agricultural Practices (MyGAP) and implemented the Integrated Pest Management (IPM).

These conditions would require the ripe fruits to fall on the netting, which was mounted slightly above the ground where the durian trees were grown. The fruits should not be in contact with soil and plant debris nor can it be damaged or bruised during harvest and post-harvest treatment.

Based on Figure 6, this study found that outbound logistics spent the most amount of time, thus, a critical node in the supply chain. Refrigerated container, also known as reefer, was used to maintain the required temperature for the frozen whole durian. During the entire sea voyage period (i.e. 10 – 11 days), the appointed sea freight company was responsible for ensuring that the container safely arrived at Guangzhou Port before transporting it to the warehouse located in Shenzhen, which was approximately 150 km away from the port. The distribution centre known as *Zhen Yin Yuen Xing* Frozen Shop (ZYYX Frozen Shop) was located in the city centre of southern Mainland China. The ZYYX Frozen Shop was also a distributor for

Pagoda. Being a large-scale fruit chain store, Pagoda had 4,500 outlets across China. At Pagoda, the frozen whole durian must be stored and retained at -18°C or below to maintain fruit quality (e.g. aroma, taste, colour and texture). Otherwise, the quality would likely deteriorate.

Cost Translation Matrix

Cost translation matrix aims to convert the estimated cost into a format that allows the cost of each supply chain activity is estimated. *Table 2* summarizes the breakdown of estimated costs for exporting one frozen whole durian from Malaysia to China.

Based on *Table 2*, farming, inbound logistics and retail can be assumed as operating with minimal cost. The high cost was largely accumulated in the processing and outbound logistics. In the processing stage, the cost of RM10.50/kg accounted for direct and indirect costs, such as utility, water and electricity, labour, equipment maintenance, and management. Besides that, usage of nitrogen gas for cryogenic freezing treatment costed the highest which was almost 23% or RM 2.40/kg. For every 1.5 kg fruit, nitrogen gas required to freeze the fruit cryogenically costed approximately RM3.60.

Besides that, packaging incurred high cost after usage of nitrogen gas due to the vacuum packaging requirement for

Table 2. Breakdown of estimated costs for exporting one frozen whole durian from Malaysia to China

Item	Cost (RM/kg)	Percentage (%)
1. Nitrogen gas	2.40	22.9
2. Packaging	2.20	21.0
3. Machinery & equipment maintenance	2.00	19.0
4. Wages	1.75	16.7
5. Transportation maintenance	1.20	11.4
6. Utility (e.g. electricity and water)	0.40	3.8
7. Rental of ISO tank	0.35	3.3
8. Administrative work	0.20	1.9
TOTAL	10.50	100.0

export. The vacuum packaging costs RM 2.20/fruit. Next, machinery and equipment cost constituted 19% of the total cost. As a Good Manufacturing Practice (GMP)-accredited factory, all machines must be maintained periodically to operate optimally. Maintenance cost was projected at 5% in every financial year.

In addition to that, outbound logistics also incurred a substantial cost in the export supply chain. The estimated cost of outbound logistics was approximately RM8.50/kg. The cost of outbound logistics stemmed from two different types of price: (1) Freight on Board (FOB); and (2) Cost in Freight (CIF). FOB occurred when the shipment reached the port or other facility designated as the point of origin i.e. Klang Port, Malaysia whereas CIF was until the good reached the port of destination chosen

by the buyer i.e Port arrival in China. All costs would be absorbed by the retailers and subsequently reflected in the final price paid by the consumers.

Cost-Time Analysis

Cost-time analysis intends to explore the relationship between two factors (i.e. cost and time) of the supply chain, allowing us to determine efficiency of the supply chain. A graphical illustration is used to examine both factors in percentage. The Cost/Time Profile refers to a graph that compares cumulative time against cumulative cost for the supply chain process. This graphical representation is designed to highlight areas of opportunity for time and cost savings. Figure 7 illustrates the cumulative cost and time in percentage and graph.

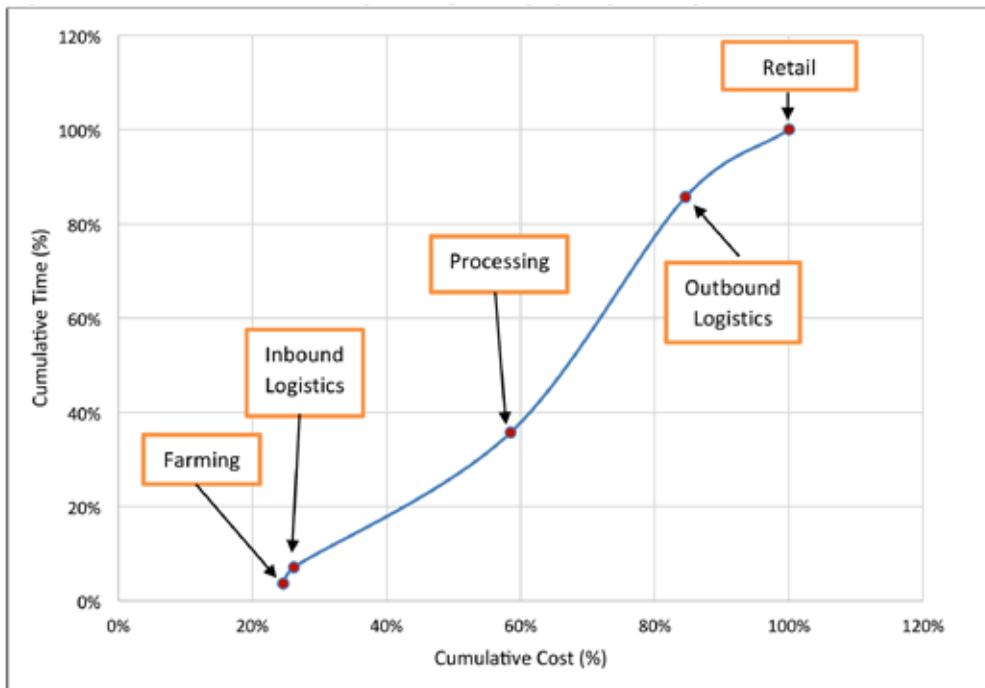


Figure 7. Cumulative cost and time in percentages and graph in percentage

Activity	Farming	Inbound Logistics	Processing	Outbound Logistics	Retail
Cumulative Cost (%)	24.2	25.7	57.5	83.3	100.0
Cumulative Time (%)	3.6	7.1	35.7	85.7	100.0

Based on *Figure 7*, this study revealed that processing and outbound logistics spent the largest amount of time, thus they were considered as the critical nodes in the supply chain. Nevertheless, farming and inbound logistics were relatively less critical. Processing frozen whole durian took up to eight days while outbound logistics for shipping the frozen whole durian from Malaysia to China took up to 14 days (until custom clearance), respectively. In short, both processing and outbound logistics spent the longest time and incurred the highest cost for exporting frozen whole durian from Malaysia to China.

Scenario evaluation

As previously mentioned, processing and outbound logistics were found as critical nodes in the frozen whole durian export supply chain from Malaysia to China. They play important roles in ensuring the functionality of the supply chain and have significant impacts on export businesses.

Farming and inbound logistics only accounted for approximately 3.6% and 3.5% of total time, respectively. These imply that farming and inbound logistics are not high-priority areas in the supply chain. In the farming stage, activities such as fruit collection, loading onto and unloading from pickup truck constituted an insignificant fraction of time.

In the processing stage, the time-based process map showed that it spent 28.6% of the total time. Processing of frozen whole durian began with sorting, followed by cryogenic freezing, and ended with vacuum packaging. These activities were integrated and automated by using conveyor-belt production system continuous sequence without interruptions or delays. As long as the farm bears its fruits, the automated operation will continue running accordingly. Cold storage follows as soon as freezing completes.

Processing incurred 31.8% of the total cost. As previously mentioned, nitrogen gas was used to freeze the whole durian cryogenically, incurring 23% of the total cost. The cost of nitrogen gas greatly depends on the gas suppliers and the number of local companies investing in high technologies. Thus far, this is the most practical technique for freezing the whole durian prior to exporting to China. Apart from freezing, vacuum packaging incurred almost 21.0% of the total cost. Vacuum packaging is used to maintain fruit quality and to prevent it from high water loss and foul odour.

Next, the cost-time analysis revealed that outbound logistics constituted almost half of the total time. This is where a good bilateral relationship between Malaysia and China, especially in promoting more efficient logistics, plays an important role in trade facilitation and trading across borders. In Malaysia, movement of goods between factories to port of discharge is generally handled by the appointed freight forwarders. Sea freight transportation occasionally renders the delivery of goods to the importing country to be considerably long in duration. Delays in the delivery may arise from any unheralded situations, such as weather conditions (e.g. storm) or technical glitch, which may inflict unfavourable financial burden upon the exporters. Approval and clearance by port authorities and customs at the entry points are extremely crucial as these would determine the onward movement of goods to the wholesalers and retailers. Well-planned refrigerated logistics, warehouse storage, and retail equipment would loosen up the bottlenecks and improve the process more efficiently. Frozen whole durian can be stored for a longer period of time. Therefore, when distributing the frozen whole durian to ZYYX Frozen Shop, experienced workers should be tasked to fill in the cold storage shelves with the frozen whole durian before the customers arrive.

Challenges and opportunities

Malaysian frozen whole durian industry and exportation of frozen whole durian to China are still at the infancy stage compared to Thailand as the world's largest durian exporter for decades. Challenges in exporting durian to China are abundant, especially in complying with the sanitary and phytosanitary (SPS) measures, stringent tariff rate, quota and other non-tariff measures (e.g. trademark, copyright and patent protection).

As mandated in the quarantine protocol, durian destined for export must be harvested from farms registered with DOA Malaysia and fulfill the MyGAP standards as established in the Codex Alimentarius Commission, specifically CODEX STAN 317-2014 (FAO 2014). For frozen whole durian, the processing facility must be registered with DOA and certified with Good Manufacturing Practice (GMP). Finally, the facility must pass requirements and inspection from the GACC.

In terms of import duty, China imposes high tariff on the imported durian product to the country. As of 2016, an import duty is levied on exported fresh durian and pulp/paste to China. An import duty rate of 20% at Normal Trade Relations (NTR) is imposed on the World Trade Organization (WTO) members. However, only 15% at NTR is imposed on the WTO members for exporting frozen whole durian (General Administration of Quality Supervision, Inspection and Quarantine 2016).

Malaysia has been a WTO member since 1995. In certain conditions, it is challenging and burdensome for industry players to fulfill the market conditions, especially in complying with the SPS measures. As such, a new or increased risk from pest or disease or other food safety or quality may lose the market access and trade. Any disruption to trade can leave exporters vulnerable if they do not have established commercial links to other available markets.

Another challenge observed is poor cold chain infrastructure in China. Whole frozen durian requires a robust cold chain infrastructure along the supply chain. The infrastructure involves refrigerated warehouses, refrigerated transportation and refrigerated equipment during the journey, producers, exporters, importers, wholesalers and retailers. However, cold chain infrastructure outside major cities and import hubs in China remains underdeveloped where most of China's advanced cold chain transportation is located (PMA 2016). Although air freight cold logistics is currently available from Malaysia to China and it saves almost half of the delivery time, refrigerated freight transportation is nevertheless more practical and economical to use.

Due to growing awareness and concern for food safety and quality issues, China has begun regulating and promoting cold chain infrastructure development plan until 2020. This is important for the industry to ensure that the fruit quality is maintained in the required cold condition and to retain product shelf life from deteriorating.

Chinese consumption is forecasted to rapidly grow and remain robust. Rising disposable income, changing lifestyle and consumer preferences lead to higher consumption of tropical fruits. In China, Musang King Malaysia is sold at premium price when compared to Thai varieties (e.g. Monthong) across wholesaler market (ChinaAg 2017). Malaysian durian is considered to be of higher quality (and better tasting) than Thai durian.

In addition to that, the current trend in China has become increasingly popular to give well-packaged imported fruits as gifts during holidays (China Yangling Agricultural Exchange 2016). Thus, it represents a unique market avenue to introduce the Malaysian frozen whole durian to the new consumers in China. Malaysian Maybank Investment Bank in Xinhua reported that durian cultivation is targeted to be potentially generate nine (9) times

more revenue compared to oil palm on a per hectare basis while generating Earnings Before Interest and Taxes (EBIT) margin an excess of 50 per cent. Considering the rising consumption and prices for domestic and export market, there is an immense opportunity for Malaysia to increase the market share. Realising the significant growth potential, the Ministry of Agriculture and Food Industries Malaysia has provided immense support for the large-scale farming of durian, hoping to achieve 50 per cent jump in export by 2030, thereby boosting the country's declining agricultural industry (The Business Times, 2019).

Other than physical market, China has also seen a rapid development in the virtual marketplaces. Major online retailers, such as Alibaba, Taobao, Tmall, Jindong, Yihadoan, and Womai provide food and beverage platform for online shopping (EU SME Centre 2015). Other than that, digital marketing through social media is also increasingly popular in China. Despite China's telecommunication and network security protocol over Western-born social media platforms (e.g. Twitter, Facebook, and YouTube), there are other equivalent social media applications in China, such as RenRen (similar to Facebook), Weibo (micro-blogging site akin to Twitter), WeChat and Youku (similar to YouTube). These applications are widely used among the Chinese consumers (Gemma 2013) to buy various products online. Realising the opportunities in the virtual marketplace, Malaysian durian producers are encouraged to market their produce through these virtual marketplaces to reach out to more Chinese consumers.

Recommendation and strategy

Supply chain integration

For an efficient export supply chain of frozen whole durian, the main strategy is to integrate and manage all activities with trust. According to Tarek (2006), as cited in Taylor (2006), establishment of a dedicated value stream with commitment of supply

chain partners to work together over an indefinite period is a necessary pre-requisite to a significant supply chain improvement as it establishes a basis from which other lean improvement strategies could be adopted. As mentioned earlier, frozen whole durian requires cold chain infrastructure which consists of refrigerated logistics, storage, and equipment. Close collaboration and cross-functional team in the supply side will necessitate significant investment of time and money. Trust is the key element to a successful supply chain relationship. However, building trust is a long-term process, requiring a substantial amount of time spent on interactions between the individual companies. In fostering and galvanizing the trust, mutual linkage between managers at farm and processing facility must be established. This would help producers develop important key performance indicators (KPI) and lay out clear agreement and commitment among the managers in the supply chain.

Building networks and strengthening bilateral trade between Malaysia and China are crucial to avoid poor product handling, processing, cold chain management, and retail execution. As refrigerated infrastructure is one of the important elements in ensuring the quality of frozen whole durian, Malaysian exporters are suggested to forge partnership with established export specialists, international retail chains (e.g. Walmart, Carrefour, China Resources Vanguard (CRV)), and fruit retailers (e.g. Pagoda). Both strategies would expedite integration of the supply chain of frozen whole durian, thereby mitigating the risks of navigating China market.

Despite the above strategies, it is already known that China imposes stringent laws and protocols in enforcing trade regulations. Strong support and constant effort from exporters and government are needed to keep close with General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ), its exports,

and other Chinese customs officials for a beneficial trade relationship in the future. Likewise, this case study has observed that exporters have been accompanied by ZYYX Frozen Shop, which is one of the distributors for Pagoda in the southern Mainland China. At present, Pagoda has 4,500 outlet-stores across China and it owns an online platform, known as Pagoda Xinxiang (a mini-program within WeChat), for selling fresh food (Cheng 2019). Overall, the integration of supply chain activities offers enormous cost-saving benefits, an efficient supply chain, and elimination of waste.

Conclusion

The goal of this paper was to gain better understanding in the export supply chain of frozen whole durian from Malaysia to China following the new export protocol recently signed between the two countries. The frozen whole durian export supply chain from Malaysia to China began with farming, inbound logistics, processing, outbound logistics and retail. Processing involved cleaning, drying, cryogenic freezing, and packaging. Based on the SCCMT, this study found that the total duration taken to complete all stages in the supply chain was 28 days. Processing and outbound logistics were the critical nodes in the export supply chain. Both stages spent the most amount of time and incurred the highest cost in the entire supply chain. Long duration and high cost of processing were attributable to the usage of nitrogen gas for cryogenic freezing of whole durian, vacuum packaging technology, and machinery and equipment maintenance. In terms of outbound logistics, sea freight voyage took about 10-11 days to reach the port of China. The distribution of frozen whole durian to the wholesalers and retailers relied on the approvals and clearance from the port authorities and customs in China.

Durian market to China is predicted to increase significantly in new future due to the rising of disposable income, lifestyle and preference among Chinese. This

represents good avenue for the Malaysian frozen whole durian as well as pulp and paste. Durian plantation has become the next profitable investment in Malaysia for about 50% margin excess compared to oil palm plantation. Among the challenges identified in the frozen whole durian export supply chain are complying with stringent trade protocol enforced by China e.g. SPS requirements, high tariff rate and other non-tariff measures and local requirements for registering with DOA; getting MyGAP certification for farms and GMP certification for processing facility; the delay in delivery of container to the importing country; and the lack of cold storage infrastructure in southern Mainland China.

In view of vast opportunities arising from the new protocol, supply chain integration is highly anticipated for a more efficient functionality of supply chain. All stages are integrated through the establishment of cross-functional working team with trust and full commitment. Next, the Malaysian exporters are encouraged to consider forging partnerships with export specialists and international chain stores, domestically and abroad. On top of accessing physical market in China, the exporters are encouraged to market their frozen whole durian via virtual marketplaces. In the long run, Malaysia and China would enjoy substantial bilateral trade benefits by reducing unnecessary regulatory burden for trading across borders.

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Abstrak

Malaysia telah menikmati pertumbuhan eksport pulpa dan isi durian sejuk beku dengan pesat bermula selepas mendapat akses pasaran ke China pada tahun 2011. Pada tahun 2018, protokol baru eksport bagi durian sejuk beku dalam bentuk biji telah dimuktamadkan dan ditandatangani antara Malaysia dan China. Protokol ini menyediakan peluang pasaran yang terjamin bagi durian sejuk beku dalam bentuk biji dengan menjadikan Malaysia sebagai negara perdagangan penting China. Namun, kefahaman terhadap protokol baru ini timbul dalam kalangan pengeksport durian Malaysia dalam memahami rantaian bekalan ke China. Oleh itu, bagi memahami rantaian bekalan eksport ini, adalah mustahak untuk membuat keputusan yang tepat. Justeru, kajian kes rantaian bekalan eksport durian sejuk beku dari ladang Malaysia ke peruncit di Shenzhen, China telah dijalankan dan dianalisis menggunakan Kit Rangkaian Bekalan dan Pemetaan Kos (SCCMT). Kajian ini menunjukkan pemprosesan dan logistik keluar adalah nod yang sangat penting dalam rantaian bekalan eksport durian sejuk beku dalam bentuk biji. Kedua-dua peringkat menggunakan masa yang paling banyak dan mempunyai pecahan kos tertinggi dalam gabungan rantaian bekalan. Semua peringkat perlu bersatu melalui persepakatan satu pasukan yang berfungsi penuh dengan kepercayaan dan komitmen. Secara keseluruhannya, kajian kes ini diharapkan dapat mendorong lonjakan eksport durian Malaysia pada masa depan.