

## **The preferences towards local and imported matured coconut using the Delphi and AHP approach**

(Kecenderungan terhadap penggunaan kelapa tua tempatan dan import menggunakan pendekatan Delphi dan AHP)

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Keywords: Analytical Hierarchy Process, coconut, Delphi technique, multicriteria decision making

### **Abstract**

The purpose of this paper is to demonstrate the application of the Delphi technique and the Analytical Hierarchy Process (AHP) in the selection of local or imported matured coconut which is considered important to help coconut processors decide on suitability for venture. A total of 34 coconut processing entrepreneurs were selected as respondents. The Delphi research identified 30 criteria that could influence the choice of a mature coconut. Using two rounds of the Delphi technique, the 30 criterias were consolidated into nine criteria that influenced decision-making regarding mature coconut selection, namely minimal damage rate, consistent delivery, easy purchasing arrangement, fast delivery, low price, meat thickness, fatty flesh, big sized nut and high volume of coconut water. When comparing imported and local coconuts using AHP technology, entrepreneurs are more likely to choose imported coconuts with a weight score of 56.9% than local coconuts with a weight score of 43.1%. The results of this study can be used as a baseline information for industry players to understand the preference of coconut entrepreneurs over factors that choosing local and imported mature coconut. In addition, the information can also be used as a reference to formulate strategies to develop the coconut industry in Malaysia and further strengthen the implementation of the national coconut industry program.

### **Introduction**

The national demand for coconut products is increasing every year. From 2016 to 2021, Malaysia imported an average of 223,434 tonnes of fresh coconut annually (DOSM 2022). As the oldest industrial crop in Malaysia, the coconut industry contributed up to RM72.8 million or 0.06% to Malaysia's agricultural export earnings in 2020 (DOSM 2021). In 2020, the export value of coconut products valued at RM1.14 billion increased by 32.4% compared to the export value of RM873 million in 2015, while the import value of coconut products

rose from RM979 million (2015) to RM1.3 billion in 2020 (DOA 2021). This increasing trend is in line with the increase in the import of mature coconut, which is used as the main source to manufacture these products. Demand for imported mature coconuts increased due to insufficient local coconut supply, which could not meet demand from the coconut processing industry.

The increasing demand from the industry also affects the increase in the number of importers of mature coconuts.

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In 2017, a total of 21 companies received permits to import mature coconuts and the number of importers increased to 35 in 2022. In addition, Malaysia only imports mature coconuts from Indonesia, as shipments from several neighbouring countries like the Philippines are prohibited due to disease transmission factors. Thailand does not export its coconut as it is primarily sufficient for the local needs alone.

In 2018, some local media reported on the issue of the glut of mature coconuts in coconut plantations. Coconut farmers claim that this situation is due to the abundance of imported coconuts, while product operators claim the local coconut supply is insufficient, leading to mature coconuts being imported (Mohd Hafizudin 2018). Does the industry lean towards imported mature coconuts rather than domestic coconuts? What are the factors that the coconut processing industry to choose between imported coconut or local coconut in product processing? Is it true that domestic coconuts are better quality than imported coconuts? Therefore, a study was conducted to identify the preferences of coconut processors towards local and imported mature coconuts. In addition, this study will identify the factors that influence the preference of coconut processors to choose suitable coconuts for processing.

### **Literature review**

Decision-making is the study of identifying and choosing alternatives based on the values and preferences of the decision-maker. Making a decision implies that there are alternative choices to be considered. In such a case, we want to identify these alternatives as well as to choose the ones that best fit our goals, criteria, objectives, desires and values (Harris 2002). When we have alternatives or criteria, it should be related to the selection process to make perfect decisions. Saaty (2006) stated that alternatives and criteria are important elements for the setup of any selection in decision making. There are several scientific

methods to develop criteria such as Delphi method and Factor analysis.

The Delphi method was used to gather the opinion of experts through a structured questionnaire. It was developed by Dalkey and Helmer (1963) at the Rank Corporation for military decision purposes. It was used to determine the running of the nuclear war in the 1950s (Kahn and Herman 1965). This technique was widely used to generate forecasts in technology, education and other related fields (Cornish 1977). It was designed as a combination of group ideas and it was also a group communication process that was aimed at addressing specific issues or problems. A series of questionnaires were sent to selected respondents (the Delphi group) through a facilitator who oversees the responses of their panel of experts. The group does not meet face-to-face. All communications are normally in writing (letters or emails) and surveys. Members of the groups are selected based on their expertise or they have relevant information to be considered (Armstrong 2001).

Luzon and El-Sayegh (2016) identified supplier selection criteria for oil and gas projects in UAE using the Delphi method. They stated the top ten criteria using this method to two main groups, each consisting of five selection factors. Group one includes technical and commercial aspects, which include delivery, claims, price, service and warranties and quality. Group two is company-related aspects, which include the financial position, technical capability, production, facility and capability, performance history and geographical location. Chen et al. (2013) used the Delphi method to list down possible criteria to identify the content and priorities of health professional education in child abuse by integrating expert opinions and achieving consensus. A three-round Delphi study was conducted with 25 multidisciplinary experts in health care, social welfare, psychology and counselling, law and jurisdiction.

They found several criteria such as the importance of knowledge, subjective norms, attitudes, skills, team collaboration and teaching strategies.

The Analytic Hierarchy Process (AHP) model, developed by Saaty (1980), has been used to obtain a ratio scale of importance for  $n$  alternatives or options. The AHP has been very successful in gaining the acceptance of practitioners, possibly owing to the helpfulness of the hierarchy problem representations and the appeal of pairwise comparisons in option elicitation (Buede 1992). This approach is an effective tool for achieving consensus in group decisions (Bahurmoz 2003). The basic principle of the procedure involves setting up a matrix consisting of observations or judgments based on pairwise comparisons of the relative importance between and among the elements (Mendoza and Sprouse 1989).

In the analytic hierarchy process, the alternatives or in this case, two types of coconut were used as alternatives valued between 1 (denoting equal importance) and 9 (denoting absolute importance) depending on the preference of the decision-makers. According to the procedure, there are nine levels of alternatives or importance. In pairwise comparison, the alternative might be equally, weakly, strongly, very strongly and absolutely more important. The alternatives as indicated by Saaty (1980), will receive a value between 1 (equally preferred) and 9 (extremely preferred) depending on the preference of decision makers. The value between 1 and 9 shows the different degrees of importance from equal to extreme by using the relative scale measurement. This discretised ratio scale such as the one to nine scales of the AHP can be very helpful in preference elicitation.

Azizi et al. (2016) developed a rating model using AHP for the selection of solar wood drying locations. They identified five main criteria such as rules and regulations, economics, human and technique, material and products and infrastructure. 12 sub-criteria had been identified in this study and

nine locations had been recognised as an alternative for solar wood drying locations. All criteria were analysed using the AHP technique and packed as a criteria model for the selection of solar wood drying location.

Kim et al. (2016) implemented the AHP technique in developing a decision support model for a high-performance computing system selection for computational science. They examined three infrastructures for scientific research through literature reviews, factors to be considered from a scientist's point of view and then introduced AHP as an approach for choosing a proper infrastructure. They proposed a model that has an appropriate infrastructure selection reflecting various aspects of computational science's properties via AHP. Three criteria that had been considered in their study were on the aspect of the economy, operations and technology. Under three aspects, Kim et al. listed 15 sub-criteria that have been used to consider high-performance computing system selection. All criteria and sub-criteria in their study were packed as a decision-support model.

### **Materials and methods**

The study involved two phases. The first phase is determining the selection criteria categories of imported and local mature coconuts. Collecting information and data involves experts in various aspects of coconut production, marketing knowledge and experience in the coconut industry. All respondents were allowed to list as many coconut selection criteria as possible. The data collection technique used the Delphi technique through an open-ended questionnaire. The results from the first phase will be used as constructs, and criteria dimensions will be used for designing the questionnaire in the second phase. This questionnaire uses a pairwise comparison design to suit the AHP analysis.

The questionnaire was divided into two parts. The first section covers paired comparisons for coconut selection criteria

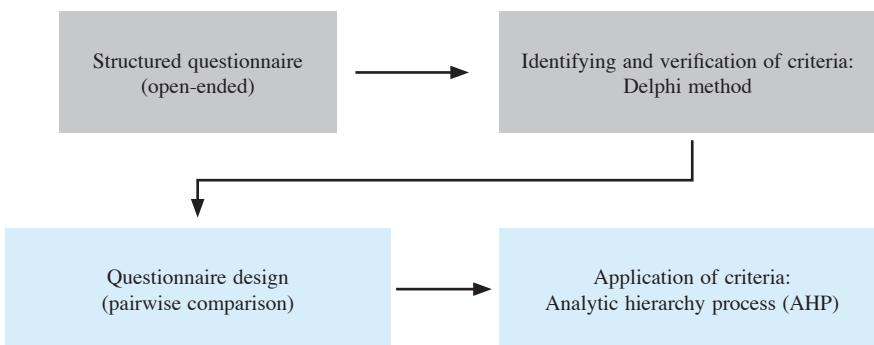
and the second is a paired comparison between coconut types and coconut selection criteria. The preparation of questionnaires for this AHP technique used an online medium through the Business Performance Management Singapore (BPMSG) system. This phase is used to apply the criteria model to select or place the best coconut, which is the tendency of entrepreneurs. This phase uses AHP as an analytical tool to analyse the data obtained from the first phase. *Figure 1* below shows the analytical framework of this study.

Data collection began with obtaining consent from prospective respondents to participate in the study. Eight out of ten coconut-based product entrepreneurs agreed to cooperate in this study. The respondents consisted of eight coconut-based product processing operators with more than five years of experience in the industry. Eight respondents were considered sufficient to obtain the required results using this method. Williams and Webb (1994) mentioned that there was no specific mechanism for identifying the number of experts or panels using this technique. Determination of panel size can be made according to the nature of the topic or research such as the availability of time and funds (Van Zolingen and Klaassen 2003). However, Akins et al. (2005) mentioned that the sample size for Delphi studies varied depending on the research topic and the specific situation. For example, Lam et al. (2000) used three experts involving three panels. Skulmoski

and Hartman (2007) listed some literature with appropriate sample size and that the minimum number of respondents was three, while the highest was 171. *Table 1* shows several literature sources using the Delphi method with the corresponding number of sample sizes.

Interviews were conducted face-to-face with the respondents, while telephone interviews and video call platforms were conducted with those who could not attend the physical interview. Two rounds of data collection was carried out to ensure the validity of the data. In the first round of the Delphi technique, a questionnaire was sent to the entrepreneurs who had agreed to participate. An inductive approach is used where entrepreneurs are invited to generate ideas and given the freedom to respond. All respondents were allowed to list coconut selection criteria as much as possible.

All the criteria listed by the respondents in the first round of survey were arranged into a spreadsheet according to the group of criteria. This was then sent back to the same respondents for the process of confirming their consent in the second round survey. Feedback from the second round was analysed using descriptive analysis to determine criterion consensus and relative importance for each item based on participant responses. The second round consensus results were then evaluated, corrected and used for the second phase of data collection using the AHP technique. The survey for the first phase took five



*Figure 1. Study analysis framework*

weeks, of which the first two weeks were for the first round survey, followed by one week for data compilation and the last two weeks for the second round survey.

Thirty four coconut based product entrepreneurs were selected as participants in a survey conducted online and briefed in an online meeting through Google Meet platform. The number of respondents were

sufficient based on literature review. Mitchel and Wasil (1989) had listed several of the studies in which the AHP was applied by Wood Gordon Management in their research with *Table 2* illustrating the sample size for each study. Other literature supporting small sampling were Ruusunen and Hamalainen (1989) with 18 managers, Fatti (1989) with 15 decision-makers, Ehie (1989) with 12

Table 1. Delphi method diversity – published research

Authors	Research	Rounds	Sample sizes
Gustafson et al. (1973)	Estimate almanac events to investigate Delphi accuracy	2	4
Hartman and Baldwin (1995)	Validate research outcomes	1	62
Czinkota and Ronkainen (1997)	Impact analysis of changes to the international business environment	3	34
Kuo and Yu (1999)	Identify national park selection criteria	1	28
Nambisan et al. (1999)	Develop taxonomy of organisational mechanisms	3	6
Lam et al. (2000)	Develop rules for a ceramic casting process	3	3
Roberson et al. (2005)	Examine and explain how recruitment message specificity influences job seeker attraction to organisations	2	171

Source: Adapted from Skulmoski and Hartman (2007)

Table 2. Sample sizes for problem analysed employing AHP by the Wood Gordon Consulting Firm

Client	Problem	Sample size
Government	Evaluate nuclear power options	6
Hospital	Priorities for a renovation project	8
Government	Criteria for selecting contractors	10
School District	Select senior administrator	5
Government	Criteria for contractor selection	3
Hospital	Design a computer for four hospitals	8
Postal Service	Set capital project priorities	60
Government	Develop principles for regulating trucking	30
Hospital	Strategic planning for program specialisation	8
Military	Allocate equipment maintenance to contractors	50
Financial Institution	Select electronic data processing systems	12
Military	Allocate equipment maintenance to contractors	50
Energy Department	Contingency plan for energy shortage	12
Disease Control Agency	Alternative for AIDS response	15

Source: Adapted from Mitchel and Wasil (1989)

World Bank Staff and Beaumariage (1990) with four engineers.

During the session with 34 coconut based product entrepreneurs, the participants were given two links to the BPMSG system. Respondents will fill in this online survey form based on their experience and expertise in choosing the type of mature coconut, local or imported. Upon completion of this questionnaire, researchers can continue to make analyses of the system that has been equipped with AHP technical calculator software. The results of the analysis must comply with the Inconsistency Index (CR) and should be equal to or less than 10% ( $CR \leq 0.1$ ). Larger CR values require decision-makers to review previously made judgments that may result in incorrect judgments.

## Results and discussion

### *Delphi technique*

The Delphi technique is conducted in two rounds. In the first round, data was collected from all these coconut product operators. In the second round, this data will be verified according to a group of criteria that have been compiled by the researcher based on the literature review. The results from this phase will be used as constructs and criteria dimensions for AHP. *Table 3* shows the criteria collected in the first round of Delphi.

The results of the first round criteria listing are then grouped by class or group based on the similarity of sentence content and citation. The distribution of the selection criteria groups is shown in *Figure 2*.

In the second round of the Delphi technique, the recommendations from the first round are then sent back to the same industry operators to assess the agreement as to whether the criteria fit in the group or otherwise. Finally, some criteria were dropped if the consensus value was below 35% (Maite 2021) and some criteria were split into two groups with the respondents' suggestions. Finally, as a result of this Delphi technique, the results obtained as many as nine large groups of criteria that

Table 3. List of coconut selection criteria in the first round of Delphi

Criteria and items	First round: suggestion % (n = 8)
High fat	100 (8)
Heavy	100 (8)
Cheap	100 (8)
The white colour of the flesh	75 (6)
Flesh not too thin	75 (6)
Big shell	75 (6)
Not too expensive	75 (6)
Supply was sufficient	75 (6)
Just in time (JIT) concept	75 (6)
No bureaucracy	75 (6)
Long life span	75 (6)
Less damaged	63 (5)
Grade A and B	50 (4)
Affordable price	50 (4)
Consistent stock	50 (4)
Not easily damaged	50 (4)
A high volume of water	38 (3)
Have a coconut water	38 (3)
No need to apply for an AP	38 (3)
Deal directly with a producer	38 (3)
More flesh	25 (2)
Always available coconut	25 (2)
Available when needed	25 (2)
Supply is not delay	25 (2)
There is a coir crest	25 (2)
The flesh is not mushy	13 (1)
Weighs 2 kg or more	13 (1)
Flavoured water	13 (1)
Just order and it will arrive quickly	13 (1)
95% of the nut volume is good	13 (1)

will be taken to the second phase of the study using the AHP technique. *Figure 3* shows the nine groups of final result criteria from the Delphi technique.

### *AHP technique*

Determination and validation for criterion ranking were carried out with mean scores for criteria ranging between 0 and 1. This

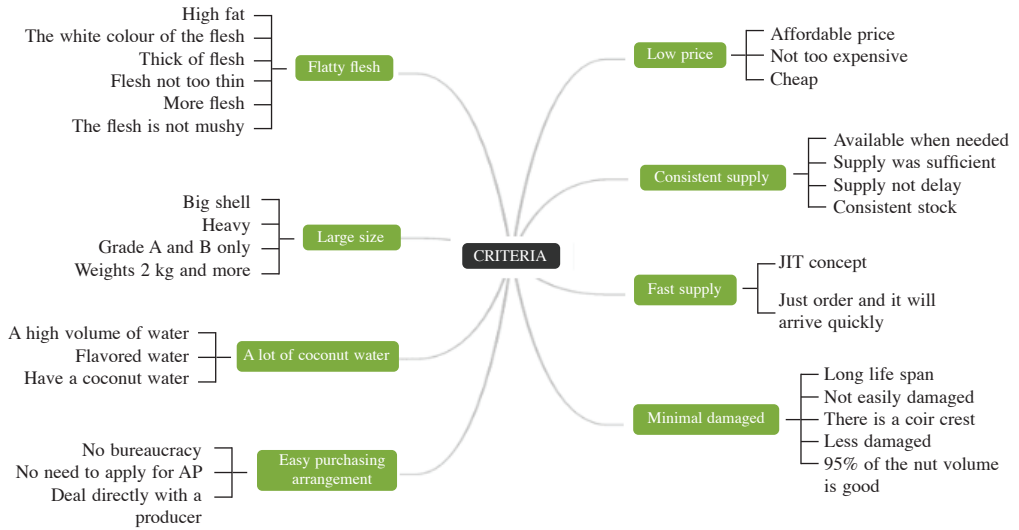


Figure 2. Distribution of criterion groups in the second round of Delphi

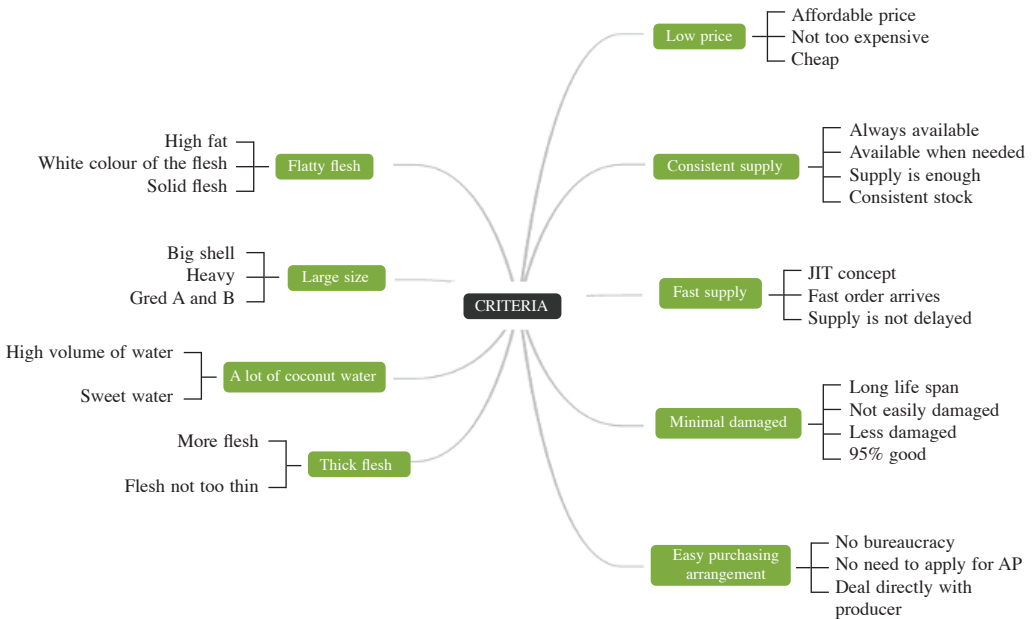


Figure 3. Results of the leading criterion group after two rounds of the Delphi technique

study used aggregated individual preference (AIP) and arithmetic mean (AM) to calculate the weight mean in AHP calculation through the BPMSG system. Table 4 shows that the value of the inconsistency ratio is 0.013, meaning that the results of the AHP analysis are considered acceptable, as stated by Saaty

(2006). He explained that the value of the inconsistent ratio should be less than 0.1 to be considered acceptable. The highest ranking for the criterion in this analysis is 'minimum damage rate', with an average weight of 0.202. Through observations during the survey, most entrepreneurs have



stated that the coconuts received should be in good condition and not damaged. Damage to the coconut will invite losses and additional costs to manage cleaning. The level of damage still accepted by the operator is around 5%. This means that if the operator gets a supply of 1,000 coconuts, then the level of damage that can be received is a maximum of 50 nuts, for which the cost of loss reaches RM45.00. Table 4 shows the result of the AHP analysis using BPMSG.

Two types of mature coconuts are set to see the tendency of entrepreneurs, namely imported coconuts and local coconuts, in terms of selecting mature coconuts, in terms of selecting mature coconuts. Figure 4 shows that imported mature coconuts with a weight average of 0.569 (56.9%) are the choice of entrepreneurs to be used as input for processing coconut based products.

### Conclusion and recommendations

This research provides many good lessons and insights into the coconut industry and supports the decision-making process. The survey fulfilled all objectives of the research. The decisions had been made by coconut processing entrepreneurs to use imported or local mature coconut based on several criteria. The research made use of the Delphi method to identify the selection criteria. The findings indicated 30 sub-criteria which had to be investigated. Group similarity was conducted which elicited the coconut selection that contained nine groups of criteria. The criteria group was used as a guideline while using the AHP technique as a preferred process for the mature coconut based on weight pairwise comparisons. The study also prioritised the ranking criteria between imported or local mature coconut.

Table 4. Result of AHP analysis

Criteria	Priority vector	Ranking
Minimum damage rate	0.202	1
Consistency supply	0.196	2
Easy purchasing arrangement	0.117	3
Fast to supply	0.108	4
Low price	0.105	5
Thick flesh	0.093	6
Fatty flesh	0.079	7
Large size	0.069	8
A lot of coconut water	0.029	9

Inconsistency ratio (CR) = 0.013 = 1.3%

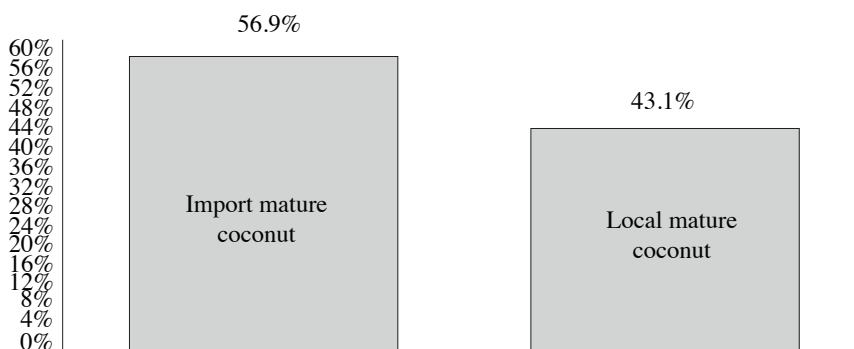


Figure 4. AHP analysis of coconut preference by coconut processing entrepreneurs



Results from AHP showed the criterion ‘minimum damage rate’ as the most important, with the second important criterion, ‘consistency supply’, followed by the third important criterion, ‘easy purchasing arrangement’. Regarding coconut preference, imported coconuts are still the choice for coconut industry players compared to local coconuts. A consistent supply is difficult to be expected even though the quality of local coconuts is higher than imported coconuts. Other criteria considered by coconut processing entrepreneurs are the nut properties such as flesh thickness, fatty flesh, large size and coconut water, but it is not the primary criteria in obtaining coconut supply. Ultimately, they require a consistent supply to ensure the production of coconut-based items would be sustained.

The study’s findings provide several important factors for policy implication especially industry players, including entrepreneurs, policymakers, researchers, government agencies and the private sector. Firstly, the authorities need to ensure that the information of local coconut supply and demand are well received and understood among industry players with efficient post-harvest handling controls so that the quality of the coconut is maintained and does not deteriorate. Secondly, well-planned coconut consistent supply should be initiated. Thirdly, the permission to import coconuts from abroad needs to be coordinated with the expected production of local coconuts so that manufacturers do not face difficulties in getting supplies while at the same time not causing dumping of local coconuts.

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### **Abstrak**

Tujuan kertas kerja ini adalah untuk menunjukkan aplikasi teknik Delphi dan Proses Hierarki Analisis (AHP) dalam pemilihan kelapa tua tempatan dan import yang dianggap penting dalam membantu pemproses kelapa membuat keputusan dalam pemilihan kelapa. Sebanyak 34 orang pemproses kelapa telah dipilih sebagai responden dalam kajian ini. Kaedah Delphi telah mengenal pasti 30 kriteria yang mempengaruhi proses pemilihan kelapa tua. Dengan menggunakan dua pusingan dalam teknik Delphi, 30 kriteria tersebut disusun kepada sembilan kriteria yang mempengaruhi keputusan pemilihan kelapa tua iaitu kadar kerosakan minimum, penghantaran yang konsisten, kaedah pembelian yang mudah, penghantaran yang cepat, harga yang rendah, ketebalan isi kelapa, isi kelapa berlemak, saiz kelapa yang besar dan isipadu air kelapa yang banyak. Perbandingan kelapa import dan kelapa tempatan menggunakan kaedah AHP, keputusan menunjukkan pemproses lebih cenderung memilih kelapa import dengan skor wajaran 56.9% berbanding dengan kelapa tempatan dengan skor wajaran 43.1%. Hasil kajian ini boleh digunakan sebagai maklumat asas untuk pemain industri memahami keutamaan pembuatan keputusan oleh pemproses kelapa berdasarkan faktor pemilihan kelapa tua tempatan dan import. Selain itu, maklumat ini juga boleh dijadikan rujukan untuk merangka strategi memajukan industri kelapa di Malaysia seterusnya memantapkan lagi pelaksanaan program industri kelapa negara.

