UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF HERBAL SELECTION CRITERIA MODEL FOR INVESTMENT AND COMMERCIALIZATION DECISION

MOHD HAFIZUDIN ZAKARIA

FP 2016 31

DEVELOPMENT OF HERBAL SELECTION CRITERIA MODEL FOR INVESTMENT AND COMMERCIALIZATION DECISION

By

MOHD HAFIZUDIN ZAKARIA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the degree of Master of Master of Science

January 2016

Abstract of thesis presented to Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science.

DEVELOPMENT OF HERBAL SELECTION CRITERIA MODEL FOR INVESTMENT AND COMMERCIALIZATION DECISION

By

MOHD HAFIZUDIN ZAKARIA

January 2016

Chairman : Amin Mahir Abdullah, PhD
Faculty : Agriculture

The National Key Economic Area (NKEA) has identified the herbal industry as one of the high value commodities to be further developed in both the production and processing sectors. Various government programs have been implemented to enhance the local herbal industry In Malaysia through the First Entry Point Projects (EPP1). Under NKEA, five herbs have been identified and proposed for commercialization in the industry: Tongkat Ali (*Eurycoma longifolia*), Kacip Fatimah (*Labisia pumila*), Dokong Anak (*Phyllanthus niruri*), Misai Kucing (*Orthosiphon stamineus, Benth*) and Hempedu Bumi (*Andrographis paniculata*). The selection of these herbs was made based on their discovery, agronomy, product development and both pre-clinical and clinical tests undertaken by policy makers and researchers. However, the selection criteria for investors should also consider other criteria such as the economic factors, environment, markets and government policies. Since such selection criteria are currently unavailable, there is a necessity for them to be identified and developed. It is also crucial to identify the order of importance of the identified criteria. The ranking of the criteria will provide an important guide in herbal selection for the decision making process by investors and policy makers. The main objective of this study is to develop the selection criteria for the commercialization of herbs and for investment decision making. This research served as a complement to the current criteria already established by policy makers. The criteria model developed will provide a helpful policy making tool which includes research, economic, environmental and other factors.

This study used primary data which were obtained using purposive sampling whereby the involvement of respondents toward the herbal industry was taken into consideration. Data collection involved three phases of interviews. First, to elicit criteria constructs using the Decision Delphi technique which involved six respondents. The Second phase was carried out by a survey which involved 220 respondents. Finally, the third stage was to rank the herbs identified by the NKEA using the developed criteria in the second phase through a pairwise comparison technique or the Analytic Hierarchy Process (AHP) involving 12 respondents. The respondents for all phases were taken from four different backgrounds consisting of decision makers, researchers, entrepreneurs and

herb cultivators. All the survey processes were carried out by face to face interviews, by telephone and by an online questionnaire using both the open-ended and close-ended structure.

Results from the Decision Delphi Method revealed that there were 29 items of herbal selection criteria identified by all experts. All these items were combined with the criteria from various literatures, and they were then grouped into six main components using the Exploratory Factor Analysis (EFA). The analysis of Analytical Hierarchy Process indicated that the most important selection criterion is “Incentive and Assistance” followed by “Community Welfare” and “Marketability”. Other criteria such as “Research and Development”, “Economic” and “Policy and Regulation” were respectively ranked fourth, fifth and sixth. This meant that incentives and assistance were the most important criteria to encourage entrepreneurs or cultivators for the manufacture of their products. At the same time, these criteria acted as a backbone or a strong supporting factor for researchers to carry out their research in the herbal cluster supported by research grants, awards, promotions, incentives, royalties and others. The outcomes of this study could be considered as futher guideline for decision makers to identify herbs which are to be addressed by the government in the development of strategies to introduce the country’s flagship herbs that will give high returns to the national economy. Other than that, the criteria model that developed will provide a useful decision making tool for herbal entrepreneurs in selecting the most suitable herbs to be cultivated or processed and also could be extend to other crops.

Abstrak tesis yang dikemukakan ini kepada Senat Universiti Putera Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN MODEL KRITERIA PEMILIHAN HERBA UNTUK PEMUTUSAN PELABURAN DAN PENGKOMERSIALAN

Oleh

MOHD HAFIZUDIN ZAKARIA

Januari 2016

Pengerusi : Amin Mahir Abdullah, PhD
Faculty : Agriculture

Bidang Keberhasilan Utama Ekonomi (NKEA) telah mengenal pasti industri herba sebagai salah satu komoditi yang bernilai tinggi untuk dimajukan lagi di dalam sektor pengeluaran dan pemprosesan. Pelbagai program kerajaan telah dilaksanakan untuk meningkatkan lagi industri herba tempatan di Malaysia melalui Projek Permulaan Pertama (EPP1). Di bawah NKEA, lima jenis herba telah dikenal pasti dan dicadangkan kepada industri untuk dikomersialkan seperti Tongkat Ali (*Eurycoma longifolia*), Kacip Fatimah (*Labisia pumila*), Dokong Anak (*Phyllanthus niruri*), Misai Kucing (*Orthosiphon stamineus, Benth*) dan Hempedu Bumi (*Andrographis paniculata*). Pemilihan herba-herba ini dibuat berdasarkan kepada faktor penemuan, agronomi, pembangunan produk serta ujian pra-klinikal dan klinikal yang ditetapkan oleh pembuat dasar. Walau bagaimanapun, kriteria pemilihan bagi seseorang pelabur seharusnya mempertimbangkan kriteria-kriteria lain seperti faktor ekonomi, alam sekitar, kebolehan pasaran dan juga dasar-dasar kerajaan sedia ada. Disebabkan kriteria pemilihan seperti ini tiada buat masa ini maka ia perlu dikenal pasti dan dibangunkan. Selain itu ia penting dibangunkan mengikut keutamaan kriteria yang telah dikenal pasti. Kedudukan keutamaan kriteria ini akan memberi panduan penting dalam pembuatan keputusan pemilihan herba oleh para pelabur dan pembuat dasar. Objektif utama kajian ini adalah untuk mengenal pasti kriteria pemilihan herba dalam mengkomersialkan dan membuat pelaburan dalam industri ini. Kajian ini akan menjadi pelengkap kepada kriteria sedia ada yang dibangunkan oleh pembuat dasar, yang mana model kriteria yang dibangunkan ini akan bertindak sebagai instrumen bantuan dalam pembuatan dasar yang mana akan mempertimbangkan faktor penyelidikan, ekonomi, persekitaran dan lain-lain lagi.

Kajian ini menggunakan data primer menggunakan pensampelan tertuju dengan mempertimbangkan responden yang terlibat di dalam industri herba. Pengumpulan data kajian ini melibatkan tiga fasa soal-selidik. Fasa pertama, untuk mengenal pasti kriteria menggunakan Teknik Pemutusan Delphi yang melibatkan enam orang responden. Fasa Kedua kajian pula melibatkan 220 orang responden. Akhir sekali, di fasa ketiga ialah menentukan kedudukan keutamaan herba yang dikenal pasti oleh NKEA menggunakan kriteria yang

dibangunkan dalam fasa kedua menerusi Teknik Perbandingan Berpasangan atau Proses Hierarki Beranalitik (AHP) yang melibatkan 12 orang responden. Kesemua responden bagi ketiga-tiga fasa ini mempunyai latar belakang yang berbeza yang terdiri daripada pembuat keputusan, penyelidik, usahawan dan petani herba. Kesemua soal-selidik ini dijalankan menerusi temu bual bersemuka, temu bual melalui telefon dan soal selidik di dalam talian dengan menggunakan borang soal selidik berstruktur bersoalan terbuka dan tertutup.

Keputusan kajian daripada Teknik Pemutusan Delphi mendapati 29 item kriteria pemilihan herba telah dikenal pasti oleh semua responden yang ditemu bual. Kesemua item ini kemudiannya digabungkan dengan kriteria dari pelbagai literatur dan dibahagikan kepada enam kriteria utama menggunakan analisis EFA. Kemudiannya, Analisis AHP mendapati kriteria pemilihan yang paling penting ialah "Insentif dan Bantuan" diikuti oleh "Kebajikan Masyarakat" dan "Kebolehan Pasaran". Manakala kriteria lain pula seperti "Penyelidikan dan Pembangunan", "Ekonomi" dan "Polisi dan Peraturan" masing-masing menduduki keutamaan tempat keempat, kelima dan keenam. Ini bermaksud, insentif dan bantuan merupakan kriteria yang paling penting sebagai penggalakan kepada usahawan atau petani dalam menghasilkan produk mereka, pada masa yang sama kriteria ini dianggap sebagai tulang belakang atau sokongan faktor yang kuat kepada penyelidik untuk menjalankan kajian berkaitan herba dengan sokongan geran penyelidikan, anugerah, kenaikan pangkat, insentif, royalti dan sebagainya. Hasil kajian ini boleh dipertimbangkan sebagai panduan untuk pembuat keputusan untuk mengenal pasti herba yang perlu diberi perhatian oleh kerajaan dalam pembangunan strategi untuk memperkenalkan herba utama negara yang akan memberi pulangan yang tinggi kepada ekonomi negara. Selain daripada itu, model kriteria yang dibangunkan ini akan membantu proses pembuatan keputusan yang berguna kepada usahawan herba dalam memilih herba yang paling sesuai untuk ditanam atau diproses dan juga boleh dipanjangkan kepada tanaman lain.

ACKNOWLEDGEMENTS

In the name of Allah, the most gracious, most merciful. All praise to Allah S.W.T who has blessed me with patience, courage and strong will during the course of the preparation of the thesis.

Foremost, I wish to express my gratitude to my supervisor, Assoc. Prof. Dr. Amin Mahir Abdullah for his support and inspiring guidance, who is ever helpful with constructive criticisms and suggestions throughout the preparation of this dissertation and who is always motivating me to continue to improve. I am eternally grateful that I have the opportunity to study under his supervision. Without his support, encouragement, motivation and advice I would not be able to start and finish this dissertation.

I would also like to thank my committee members, Assoc. Prof. Dr. Nitty Hirawaty Kamarulzaman and Dr. Ismail Abd. Latif for their valuable comments and useful recommendations in shaping the structure of this study. They had given a lot of critical remarks and suggestions for the writing this dissertation and without their help the task would have been more difficult. I am very lucky to have them to guide me along the way.

I would like to express my great appreciation to all lecturers and the staff in Department of Agribusiness and Information System for their kindness and assistance to me throughout my study.

Special thanks to the staff and officers of the Department of Agriculture Malaysia (DOA), Forest Research Institute Malaysia (FRIM), National Pharmaceutical Control Bureau (NPCB), Malaysian Agricultural Research and Development Institute (MARDI) and the Ministry of Agriculture and Agro-Based Industry (MOA) who have been involved directly or indirectly during the data collection and also for their kind cooperation with the support and valuable information throughout the research.

Lastly, my heartfelt appreciation to my beloved wife, my sweet children and my beloved parents for their love, prayer and encouragement. I do not think I will ever be able to thank all of you enough. I appreciate all of you very much. May Allah bless you all.

I certify that a Thesis Examination Committee has met on (date of viva voice) to conduct the final examination of Mohd Hafizudin bin Zakaria on his Master of Science thesis entitled "Development of Herbal Selection Criteria Model for Investment and Commercialization Decision" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the degree of Master of Science.

Members of the Thesis Examination Committee were as follows:

Zainal Abidin Mohamed, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Norsida Man, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Norlila Mohd Nawi, PhD
Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

External Examiner, PhD
Professor
Faculty of Management
Universiti Teknologi Malaysia
(External Examiner)

_____
ZULKARNAIN ZAINAL, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Amin Mahir Abdullah, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Nitty Hirawaty Kamarulzaman, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Ismail Abd. Latif, PhD
Senior Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

BUJANG KIM HUAT, Ph.D
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: _____ Date: _____

Name and Matric No.: _____

Declaration by Member of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____

Name of
Chairman of
Supervisory
Committee: _____

Signature: _____

Name of
Member of
Supervisory
Committee: _____

Signature: _____

Name of
Member of
Supervisory
Committee: _____

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

10MP	Tenth Malaysia Plan
AHP	Analytical Hierarchy Process
CDP	Corridor Development Plan
CFA	Confirmatory Factor Analysis
DAN	National Agro-Food Policy
DDM	Decision Delphi Method
DOA	Department of Agriculture Malaysia
DOSM	Department of Statistics Malaysia
DPN3	Dasar Pertanian Negara Ketiga
ECER	East Coast Economic Regions
EFA	Exploratory Factor Analysis
ETP	Economic Transformation Programme
FAHP	Fuzzy Analytical Hierarchy Process
FAO	Food and Agriculture Organization
FDM	Fuzzy Delphi Method
FRIM	Forest Research Institute Malaysia
GDP	Gross Domestic Product
KESEDAR	Lembaga Kemajuan Kelantan Selatan
KETENGAH	Lembaga Kemajuan Terengganu Tengah
MARDI	Malaysian Agricultural Research and Development Institute
MCDM	Multiple Criteria Decision Making
MOA	Ministry of Agriculture and Agro-Based Industry
NKEA	National Key Economic Area
NPCB	National Pharmaceutical Control Bureau
RMK10	Rancangan Malaysia Kesepuluh
TKPM	Permanent Food Production Park

CHAPTER 1

INTRODUCTION

This chapter will explain the background of the agricultural industry in Malaysia and narrow down the information on the Malaysia herbal industry in particular. The explanation of the problem statement, significance and scope of study will follow. Some of the thesis organization will be briefly given as preliminary guidance for the next chapters.

1.1 Background

Agriculture is the oldest industry in the world that supplies a variety of food for human survival. It also balances the needs of the world's population life. The agricultural sector has played an important role in the social and economic development of Malaysia. In 2010, the sector contributed RM51.3 billion or 7.58% to the Malaysian GDP. However, this contribution had decreased to 7.16% or RM56.3 billion in 2014. This is due to other sectors, such as manufacturing, construction and services growing more rapidly when compared to the agricultural sector (DOSM, 2014).

In the initial phase, before the country's independence, the cultivation of food crops such as rice, vegetables, fruits as well as fish and animal breeding activities had been a source of food, and had created jobs and provide income for the local population. Farming activities then were purely subsistence and practiced in traditional ways. The agricultural sector was then one of the most important features in the country's economy.

Since 1998 through the Third National Agricultural Policy (DPN3), this sector had been transformed from subsistence farming into a highly commercial and market oriented industry. The palm oil and rubber industry are examples of successful efforts in Malaysia where the country holds among the largest exporting country share of these commodities in the world. The First to the Tenth Malaysia Plan (1966–2015), saw the agricultural sector being given more emphases through various planning and increased allocations to fulfil its objectives such as the enhancement of the agricultural producers' income, the reduction of poverty and the minimization of disparity or inequity between the agricultural and non-agricultural sectors.

Table 1.1: Percentage share of GDP by Sector in Malaysia, 2005-2015

Sectors	GDP (%)					
	2005	2007	2009	2011	2013	2015
Agriculture	8.5	7.9	7.9	7.6	7.1	8.8
Mining and quarrying	13.3	11.9	10.5	8.8	8.1	8.9
Manufacturing	27.5	27.2	24.2	25.0	24.5	23.0
Construction	3.0	2.9	3.1	3.2	3.8	4.4
Services	46.8	49.2	53.2	54.2	55.2	53.5

Source: Department of Statistics Malaysia (2016)

Table 1.1 shows the percentage share of gross domestic product (GDP) by type of economic activity from 2005 to 2015. The agriculture sector remained as a fourth major contributor to the Malaysian GDP throughout these years after mining and quarrying. This sector experienced a slight decrease in GDP until 2013 due to the decline in the production of rubber and timber because of the lower hectarage of rubber and controlled logging for sustainable forest management (RMK10, 2010).

It was emphasised that more income for the country was to be generated in the Tenth Malaysia Plan (10MP) and the agriculture sector would be transformed to a high value one with upgraded strategies to achieve these objectives through various programs such as the National Key Economic Area (NKEA), the Corridor Development Plan (CDP) and the Economic Transformation Programme (ETP).

In the NKEA program, the Malaysian government has acknowledged the herbal industry as one of the promising industries in future. In addition, this industry is also very much interrelated with the development of agriculture, pharmaceuticals, life science, health care and the food industry. In all the Malaysia Development Plans, beginning from the Third to the Tenth Malaysia Plans (1976 – 2015), there are policies related to the herbal industry. The emphasis on policies related to herbs and spices in the industry has also been discussed from the First until the Third Industrial Master Plan (1986 – 2020), the First until the Third National Agricultural Policy (1984 – 2010), the National Agro-Food Policy (DAN, 2011 – 2020), the Science and Technology Policy (1988 – 2020), the National Biodiversity Policy (1998), the National Traditional and Complementary Medicine Policy (2001), and the National Key Economic Area (NKEA, 2010 - 2015).

The Herbs Development Secretariat that functions to coordinate the planning and development of the herbal industry has been established through NKEA and DAN. The secretariat had been upgraded to a division bench under the Ministry of Agriculture and Agro-Based Industry (MOA) as the Herbal

Development Division on 15th October 2014. The emphasis was on the production and development of high quality herbal products. The production and productivity of high quality herbs are further enhanced with the establishment of the Cluster Development Areas and Permanent Food Production Park (TKPM) especially for herbs and spices in the East Coast Economic Regions (ECER) inclusive of areas under the jurisdiction of the Lembaga Kemajuan Kelantan Selatan (KESEDAR) and the Lembaga Kemajuan Terengganu Tengah (KETENGAH).

Other initiatives under the NKEA have identified five types of herbs with high potentials to be commercially cultivated in Malaysia: Tongkat Ali (*Eurycoma longifolia*), Kacip Fatimah (*Labisia pumila*), Misai Kucing (*Orthosiphon stamineus*), Hempedu Bumi (*Andrographis paniculata*), and Dokong Anak (*Phyllanthus niruri*). Six types of herbs in 2012 have been considered as prioritized herbs in addition to the initial five herbs. These herbs are Mengkudu (*Morinda citrifolia*), Roselle (*Hibiscus sabdariffa L*), Ginger (*Zingiber officinale*), Mas Cotek (*Ficus deltoidea*), Belalai Gajah (*Clinacanthus nutans*) and Pegaga (*Centella asiatica*).

1.2 Overview of the Malaysian Herbal Industry

The usage of herbs and spices in daily life today was pioneered over hundreds of centuries ago around the world. In China, her community is known for their ginseng-based nutrition and health practises, and their renowned medicine halls known as *sinseh*. In India, Nepal, and Sri Lanka, their communities are proud with the practice of ayurvedic medicine that could bring a good and healthy life. The Indonesian communities are known for their *jamu*, which is a must in their food intake since childhood. In Malaysia, Malay herbs and spices are also prominent and they are often used in daily dishes.

Malaysia is largely regarded as a country that has significantly contributed to the herbal industry due to the richness of its various biological heritages in medicinal and flowering plant species. According to a report published by the Malaysian Biotechnology Corporation in 2009, Malaysia is ranked 12th in the world and fourth in Asia as a most bio-diverse country. There are about 2,000 species of herbs in Malaysia which have reportedly been used as medicines and in therapies by many strata of the society and generation (Bidin and Latiff, 1995).

According to Soepadmo (1992), there are only 1,200 species located in Peninsular Malaysia while 2,000 more can be found in Sabah and Sarawak. Most herbal plants are found growing wild in forests and some are cultivated in home yards. Currently, there are several herbs that have been cultivated for commercial purposes. The local market for herbal industry in Malaysia has recorded RM10 billion in 2008 (DAN, 2011) and this has been forecast to

increase between 8 to 15 percent annually based on the growing acceptance of natural medicine. This is estimated to reach RM32 billion in 2020. The industry has been growing steadily in recent years, from RM17 billion in 2013 to RM19 billion in 2014. It is estimated that 70 percent of the market value is from the Chinese Traditional Herbal Medicine (TCM) and the rest is from the Malay (including Indonesian) herbs, Indian herbs (Ayurvedic), and others.

This indicates that the demand for herbal products is very encouraging leading to a high demand of the raw materials in the industry. The herbal industry in Malaysia obtains its raw material supply from three main sources, namely, natural forests, cultivated areas and imports. In general, dependence of the industry on the amount of local herbal plants required for the production of herbal products is less than its reliance on imports. The bulk of the raw materials are imported from China, Indonesia and India.

This growing market provides many benefits, especially for farmers and the younger generation who see agriculture in general and the herbal industry in particular as the opportunity to invest and contribute to the industry's growth. Besides, the herbal industry offers a great opportunity for competition in the global market, and has a high rate of returns in the long run. Individuals involved not only become the producers of raw materials, but are also involved in downstream activities.

There are various types of herbal products in both the global and domestic markets. The herbal products can be divided into eight main types (MOA, 2010):

a) Medicines (phytomedicines) - derived from plants and are prepared based on the prescription, e.g. quinine, morphine and atropine.
b) Nutraceuticals - active ingredients in functional foods, tablets, and pills that could contribute to good health effects, e.g. Spirulina, COQ10, chlorella and Tongkat Ali extract pills.
c) Cosmetics - herbal ingredients for external parts of the body for the purpose of beauty, e.g. anti-aging creams and body scrub creams.
d) Functional foods - foods that are beneficial to health, e.g. Misai Kucing tea, Cincau drinks and Tunjuk Langit coffee.
e) Dietary supplements - supplements in the form of pills or tablets, e.g. garlic pills and ginseng capsules.
f) Personal care - daily use products such as soaps or shampoos, e.g. clove toothpaste, ginger soap and pennywort shampoo.
g) Flavours and fragrance - including food and non-food items; used in the fragrance, cosmetics, and aromatherapy industries, and in toiletries, e.g. essential oils, vanilla and colouring extracted from neem leaves and roselle flowers, and pesticides.
h) Botany and herbs - fresh and dried raw materials such as Mengkudu (morinda), Tongkat Ali, and Kacip Fatimah.

1.3 Malaysian Herbal Production

The areas for herb cultivation that were registered with the Department of Agriculture Malaysia (DOA) amounted to 1,198 hectares in 2011 and these had grown to 1,304 hectares in 2015 with a constant annual growth rate of 2.1 percent. Production of certain herbs* as registered by DOA decreases to 8,466 tonnes with a constant annual growth rate of -1.3 percent. The details of the planted areas and the production of herbs are as shown in Table 1.2.

Table 1.2: Planted Area and Production of Herbs* in Malaysia

Item	2011	2012	2013	2014	2015	Growth Rate (%)
Planted Areas (Hectares)	1,198	1,041	1,299	1,302	1,304	2.1
Production (Tonnes)	8,911	6,228	8,425	8,449	8,466	-1.3

*Kaemprefis Galanga, Orthosiphon Stamineus, Aloe Vera, Indian Penny-wort, Morinda Citrifolia, Tea Tree, Cymbophogon Nardus, Eurycoma Longifolia, Betel Vine

Source: Agrofood Statistics, Ministry of Agriculture and Agro-based Industry (2015)

Meanwhile, the planted areas for spices in Malaysia were 4,993 hectares in 2011 which increased to 6,095 hectares in 2015 with a constant annual growth rate of 5.9 percent. Production of certain spices* as registered by DOA increased from 32,469 tonnes in 2011 to 56,410 tonnes in 2015 with an annual growth rate 14.8 percent. The details of the planted areas and the production of spices are as shown in Table 1.3.

Table 1.3: Planted Area and Production of Major Spices* in Malaysia

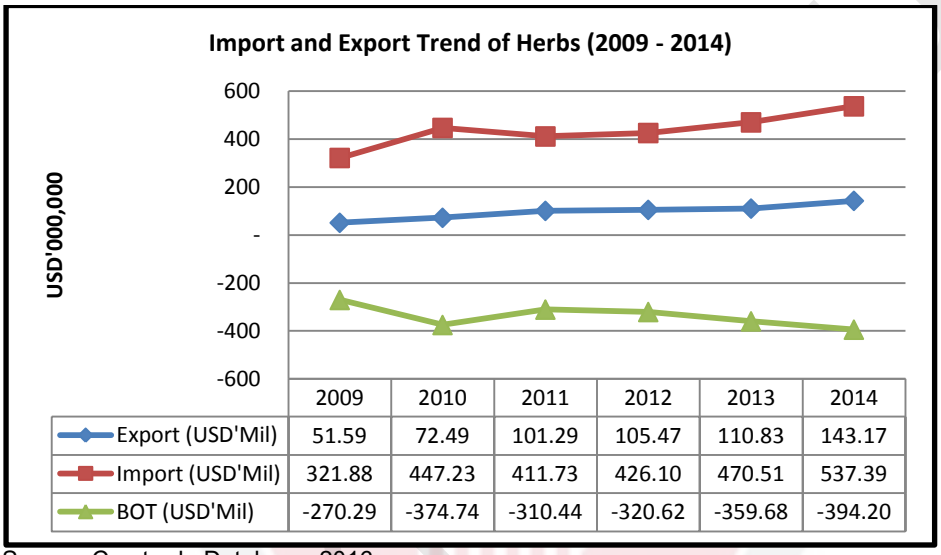
Item	2011	2012	2013	2014	2015	Growth Rate (%)
Planted Area (Hectares)	4,993	4,880	5,860	5,867	6,095	5.9
Production (Tonnes)	32,469	40,408	52,256	52,330	56,410	14.8

*Hot Chilli, Ginger, Turmeric, Greater Galangal, Musklime, Lime, Nutmeg, Lemon Grass

Source: Agrofood Statistics, Ministry of Agriculture and Agro-based Industry (2015)

1.4 Malaysian Herbal Trade

The trade value of herbs between 2009 and 2014 showed the compounded annual growth rate of 10 percent for imports and 21 percent for exports. The highest values of imports and exports were recorded in 2014 with USD537.39 million and USD143.17 million, respectively. The rapid development in the herbal industry clearly shows that the export growth rate is higher than that of the import, although there are some trade deficits. Figure 1.1 shows the import and export trends of herbs in 2009 until 2014.



	2009	2010	2011	2012	2013	2014
Export (USD'Mil)	51.59	72.49	101.29	105.47	110.83	143.17
Import (USD'Mil)	321.88	447.23	411.73	426.10	470.51	537.39
BOT (USD'Mil)	-270.29	-374.74	-310.44	-320.62	-359.68	-394.20

Source: Comtrade Database, 2016

Figure 1.1: Trends of herbal import and export, 2009 – 2014

The total value of imports has exceeded five times that of exports. This shows that the value and volume of the raw material utilized by the domestic herbal industry are huge and they come from outside sources, notably China, Indonesia and India (mostly imported by Chinese, Malay and Indian traditional medicine traders).

1.5 Supply Chain of Malaysian Herbs

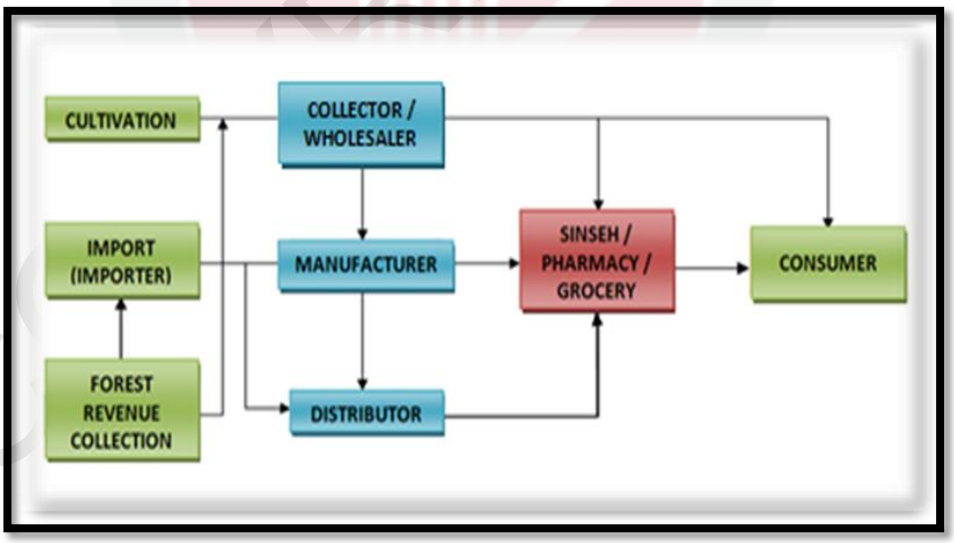
The supply chain of herbs in Malaysia consists of four levels or stages. The production and supply of herbs are derived from domestic production (farmers), forest revenue collection and imports. In general, the dependence of the industry on the amount of local herbal plants required production is less than that of the imports. The bulk of the herbal raw materials are mainly imported from China, Indonesia and India (MOA, 2010).

In certain cases, the collectors/wholesalers distribute their products to the consumer in large quantities. Some manufacturer of herbs play the rules at the semi process level, which includes grading, cleaning, drying, grinding and packaging, while other manufacturers process the raw material to manufacture end products such as herbal drinks, snacks, pills, massage oils and *maajun* (traditional herbal forms). All of these are done locally in many cases, one of which is the processing for local consumption by both the small manufacturing units or by medium-large manufacturers. In other cases, products are processed by big manufacturers for international clients. The processes are carried out according to strict quality and hygiene standards.

The rule of distributors along the herbal supply chain is to disseminate herbal products from the importers and manufacturers to the retailers: sinsehs, pharmacies and grocers. Two types of the herbal form distributed by distributors are the semi-processed (dried herbs and wet herbs) and the finished products (herbal teas, herbal soaps, shampoos and others).

The final level of the herbal supply chain is made up of consumers who are the recipients of the herbal goods, whether semi-processed or finished products that will be for their daily use.

Figure 1.2 shows the supply chain of herbs in Malaysia.



Source: Mohd Hafizudin, 2015

Figure 1.2: Supply chain of herbs in Malaysia

1.6 Problem Statement

The herbal industry has indeed been long established in the world. The rise of the former *Tanah Melayu* during the old times was also backed by the trade of herbs and spices. Nowadays, the market of herbal products has grown considerably large due to the multi-purpose nature and usages of herbs and spices. Herb products are being used as medicines and health supplements, cosmetics and beauty products, among others. Nevertheless, most of the herbal products in the domestic markets are imported. Notwithstanding that, Malaysia has a large variety of herbs which has not been fully exploited in terms of their potentials. Thus far, domestic herbs are used sporadically by small businesses and are traditionally consumed as health supplements.

Recent scientific researchers have discovered the benefits and medicinal properties of local herbs in the studies done by Vimala et al. (2012), Norhayati et al. (2012) and Saidatul Husni et al. (2012). The increasing awareness among people about health products and traditional medicines is a good starting point to further expand and improve the productivity and development of the herb industry in Malaysia for the good of all stakeholders. In order to enhance the development of the industry, the right policy direction, provision of adequate and sufficient resources, research and development of market requirements, and information need to be strategized by the government.

The findings of these researches and the interest of entrepreneurs to invest in herb production have prompted the government to give due attention to herbal crops. Subsequently, herbs are listed in the National Key Economic Area (NKEA) as high value commodities to be further developed and promoted in terms of production and marketing. Five herbs have been identified under the NKEA, for the industry for investment and commercial operation. These herbs are Tongkat Ali (*Eurycoma longifolia*), Kacip Fatimah (*Labisia pumila*), Dokong Anak (*Phyllanthus niruri*), Misai Kucing (*Orthosiphon stamineus, Benth*) and Hempedu Bumi (*Andrographis paniculata*).

NKEA expects the industry to be developed at both the upstream and downstream levels so that the contribution to the economy, in terms of value-add and industrial development, will be more significant. The government anticipates that herbal products will have the competitive advantage in both domestic and global markets. Currently, selection is based on the discovery, agronomy, product development of herbs, together with pre-clinical and clinical tests of their properties. However, the selection criteria for investors should comprise other criteria such as economic factors, environment, social, markets and also government policies. A more diversified set of criteria would be a better tool for herb investors to use in their decision making. Since such criteria are currently unavailable, they need to be identified and developed. It is also crucial to determine the order of importance of the identified criteria. The

ranking of the criteria will provide an important guide in the selection of the decision making process of the herbs by investors.

Through ranking or prioritization, industry players will be able to make investment decisions and allocate resources with regard to them. If prioritization is not made, investment decisions will merely be based on limited criteria known only to the investors, and most probably a few important factors, such as the economics, environment and others will not be considered. The effect, among others, is low global market acceptance for the products which subsequently will put business sustainability at stake. Ranking and prioritization, on the other hand, require a set of acceptance criteria, without which a good decision will be affected. The question that needs to be addressed is the existence of an acceptable set of criteria which needs to be developed. This will address the issues of resource allocation based on the ranking of the type of herbs.

1.7 Objectives of the Study

The general objective of the study is to develop the selection criteria for the commercialization and the investment decision making for herbs. To achieve this aim three objectives are formulated as follows:

a) To identify the selection criteria for herb production.
b) To develop the criteria model of herbal selection.
c) To rank the herbs and criteria based on a priority vector.

1.8 Research question

In this study, several questions were stated to achieve the objectives which coincide with the title of this study. Several questions were identified as below:

a) What the criteria have been used for the selection of herbs?
b) What is the best of criteria model have been used to select herbs?
c) What the priority ranking of herbs and selection criteria?

1.9 Significance of Study

The findings of this study will serve as a complement to the current criteria already established by previous policy makers. The criteria model developed will be a guideline for policy makers and will include research, economic, environmental and other factors. The model developed will provide a useful decision making tool for the herbal entrepreneurs in the selection of suitable

herbs to be cultivated or processed. The process of the criteria search, model development and ranking of selected herbs will contribute towards the knowledge for a research methodology package that could be used for other research studies.

1.10 Organization of the Thesis

The organization of the thesis has been divided into five major chapters and a brief summary of the contents of each chapter is presented below:

Chapter 1: Introduction: discussion about the research project undertaken and the importance of research. An explanation of the current issues concerning the herbal industry which will cover an overview of the Malaysian herbal industry in terms of market size, Malaysian policies, production, trade and supply chain. This chapter will also include problem statements, some of the objectives and significance of the study.

Chapter 2: Literature Review: more detailed literature review of the relationship amongst policy, decision making, criteria development and alternative selections. In addition, the attributes of crop and the selection criteria of products which are adopted for this study will be explained. Furthermore, this chapter will focus on previous research that are related to the selection criteria development and the methods that have been used in past studies.

Chapter 3: Research Methodology: detailed explanation of research framework, source of data that has been used and the questionnaire design. At the same time, discussion about the method of analyses such as the descriptive analysis, reliability analysis, exploratory factor analysis, analytical hierarchy analysis, and the consistency index will be touched upon.

Chapter 4: Results and Discussion: analyses of the whole data collection will be explained in this chapter to cover all analyses that are stated in Chapter 3.

Chapter 5: Summary and Conclusion: the summary with explanations and the conclusion of the dissertation will be given based on the objectives of the research. In addition, it will also include the implications of the study based on the findings obtained. Limitations and recommendations of the study are also described in this chapter.

REFERENCES

Alphonce, C. B. (1997). Application of the analytic hierarchy process in agriculture in developing countries. *Agricultural Systems*, 53(1), 97–112. doi:10.1016/S0308-521X(96)00035-2.

Akins, R. B., Tolson, H., & Cole, B. R. (2005). Stability of response characteristics of a Delphi panel: Application of bootstrap data expansion. *BMC Medical Research Methodology*, 5(37), 1–12.

Armstrong, J. S., (2001). Principles of Forecasting: A Handbook for Researchers and Practitioners, Kluwer Academic Publishers, 125-144

Azizi, M., Mohebbi, N., & De Felice, F. (2016). Developing a Rating Model for Selection Solar Wood Drying Location. *Agriculture and Agricultural Science Procedia*, *8*, 378–386

Bahurmoz, A. M. A. (2003). The analytic hierarchy process at Dar Al-Hekma, Saudi Arabia. *INFORMS VOL. 33,* No. 4, July-August 2003, 70 – 78.

Beaumariage, G.T. (1990). Investigation of an Object Oriented Modeling Environment for the Generation of Simulation Models. Doctorial Dissertation. Oklahoma State University, United States.

Bhatta, G. D., & Doppler, W. (2010). Farming Differentiation in the Rural-urban Interface of the Middle Mountains, Nepal: Application of Analytic Hierarchy Process (AHP) Modeling. *Journal of Agricultural Science Vol., 2(4), 37–51.*

Bidin, A. A., & Latiff, A. (1995). The status of terrestrial biodiversity in Malaysia. In : A. H. Zakri (Ed.). *Prospects in biodiversity prospecting* (pp. 59-73). Genetic Society of Malaysia & Universiti Kebangsaan Malaysia, Kuala Lumpur

Buede, D. M. (1992). Software Review. Three Packages for AHP: Criterium, Experts Choice and HIPRE 3+. *Journal of Multi-Criteria Decision Analysis,* 1, 119-121.

Bryant, F. B., Yarnold, P. R., Grimm, L. G. (1995). Reading and understanding multivariate statistics (pp. 99-136). Washington, DC.

Chen, Y., Fetzer, S., Lin, C., Huang, J., & Feng, J. (2013). Children and Youth Services Review Healthcare professionals' priorities for child abuse educational programming : A Delphi study. *Children and Youth Services Review*, *35*(1), 168–173.

Cheng, J., & Tang, C. (2009). An Application of Fuzzy Delphi and Fuzzy AHP for Multi-criteria Evaluation on Bicycle Industry Supply Chains. *WSEAS TRANSACTIONS on SYSTEMS and CONTROL,* 4(1), 21-34.

Christian. (1997). Application of the Analytic Hierarchy Process in Agriculture in Developing Countries. *Agricultural System*, 97-112.

Churchill, G.A. (1991). *Marketing Research: Methodological Foundations* (5th ed.) The Dryden Press, New York.

Coakes, S.J., Steed, L., & Ong, C. (2009.) *SPSS Analysis Without Anguish Version 16.0 for Windows.* John Wiley & Sons, Australia.

Cobuloglu, H. I., & Büyüktahtakın, İ. E. (2014). A Multi-Criteria Approach for Biomass Crop Selection under Fuzzy Environment. *Proceedings of the 2014 Industrial and Systems Engineering Research Conference*.

Comrey, A. L., & Lee, H. B. (1992). *A first course in factor analysis*. Hillsdale, NJ: Erlbaum.

Comtrade. (2016). International Trade Statistics Database, *http://comtrade.un.org/*. Retrieved on April 2016.

Conway, J. M., & Huffcutt, A. L. (2003). A Review and Evaluation of Exploratory Factor Analysis Practices in Organizational Research. *Organizational Research Methods*, 6 (2), 147–168.

Cornish, E., (1977). *The study of the future*. World Future Society: Washington, D.C.

Costello, A. B., & Osborne, J. W. (2005). Best Practices in Exploratory Factor Analysis: Four Recommendations for Getting the Most from Your Analysis. *Practical Assessment, Research & Evaluation*. 2005; 10(7):1-9.

Custer, R. L., Scarcella, J. A., Stewart, B. R. (1999). The Modified Delphi Technique - A Rotational Modification. *Journal of Vocational and Technical Education*. Vol. 15, Num. 2, Spring 1999. Retrieved March 5, 2010.

Dalkey, N. C., & Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Management Science.* Vol. 9, 458–467.

Dasar Agro-Makanan Negara 2011-2020 (2011). Kementerian Pertanian Malaysia dan Industri Asas Tani. Putrajaya.

De Silva, T. (1997). Industrial utilisation of medicinal plants in developing countries, Non-wood Forest Products II: *Medicinal plants for forest conservation and healthcare,* FAO, Rome, Italy.

DeCoster, J. (1998). Overview of Factor Analysis. Retrieved November 21, 2013, from http://www.stat-help.com/notes.html

Delbari, S. A., Ng, S. I., Aziz, Y. A., & Ho, J. A. (2016). An investigation of key competitiveness indicators and drivers of full-service airlines using Delphi and AHP techniques. *Journal of Air Transport Management*, *52*, 23 – 34.

Department of Statistics Malaysia. (2016). Report of Annual Gross Domestic Product 2005 – 2015. Putrajaya, Malaysia

Ehie, C. I. (1989). An Integrated Multi-Objective Decision Model for Industry in a Less Developing Country. Doctoral dissertation, University of Missouri-Rolla

Elizabeth, D., John, B., & L.Tipton, J. (2000). *Plant Selection and Selecting Your Plants*, The University of Arizona Cooperative Extension. College of Agriculture, The University of Arizona.

Fatti, L. P. (1989). Water Research Planning in South Africa. In B.L. Golden, E.A. Wasil, & P.T. Harker (Ed.), *The Analytic Hierarchy Process: Applications and Studies* (pp. 122- 32). Berlin, Germany: Springer-Verlag.

Ghide, A., & Suphanchaimant, N. (2014). Farmer Decision Making on Crop Selection for the Fallow Period after Sugarcane ratoon, Ban Haed Khon Kaen, Thailand. In *Graduate Research Conference 2014* (pp. 2849–2859).

Gorsuch, R. L. (1983). *Factor analysis* (2nd Ed.). Hillsdale, NJ: Erlbaum.

Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2010). *Multivariate data analysis* (7th ed.). Upper Saddle, NJ: Pearson Prentice Hall.

Harris, R. A. (2002). *Creative Problem Solving: A Step-by-Step Approach* (pp. 106). Los Angeles: Pyrczak Publishing.

Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing* 32(4) 1008 - 1015.

Henson, R. K., Roberts J. K. (2006). Use of Exploratory Factor Analysis in Published Research: Common Errors and Some Comment on Improved Practice. *Educational and Psychological Measurement* 66(3)

Hong, H. G. (2015). Success Factors of Mobile-Commerce System. *Indian Journal of Science and Technology*, *8*(7), 630–637.

Hovanov, N., Kolari, J., & Sokolov, M. (2008). Deriving weights from general pairwise comparisons matrices. *Mathematical Social Sciences 55*, 205-220.

Kahn & Herman. (1965). *Thinking About the Unthinkable*. New York: Horizon Press.

Keirungi, J., & Fabricius, C. (2005). Selecting medicinal plants for cultivation at Nqabara on the Eastern Cape Wild Coast, South Africa. *South African Journal of Science*, 101(December), 497-501.

Kim, N., Park, H. W., Park, S., Lee, H., Information, T., & Korea, S. (2016). Developing a Decision Support Model for a High Performance Computing System Selection for Computational Science using AHP. *International Journal of U- and E- Service, Science and Technology*, *9*(3), 9–16.

Kline, P. (1979). *Psychometrics and psychology*. London: Acaderric Press.

Ko, J. (2005). Solving a distribution facility location problem using an analytic hierarchy process approach. In *8th International Symposium on AHP*, 2005. Honalulu, Hawaii.

Lam, S. S. Y., Petri, K. L., & Smith, A. E. (2000). Prediction and optimization of a ceramic casting process using a hierarchical hybrid system of neural networks and fuzzy logic. *IIE Transactions*, 32(1), 83 - 92.

Lin, C., Tan, B., & Chung, S. (2002). The critical factors for technology absorptive capacity. Ind. *Manage. Data Syst*., 102 (6), 300-308.

Lowi, T. (1970). Decision Making vs. Policy Making: Toward an Antidote for Technocracy. In T. Lowi (Ed.), *Public Administration Review*: *30(3)*, 314-325.

Luzon, B., & El-Sayegh, S. M. (2016). Evaluating supplier selection criteria for oil and gas projects in the UAE using AHP and Delphi. *International Journal of Construction Management*, *16*(2), 175–183. http://doi.org/10.1080/15623599.2016.1146112

Ma Dolores, C. T. (2007). Purposive Sampling as a Tool for Informant Selection. *A Journal of Plants, People and Applied Research*, *5* (Ethnobotany Research & Applications), 147–158.

Mak, T. K., & Nebebe, F. (2016). Factor Analysis and Methods of Supplier Selection. *International Journal of Supply Chain Management*, *5*(1), 1-9

Malaysia, (2010). Rancangan Malaysia Kesepuluh 2011 – 2015

Malaysia. (1988). Science and Technology Policy 1988 – 2020

Malaysian Biotechnology Corporation. (2009). *Overview: Malaysian Agricultural Biotechnology*. Kuala Lumpur

Martin, F. (1988). Food Security and Comparative Advantage in Senegal: a Micro-Macro Approach. PhD Dissertation, Michigan State University, USA.

Mawapanga, M. N., & Debertin, D. L. (1996). Choosing between Alternative Farming Systems : An Application of the Analytic Hierarchy Process. *Review of Agricultural economics*, *18(3)*, 385–401.

McCauley, C. D., Ruderman, M. N., Ohlott, P. J., & Morrow, J. E. (1994). Assessing the developmental components of managerial jobs. *Journal of Applied Psychology*, 79, 544-560.

Mendoza, A. G., and Sprouse, W. (1989). Forest Planning and Decision Making Under Fuzzy Enviroment: An Overview and Illustration. *Forest Science, 35(2), 481-502.*

Micheal, S. L. B. (1989). Factor Analysis and Related Techniques International Handbooks of Quantitative Applications in the Social Sciences Volume 5, Sage Publications.

Millet, I., Saaty, T. (2000). On the relativity of relative measures accommodating both rank preservation and rank reversals in the AHP. *European Journal of Operational Research,* 121(1) 205-212.

Ministry of Agricultural and Agro-Based Industry, Malaysia (2010). Review of "Audit of Resources Supporting the Malaysian Herbal Industry, 2002 - 2003". Malaysia.

Ministry of Agricultural and Agro-Based Industry. (2011). Agricultural NKEA: Herbs Sub-Sector. Limited Circulation, Malaysia.

Ministry of Agriculture and Agro-based Industry. (2015). Agrofood Statistic 2015, Malaysia.

Ministry of Health. (2001). National Traditional and Complementary Medicine Policy. Malaysia

Ministry of International Trade and Industry. (2006). Third Industrial Master Plan (2006 – 2020). Malaysia

Ministry of Natural Resources and Environment. (1998). *National Biodiversity Policy.* Malaysia

Mitchel H.K. & Wasil, E. A. (1989). AHP in Practice and Observations from a Management Consulting Perspective. In B.L. Golden (Ed.), *The Analytic Hierarchy Process: Applications and Studies*, 192-202, Berlin, Germany: Springer-Verlag, Berlin.

Mohd Hafizudin, Z. (2015). Review of policies and issues in the Malaysian herbal industry. *FFTC Agricultural Policy Articles,* Issues 20 Mac 2015

Munasinghe. (2008). Making Development More Sustainable*: Sustainomics Framework and Applications.* The Encyclopedia of Earth.

Norhayati, I., Ling, S.K., Getha, K., Mohd Ilham, A., Muhd Haffiz, J., Lili Sahira, H., Muhammad Syamil, A. & Siti Syarifah, M. (2012). Antitrypanosomal Activity of Falavonoid Isolated from Chromoleana odorata (L.) King and Robinson. *Proceedings of the Seminar on Medicinal & Aromatic Plants*, (MAP): 110-116.

Norusis, M.J. (1993). *SPSS for Windows: Professional Statistics*, Release 6.0. p. 47-82. Chicago, IL: SPSS Inc.

Nunnally, J.C., Bernstein, I.H. (1994). *Psychometric theor*y. New York: McGraw-Hill.

Pett, M.A., Lackey, N.R., Sullivan, J. J. (2003). Making Sense of Factor Analysis: The use of factor analysis for instrument development in health care research. California: Sage Publications Inc; 2003.

Rezaei-Moghaddam, K., & Karami, E. (2007). A multiple criteria evaluation of sustainable agricultural development models using AHP. *Environment, Development and Sustainability*, 10(4), 407–426.

Ruusunen J. and P. R. Hamalainen (1989). Project Selection by an Integrated Decision Aid., In B.L. Golden, E.A. Wasil, and P.T. Harker, (Eds.), *The Analytic Hierarchy Process: Applications and Studies* (pp. 101-21). Berlin, Germany: Springer-Verlag.

Saaty, T. L. (2006). Fundamental of Decision Making and Priority Theory with the Analytic Hierarchy Process. (6th Edition) Pittsburgh: RWS Publication.

Saaty, T. L. (1980). *The Analytical Hierarchy Process*. McGraw-Hill, New York.

Saaty, T. L., & Vargas. (1993). Experiments on rank preservation and reversal in relative measurement. *Mathematic Computer Modelling* 17(4/5) 13-18.

Saaty, T. L. (1996). Decision Making for Leaders: *The Analytic Hierarchy Process for Decisions in a Complex World*. RWS Publications, Pittsburgh, PA.

Saidatul Husni, S., Fauziah, A., Fadzureena, J., Siti Kamariah, H., Hani Idayu, B., & Nor Azah, M.A. (2012). Active Ingredient for Herbal Product from Tetracera maingayi. *Proceedings of the Seminar on Medicinal & Aromatic Plants*, (MAP): 142-148

Sarang, J. P., Bhasin, H. V., Verma, R., & Kharat, M. G. (2016). Critical Success Factors for Supplier Development and Buyer Supplier Relationship: Exploratory Factor Analysis. *International Journal of Strategic Decision Sciences (IJSDS), 7*(1), 18-38. doi:10.4018/IJSDS.2016010102

Saunders, Lewis & Thornhill. (2007). *Research Methods in Business*, 4th Edition Pearson Education.

Schweigman, C. (1985). *Operations Research Problems in Agriculture in Developing Countries*. Tanzania Publishing House, Dar es Salaam, Tanzania.

Shaller, N. (1993). The concept of agricultural sustainability. *Agricultural Economic Environment*. 46: 89–97

Skulmoski, G. J., & Hartman, F. T. (2007). The Delphi Method for Graduate Research. *Journal of Information Technology Education*, *6*.

Soepadmo, E. (1992). Conservation Status of Medicinal Plants in Peninsular Malaysia. In Khozirah Shaari, Azizol Abd. Kadir & Abd. Razak Mohd. Ali, (Eds.). *Medicinal Products from Tropical Rain Forests*, FRIM, Kuala Lumpur, Malaysia: 13−23.

Swift, C. O. (1995). Preferences for single sourcing and supplier selection criteria. *Journal of Business Research*, 32(2), 105–111.

Tabachnick, B.G., & Fidell, L.S. (2001). *Using multivariate statistics (*4th Edition). Boston, MA: Allyn& Bacon.

Tabachnik, B.G., & Fidell, L.S. (2007). Using Multivariate Statistics (5th Edition). Boston. MA: Pearson.

Taylor, W. B. (2002). *Management Science* (7th Edition). United State: Prentice Hall.

Thompson, B. (2004). Exploratory and confirmatory factor analysis: Understanding concepts and application. Washington, DC: American Psychological Association.

Tipmontian, J., Rao, K. S., & Rajmohan, M. (2012).Integrating Fuzzy Delphi Method and Analytic Hierarchy Process for the Selection of Post-Harvest Technology. *European Journal of Scientific Research*, 80(2), 244-259.

Van Zolingen, S.J. and Klaassen, C.A. (2003). Selection processes in a Delphi study about key qualifications in Senior Secondary Vocational Education. *Technological Forecasting and Social Change,* (70), 317-340.

Vimala, S., Shalini, M. Khairunnisa, A.S., Juliza, M. & Abdull Rashih, A. (2012). Antioxidant Evaluation: ORAX Analysis of Common Spices Used in Malaysia. *Proceedings of the Seminar on Medicinal & Aromatic Plants*, (MAP): 99-109.

Walker, J., & Maddan, S. (2009). *Statistics in criminology and criminal justice: analysis and interpretation* (3rd edition), (pp. 324–349). Burlington, Massachusetts, United States: Jones & Bartlett Publishers.

Wang, C.C., Wang, Y., Zhang, K., Fang, J., Liu, W., Luo, S., Tang, S., Wang, S. & Lu, V.C. (2003). Reproductive health indicators for China's rural areas. *Social Science and Medicine* 57(2): 217-225.

WHO, IUCN, WWF. (1993). Guidelines on the conservation of medicinal plants. Gland, Switzerland.

Williams, P.L. & Webb, C. (1994). The Delphi technique: A methodological discussion. *Journal of Advanced Nursing* (19): 180-186.

Williams, B., Brown, T. & Onsman, A. (2010). Exploratory factor analysis : A five-step guide for novices. *Australasian Journal of Paramedicine*, *8*(3).

Wilson, A., & Tyrchniewicz, A. (1995). *Agriculture and Sustainable Development : Policy Analysis on the Great Plains* (1st Edition). Winnipeg, Manitoba, Canada: International Institute for Sustainable Development (IIDD).