

A Quantitative Methodology To Test The Ecological Modernization Theory (EMT): The First Steps For The Palm Oil Production Chain In Malaysia

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Abstract

The aim of this paper is to develop a quantitative methodology to test the Ecological Modernization Theory (EMT). This is a pioneering research as the EMT has not been quantitatively tested before. The sector selected is the palm oil production chain in Malaysia. Background information is provided in relation to the two central tenets of EMT, political modernisation and the market aspect that will be operationalized via the two linkages expressed as the government-industry (G-I) linkage and the industry-industry (I-I) linkage. The background information, which is culled from secondary and primary research, helps in developing the 8 hypotheses grouped around the G-I linkage and the I-I linkage, and also the Environmental Performance Indicators. The statistical tools that will be applied in the quantitative methodology are correlation analysis, multiple regression analysis, cross tabulation, and Cronbach Alpha.

Introduction

The aim of this paper is to develop a quantitative methodology to test the Ecological Modernization Theory (EMT). This is a pioneering research as the EMT has not been quantitatively tested before. The sector selected is the palm oil production chain in Malaysia. The background information, which is culled from secondary and primary research, helps in the shaping of the research methodology at a later stage in this paper.

An overview of the palm oil production chain in Malaysia

Malaysia has undergone two phases of modern economic development. The first phase of agriculture economic development was as a result of the British colonial legacy where the then Malaya (today West Malaysia) was treated as a commodity producer state. The first major commercial crop was rubber and this was followed by oil palm and cocoa. From a mere 400 hectares in 1920, the area under oil palm cultivation has expanded to 54,000 hectares in 1960 (DOE, 1999:5), and to 3,670,243 hectares in 2002 (MPOB, 2003(a):1). This phenomenal growth in hectareage was obviously accompanied by the rising production of palm oil based products. As an example, in 1960, the production of crude palm oil was 91,793 tonnes (PORLA, 1991: 22), and it has expanded to 11,909,298 tonnes in 2002 (MPOB, 2003(a): 33). This shows a remarkable volume increase of 12,874% over these two periods.

The second phase of modern economic development in Malaysia focused primarily on industrialisation. The various Malaysia Plans (development in orientation), Industrial Master Plans and National Agriculture Policies led to the prioritisation of resource-based industries in terms of downstreaming activities that are manufacturing-based. The promotion of downstreaming activities in the palm oil production chain, which has a value-added focus, started off with palm oil milling. Palm oil milling, in which the main resource input is matured fresh fruit bunches, lead to the production of crude palm oil and palm kernels. The palm kernels are sent to the palm kernel crusher where in the extraction process, crude palm kernel oil and palm kernel meal are produced. Further value-added can be carried out in the form of refining, oleochemical production and specialty fats production. Refineries and specialty fats manufacturing plants produce mainly food-based products whereas oleochemical manufacturing plants focus primarily on non-food-based products. Appendix I shows the types of manufacturing activities and the associated products produced. The list of oil palm products in Appendix I is not exhaustive in nature.

Currently palm oil milling, palm kernel crushing and refining has moved to a very high gear in Malaysia with the presence of 362 operating mills, 36 operating palm kernel crushers and 47 operating refineries. At this juncture, the Malaysian government is actively encouraging companies to move up the value chain by participating in oleochemical production and specialty fats production. There are altogether 16 oleochemical plants and also 16 specialty fats production facilities (MPOB, 2003(a)), MPOB and Joka-Aki Technology Sdn. Bhd., 2003).

Environmental Issues Pertaining to the Palm Oil Production Chain

The upstream activities that are related to oil palm planting have adverse impacts on the environment in the initial years of development. The first phase of agriculture economic development in Malaysia, as mentioned earlier, which was primarily upstream, led to the clearing of natural forests for oil palm planting. The clearing of natural forests has a direct impact on the ecosystem health. In cases where replantation exercise took place, that is the old rubber trees (past its prime) are replanted with oil palm trees, the effect on the environment is limited or indirect. Land preparation in the earlier years, where either the natural forests or rubber trees are logged prior to the slash and burn exercise in preparation for planting activities, has negative ecological effect, especially in terms of air pollution. However in the later years, the old rubber trees are treated as a valuable resource for the wood-based industry. With effective marketing efforts, these old rubber tree trunks are branded as Malaysian oak and are used mainly in the manufacturing of wooden furniture. This move is deemed to be much more friendlier towards the environment instead of the slash and burn method adopted in the earlier years.

The exposed land, after the felling of the trees, is affected by soil erosion which consequently leads to loss of soil fertility. The nurturing of immature palm trees and the management of the fields during the harvesting cycles where the application of fertiliser, pesticide and herbicide can lead to runoffs that will pollute the river system (DOE, 1999). In order to reduce fertiliser utilisation, which is cost-saving cum environmentally friendly, the fronds of the palm trees and the empty fruit bunches (after milling) are placed on the fields for mulching in order to be converted as organic fertiliser.

The harvesting process where a harvester using a long harvesting pole to cut the fresh fruit bunches from the palm trees is very labour intensive. The selection of ripe fresh fruit bunches will have an impact on yield as young, immature fruits will lead to lower yield and lower quality oils. The attendant logistics of transporting the fresh fruit bunches from the harvested area to the mill has also to be dealt with. The faster the fresh fruit bunches are sent to the palm oil mill, the higher the yield and the higher the quality of oil that can be obtained. The Malaysian Palm Oil Board, a statutory body whose principle functions amongst others are licensing and enforcement, and research and development, has given a warning that the Oil Extraction Rate (OER) of 18% must be minimally met by all palm oil mills. If the OER, which is based on the weightage of the fresh fruit bunches, for any palm oil mill which falls below that of 18%, it means that the operating license is breached and appropriate action will be taken (New Sunday Times, 22 December 2002). This implies that the factories must only accept ripe fruits and reject young fruits and at the same time the production process must be up to the mark.

The next cycle of replanting, where the non-productive old palm trees are felled and replaced by higher yielding clones, will have an impact on productivity. The earlier method of slash and burn has to a certain extent given way to a zero burn method where environmentally friendly plantations, chip and pulverize the old palm trunks for composting purpose. The selection of the type of clone in the replanting process is an integral component in the productivity equation. The higher yielding clones are much more expensive as compared to the lower yielding ones but the impact on productivity on a long term basis is very telling indeed.

The fruits of labour from the fields, be it in a plantation or a smallholding, are the feedstock for the palm oil mills. As such, milling is the next step in the value chain. The prioritisation of resource-based industries as mentioned earlier led to the phenomenal growth in palm oil milling which has continued unabated till today. Palm oil milling produces two main products and they

are crude palm oil (CPO) and palm kernel. Palm kernels are sent to palm kernel-crushing plants to extract crude palm kernel oil (CPKO). At some palm oil mills, palm kernel crushers or facilities are available to exploit the economies of scope. Palm oil mills began to sprout in oil palm plantations for reasons of logistics, a steady source of water supply and the availability of land to construct a factory. As most of these oil palm plantations own vast tracts of land, the possibility of a river system passing through the land is very high indeed. As such, the plantation companies also own the vast majority of the palm oil mills. The process of vertical integration for these two commercial concerns i.e. plantation and palm oil mill is based on the *raison d'être* of economics. Without a mill, the plantation will have to source for a purchaser of the fresh fruit bunches which will most likely be a mill in the vicinity. As such, there are economies of scope by having a plantation and a palm oil mill within the plantation. The palm oil mills have a steady source of feedstock and this is supplemented by smallholders who have fields in the vicinity of the palm oil mills. Transportation costs will be fairly negligible in terms of transferring the harvested fresh fruit bunches to the nearby palm oil mills and this in turn will help to retain the freshness of the fruits.

The palm oil mills are located close to rivers and streams as milling requires a vast amount of water. As most of these mills are located in the interior or rural areas, the discharging of palm oil mill effluent (POME) into the receiving waterways, which are likely to be upstream, has the potential to create adverse environmental consequences downstream. This negative environmental impact will affect riverine communities and users of water from an economic, social and health perspective. The POME can also cause odour pollution as it is foul smelling in nature if not treated. POME is a combination of 3 principal sources of wastewaters that are generated as part of the milling process:

1. The FFB is subjected to steam-heat treatment for the purpose of sterilization where amongst the main reasons are to prevent the formation of free fatty acids as a consequence of enzyme actions and also to facilitate the stripping of the fruits from the bunch stalks. The sterilizer condensate, which is the steam condensate being discharged as wastewater, constitutes approximately 36% of POME.
2. In crude palm oil extraction, hot water is added to the oil to enhance its flow. This crude oil slurry is fed to a clarification tank for oil separation. The water and fibrous debris are discharged as clarification wastewater where it constitutes approximately 60% of POME.
3. After the nuts are cracked, the kernels and shells need to be separated and the most popular separator is the hydrocyclone. The discharge from this process is known as hydrocyclone wastewater, which constitutes approximately 4% of POME (DOE, 1999).

The raw POME which has an extremely high organic content, when discharged into the waterways can lead to rapid deterioration in the ecosystem health. As such, the raw POME has to be treated by a combination of physical (the removal of sand, grit and settled solids) and biological (to treat the organic content) processes. In the late 1970s and early 1980s, some plantation firms utilised the raw POME as part of cropland application as it has high fertiliser value. DOE discourages this type of action as it can lead to groundwater contamination, surface water pollution and nuisance conditions like having a large population of flies and odour pollution. However, if raw POME is treated accordingly, the treated effluent is a rich source of nutrient where it can be used for cropland application (DOE, 1999).

In the second half of the 1970s, the palm oil milling sub-sector was the single largest source of organic pollution. At approximately the same time, the Environmental Quality Act 1974 was legislated for the prevention, abatement and control of pollution, and also for environmental enhancement. Since then, the EQA was amended 3 times and today it has 22 pieces of subsidiary legislation, 13 sets of regulations, 1 set of rules and 8 sets of orders (DOE, 1999: 32). The EQA is

a Federal legislation and as such is enforced by a Federal agency, that is the Department of Environment. The EQA and industry-specific regulations for the crude palm oil sub-sector, that is, the Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations 1977 are the principal legislative instruments for this sub-sectors (DOE, 1999). The relevant provisions of the subsidiary legislation are also applicable to this sub-sector. This means that the regulatory controls of the crude palm oil sub-sector cover the prescribed premises where licensing is required, effluent discharge, air emissions, noise emissions and disposal of scheduled waste. However, for the plantations, refineries, oleochemical plants and specialty fats or palm oil finished products plants, the principal legislation is the EQA and supported by the relevant provisions of the subsidiary legislation. The regulatory controls of these sub-sectors cover effluent discharge, air emissions, noise emissions and disposal of scheduled waste. On a general basis, there are also other pieces of legislation by the Federal, State and Local Government authorities that also focus on the environment.

The waste fibre and shell materials are used as solid fuel for the steam boiler. This is deemed to be environmentally friendly, as these materials are not treated as wastes and used as a form of energy. Palm oil mills, in general, are self-sufficient in energy generation as there is an abundance of such materials. However steam boilers can emit black smoke as a consequence of incomplete combustion of the solid waste material. This can lead to smoke and dust pollution. The Department of Environment has specified that on any day of mill operation, the maximum time allowable for black smoke emission is 15 minutes. Another caveat is that for any hour selected, the maximum is 5 minutes per hour. This means that black smoke emission is only allowable for 5 minutes per hour for any 3 hours selected per day (Environmental Quality Act and Regulations: All Amendments Up To September, 2002).

The empty fruit bunches, after oil milling, is either incinerated to produce potash ash for cropland application as fertiliser or send to the fields for the superior process of mulching. DOE has discouraged the use of incineration so as to reduce air pollution (DOE, 1999).

The palm kernels are sent to the palm kernel crushers where the process of crushing will help to extract the main product, that is the crude palm kernel oil and the by-product being palm kernel meal. Further downstreaming means that the palm kernel meal will be blended to make animal feed. Palm kernel crushing can be deemed to be very environmentally friendly as 100% of the kernel is used. Effluent comes in the form of wastewater, which is generated when the crushing facilities are cleansed by the utilisation of water and chemicals. Cleaning is as a consequence of oil spillage or leakage, or as part of good housekeeping practices. This wastewater is fed to the oil/fat trap to enable oil recovery and oil loss minimisation before the wastewater reaches the water treatment plant. Once the wastewater is treated, the recycled water is used for in-house facilities.

The CPO and CPKO extracted from palm oil milling and palm kernel crushing respectively are sent as feedstocks to either refineries or oleochemical plants. Oleochemical plants not only utilise CPO and CPKO but also refined palm oil and refined palm kernel oil as feedstocks. The specialty fats or palm oil finished products plants utilise the outputs of refineries as feedstocks.

In refining where the process of refining, bleaching and deodorising (RBD) is adopted, bleaching earth is used in the bleaching process where the spent bleaching earth is removed via the filter system. The problem is the disposal of the spent bleaching earth which is classified as a form of hazardous waste. There exist recycling firms where the spent bleaching earth undergoes the recovery process.

Likewise as in palm kernel crushers, refineries, oleochemical plants and specialty fats or palm oil finished products plants and bulking installations face the same problem of oil spillage or leakage. Cleaning, as a consequence of oil spillage or leakage, or as part of good housekeeping practices, utilises water and chemical. And likewise, this wastewater is fed to the oil/fat trap to enable oil recovery and oil loss minimisation before the wastewater reaches the water treatment plant. Once the wastewater is treated, the recycled water is used for in-house facilities.

Institutional Framework in the Palm Oil Production Chain In Malaysia

The institutional framework for the palm oil production chain in Malaysia can be divided into three institutional clusters. They are the government institutions' cluster, the industry representatives' cluster and the non-government organisations' cluster. The focus of this paper is the government institutions' cluster and the industry representatives' cluster. The government institutions cluster that has a direct or indirect relationship with the palm oil production chain are the Ministry of Science, Technology and Environment, the Environment Quality Council, the Department of Environment, the Ministry of Primary Industries, the Malaysian Palm Oil Board and the Malaysian Palm Oil Promotion Council.

The National Policy on the Environment was launched on the 14th November 2002 where all ongoing and future development projects will come under its ambit. The National Policy on the Environment takes a holistic view in terms of development where this policy is meant to support the green strategy embodied in the various Malaysia Plans. The green strategy encompasses natural resource management and the prevention and control of environmental degradation (DOE (a), Online). The National Policy on the Environment comes under the ambit of the Ministry of Science, Technology and Environment. This is abetted by the Environmental Quality Act 1974 where the Environmental Quality Council was established under Section 4(1) of this act (DOE (b), Online). The role of the Environmental Quality Council is to advise the Ministry of Science, Technology and Environment on matters in relation to the Act and any matter referred by the Minister concerned. The Environmental Quality Council draws its members from the academia, the states of Sabah and Sarawak, the various related Ministries, industry representatives and non-governmental organisations. This council also provides policy guidance to the Department of Environment, which is basically involved in enforcement work in relation to the EQA.

The Ministry of Primary Industries as the name suggests, covers all primary industries of which the palm oil production chain is one. Its responsibility encompasses production, processing, marketing and research for primary commodities (MPOPC, Online). The Malaysian Palm Oil Board, established on 1st May 2000 by an Act of Parliament and under the Ministry of Primary Industries' hierarchy, has taken over the functions of Palm Oil Research Institute of Malaysia (PORIM) and the Palm Oil Registration and Licensing Authority (PORLA) (MPOB, Online). MPOB also collects cess from the palm oil millers and kernel crushers on the basis of every tonne of palm oil and palm kernel oil produced to fund its activities. The Malaysian Palm oil Promotion Council, also under the Ministry of Primary Industries' hierarchy, is committed in making Malaysia palm oil the world's leading vegetable oil and Malaysia the focal point of the international oils and fats market (MPOPC, Online). The institutions which play an advisory role in the Malaysian Palm Oil Promotion Council are the Malaysian Palm Oil Board (under the aegis of the same ministry) and industry representatives like the Malaysian Palm Oil Association (MPOA), the Palm Oil Millers' Association of Malaysia (POMA), the Malaysian Edible Oil Manufacturers' Association (MEOMA), the Palm Oil Refiners Association of Malaysia

(PORAM), the Malaysian Oleochemical Manufacturers Group (MOMG), a group in the Federation of Malaysian Manufacturers and the National Association of Smallholders (NASH).

The industry representatives' cluster has players like the Malaysian Palm Oil Association, the Palm Oil Millers Association of Malaysia, the Malaysian Edible Oil Manufacturers Association, the Palm Oil Refiners Association of Malaysia, the Malaysian Oleochemical Manufacturers Group, a group in the Federation of Malaysian Manufacturers and the National Association of Smallholders (MPOPC, Online). The Rubber Growers Association, the United Planting Association of Malaysia and the Malaysian Palm Oil Growers Council were dissolved in a rationalisation exercise where it led to the formation of an umbrella entity in 1999, that is the Malaysian Palm Oil Association (MPOA, Online). The Malaysian Palm Oil Association has been tasked with the long-term growth and development of the Malaysian palm oil industry, especially that of the oil milling and the plantation crop industry which covers oil palm, rubber, coconut, sugar cane, cocoa, tea, banana and pineapple. The Palm Oil Millers Association was established as the official representative of the millers and also to act as a mediator in the settling of disputes among its members and also between the millers and suppliers of fresh fruit bunches. The Malaysian Edible Oil Manufacturers Association was formed in 1961 for the vested interest of the edible oil millers. The Palm Oil Millers Association hopes by having its own code of conduct and regulations, its members will be able to attain the production of high quality products. The Palm Oil Refiners Association of Malaysia was formed as a trade association for the refining and processing industry. Its role is to promote the refining and fractionation of palm oil and the manufacture of all palm products and by-products. It also has to support its members in attaining standard specifications for refined palm oil and its derivatives. The Palm Oil Refiners Association of Malaysia has issued a bulk contract for refined palm oil products for the past 15 years. The shippers, traders and dealers in Europe, the USA and Asia have widely accepted this bulk contract. The Malaysian Oleochemical Manufacturers Group was established in 1984 as a group under the Chemistry Industries Council of Malaysia. Today it is also a group under the Federation Of Malaysian Manufacturers. The primary objective of this group is to promote the interest of the oleochemical industry in Malaysia. The National Association of Smallholders is an umbrella body for all smallholders' associations in the country. The primary objective is to protect and promote the interest of smallholders where some smallholders have the oil palm crop in their fields. These oil palm smallholders will sell their harvest of ripe fresh fruit bunches to the nearby palm oil mills.

Industry Structure of the Palm Oil Production Chain in Malaysia

The genesis of the plantation industry was borne out of the British legacy where the then Malaya was treated as a primary commodity-producing colony. Since then, many of these plantation companies that have a listing in the Kuala Lumpur Stock Exchange, have changed ownership, that is from foreign ownership to that of local interest. Such likes are Sime Darby Berhad (Public Limited), Guthrie Berhad (Public Limited), Kulim Berhad (Public Limited), Golden Hope Berhad (Public Limited), Island and Peninsular Berhad (Public Limited) etc. These companies that started off as plantation companies have initially moved downstream especially in palm oil milling so as to harvest the benefits of economies of scale. In the 1980s and 1990s, and till today, many of these 'traditional' public listed companies have moved downstream in the areas of refining, oleochemical production and specialty fats production. These firms are highly vertically integrated in Malaysia and mainly export their various processed palm oil products in the international market. The more adventurous companies have gone overseas by having high value added palm oil related manufacturing facilities located there. These 'traditional' public listed

companies are going through a consolidation phase via merger and acquisition. A good example is the merger exercise between Golden Hope Berhad and Island and Peninsular Berhad (Sidek Kamiso, 2003).

Besides these 'traditional' public listed companies, FELDA, a vehicle of the Federal Government to help its citizens to attain a higher standard of living (Malaysia, 1991), has grown the palm oil business aggressively. FELDA can be considered the biggest palm oil company in Malaysia once its rationalisation exercise and public-listing has been completed. It is highly vertically integrated and is involved in plantation, milling, crushing, refining, oleochemical production, specialty fats production and even bulking facilities. FELCRA, another government vehicle, which is primarily involved in land consolidation and rehabilitation (Malaysia, 1991), and state corporations like Perbadanan Johor are also fairly highly vertically integrated in the palm oil production chain. The 'traditional' public listed companies, together with FELDA, FELCRA and state corporations are major league players in the Malaysian palm oil production chain.

The minor league in the Malaysian palm oil production chain has these following players concerned. Smaller-sized plantations, which are locally owned, either have remained as it is or have ventured into palm oil milling. The minor league also covers smaller plantations not only having milling but also palm kernel crushing facilities. A small number of firms that can be classified as *combined downstream corporations* is involved in two or at the most three sub-sectors for the various permutations of milling, palm kernel crushing, refining, oleochemical production and specialty fats production that do not own any plantation at all. Beside these players, there are standalone palm oil mills, standalone palm kernel crushers, standalone palm oil refineries and also standalone specialty fats production firms that do not own any plantation at all. These *combined downstream corporations* and standalones are either locally-owned or foreign-owned. Some of these *combined downstream corporations* that have invested in refining and oleochemical production, have mother or parent companies that are either large local corporations or multinationals. These *combined downstream corporations*, in the form of subsidiaries, are only minor league players in the palm oil production chain. However, this type of corporations has the potential to grow big in the years to come by tapping on the abundant resources for the downstreaming activities in Malaysia.

Export Orientation of the Palm Oil Production Chain in Malaysia

The export value of the palm oil production chain, which constitutes that of palm oil (crude palm oil and processed palm oil), palm kernel oil (crude palm kernel oil and processed palm kernel oil), palm kernel cake, oleochemicals, palm oil finished products and other oil palm related products, is RM19.6 billion in 2002, a 38.1% increase as opposed to RM14.2 billion in 2001. However, the export volume has increased marginally by 0.4%, that is 14,691,713 million tonnes in 2002 as compared to 14,630,035 in 2001. The higher increase in export value as compared to export volume is due to higher market prices for all the above products. The palm oil production chain is one of the largest contributors to the Malaysian export coffers. In addition, Malaysia also has significantly increased its import of oil palm products, constituting of palm oil, palm kernel oil and palm kernel, from 286,343 tonnes at a value of RM257.4 million in 2001 to 520,035 tonnes at a value of RM674.6 million. This shows a volume increase and value increase of 81.6% and 162.1% respectively (MPOB, 2003(b)). The import is either for the purpose of further downstreaming processing in Malaysia or transshipment to international markets. The export of Malaysian oil palm products is a part of the international oils and fats market where market demand emanates from the developed regions, emerging economies and developing economies.

Research Methodology

In this paper, the two central tenets of Ecological Modernisation Theory, political modernisation and the market aspect will be operationalized via the two linkages expressed as the government-industry linkage (G-I) and the industry-industry (I-I) linkage. This is to test whether the nature of these two linkages makes any difference in environmental reforms in the palm oil production sector. For the G-I linkage, the EMT postulated that the state's involvement in environmental policy is irrefutable but the difference lies in the way the state relates to the industrial polluters. The I-I linkage takes into account the relations and interactions between firms from the vertical and horizontal perspective (Mol, 1995).

The development of a quantitative methodology to test EMT has led to the formation of two sets of variables: the independent and dependent/outcome variables. The former set consists of an operationalization of the G-I linkage and I-I linkage for the purpose of 'measuring' the linkages. The latter set is in terms of 'measuring' the outcomes. This paper, which is based on the pilot study, is to clarify which variables can be used, especially in terms of availability and reliability of data. Besides this, it also aids in the selection of the types of respondents for the research proper.

The advantage of adopting a quantitative model is that it provides a good representation of the sector studied. The quantitative model developed can also be applied to other sectors and countries as well.

The state of Johore in Peninsular Malaysia was chosen for the pilot study as it can be considered the most developed state in terms of the palm oil production chain in Malaysia. It has the entire chain where it encompasses the upstream plantation sub-sector, milling sub-sector, palm kernel crushing sub-sector, refining sub-sector, oleochemical production sub-sector, bulking installation sub-sector and exporting sub-sector. The completeness of the palm oil production chain in Johore allows the study of the chain effect, that is highly vertically integrated firms versus lowly vertically integrated firms and also upstream dominant firms versus downstream dominant firms. The Johore state also has a good representation of the major league players like the 'traditional' public-listed companies, FELDA, FELCRA and Johore Corporation (a state corporation) in the palm oil production chain. Likewise, the minor league players like smaller-sized plantations with either a mill or otherwise, *combined downstream corporations*, standalone palm oil mills, standalone palm kernel crushers, refineries, oleochemical production firms and specialty fats production firms are also located in Johore.

As the state of Johore is a good representation of the palm oil production chain in Malaysia, it is suggested that a population study of all the players be carried out instead of sampling. The research results will be a good representation of the population. Besides that, the number of players is manageable as the Johore state has 37 corporations that are involved in milling (13 corporations have multiple mills in Johore; the remaining corporations have a palm oil mill each in Johore), 12 corporations involved in palm kernel crushing (all the corporations have a palm kernel crusher each in Johore), 15 corporations involved in refining (1 corporation has 3 refineries in Johore; 1 corporation has 2 refineries in Johore; the remaining corporations have a refinery each), 5 corporations involved in oleochemical production (all the corporations have an oleochemical production plant each) and 6 corporations involved in specialty fats production (all the corporations have a specialty fats production plant each) (MPOB, 2002, MPOB and Jora-Aki Technology Sdn. Bhd., 2003). As the number of corporations involved in refining, oleochemical production and specialty fats productions is fairly small, a population study would be more appropriate.

For this pilot study, a cross-section of firms in the palm oil production chain has been selected. This is shown in Table 1 below. The respondents selected were based on accessibility and the time constraint faced for this pilot study.

Table 1 Background of Respondents In The Palm Oil Production Chain

Types of Activities	Milling	Exporting and Palm Kernel Crushing	Exporting and Refining	Exporting, Refining and Specialty Fats Production	Exporting and Oleochemical Production	Total number of respondent firms
Number of respondent firms	4	1	1	3	1	10

Based on the narrative above, which is culled from primary (pilot study) and secondary sources, the various hypotheses outlined in Table 2 were developed.

TABLE 2 LIST OF HYPOTHESES BASED ON THE GOVERNMENT-INDUSTRY LINKAGE (G-I) AND INDUSTRY-INDUSTRY LINKAGE (I-I)

Hypothesis	Evaluative criteria	Operationalization of variables	<u>Sources</u>
Table 2a (G-I)			
H1: The more the industry is involved in the policy formulation and implementation, the better the environmental performance.	<ul style="list-style-type: none"> Institutional arrangements 	<ul style="list-style-type: none"> The influence of industry representatives in national councils and government institutional committees that are involved in shaping macro- policies for the sector (<i>policy formulation</i>). Policies implemented and policies that have environmental management as a central concern and their effectiveness (<i>policy implementation</i>). 	<ul style="list-style-type: none"> Interviewing firms Literature
H2: The more cooperation between G-I in technological development and technological transfer, the better the environmental performance	<ul style="list-style-type: none"> Institutional partnerships in technology development and transfer. 	<ul style="list-style-type: none"> The rate of cooperation between the company and various governmental agencies or statutory bodies in technology development. Technologies transferred that are related to new product/product 	<ul style="list-style-type: none"> Interviewing firms Literature Applications under the various governmental

		<p>development, the effectiveness of technology for the new product in increasing productivity/ value added and in environmental management (<i>only for oleochemical production and specialty fats production</i>).</p> <ul style="list-style-type: none"> Technologies transferred that are related to new process technology, the effectiveness of the new process technology in increasing productivity/ value added and in environmental management (<i>for all levels in the vertical chain, i.e. palm oil milling, palm kernel crushing, refining, oleochemical production and specialty fats production</i>). The application for the various governmental incentives (<i>for all levels in the vertical chain, i.e. palm oil milling, palm kernel crushing, refining, oleochemical production and specialty fats production</i>). 	incentives.
<p>H3: The more the regulatory efforts emphasize on the environmental issues, the better the environmental performance.</p>	<ul style="list-style-type: none"> Monitoring and enforcement by DOE Institutional arrangement amongst state/local authorities, political parties, non-governmental organisations, resident associations/ village committees 	<ul style="list-style-type: none"> The monitoring and enforcement of the Environmental Quality Act, subsidiary legislation and industry specific regulations under the Environmental Quality Act on factories Combined efforts by state/local authorities (as land come under state jurisdiction), non-governmental organisations, political parties, resident associations/village committees and DOE with regard to environmental concerns and violations 	<ul style="list-style-type: none"> Interviewing firms

	and DOE.		
H4: The more preventive the approach adopted by the various government ministries/agencies/statutory bodies, the better the environmental performance.	<ul style="list-style-type: none"> • Environmental policy approach • The level of advocacy and help in implementing the various standards 	<ul style="list-style-type: none"> • The environmental policies (e.g. OER, zero waste, etc.) advocated by the government, i.e. end-of-pipe, process-oriented and/or chain-oriented. • The advocacy and help in implementing ISO 9000 series, ISO 14000 series, ISO 18000 series (<i>only for milling, palm kernel crushing, refining, oleochemical production and specialty fats production</i>), ISO 22000 (HACCP) (<i>only for refining and specialty fats production</i>) by government ministries/agencies/statutory bodies. 	<ul style="list-style-type: none"> • Interviewing firms

Hypothesis	Evaluative criteria	Operationalization of variables	Sources
Table 2b(I-I)			
H5: The more export-oriented the companies are, the better the environmental performance.	<ul style="list-style-type: none"> • Exports according to regions. • Environmental standards/regulations according to regions. 	<ul style="list-style-type: none"> • Classification of exports by regions, i.e. EU, Other European Countries, North America, Latin America, West Asia, South Asia, Southeast Asia, East Asia, Africa and Oceania. • Existence of environmental standards or regulations as a requirement for market access to the above regions. 	<ul style="list-style-type: none"> • Interviewing firms • Statistics from MPOB
H6: The more international the relationship to developed countries, the better the environmental performance	<ul style="list-style-type: none"> • Integrated supply chain that have an operation in Malaysia or based overseas. 	<ul style="list-style-type: none"> • Part of the international integrated supply chain to TNCs or MNCs that have a domiciled operation in Malaysia: managerial/production/environmental cooperation amongst members of the chain, i.e. parent company, customers, suppliers/sub-contractors. • Existence of environmental 	<ul style="list-style-type: none"> • Literature: Company Annual Reports. • Interviewing firms.

		<p>standards or regulations as a requirement for market access for the TNCs or MNCs that have a domiciled operation in Malaysia</p> <ul style="list-style-type: none"> • Part of the international integrated supply chain to TNCs or MNCs that are based overseas: managerial/production/ environmental cooperation amongst members of the chain, i.e. parent company, customers, suppliers/sub-contractors. • Existence of environmental standards or regulations as a requirement for market access for the TNCs or MNCs that are based overseas. 	
H7: The higher the vertical integration, the better the environmental performance.	<ul style="list-style-type: none"> • The level of vertical integration • Exports according to regions. • Environmental standards/regulations according to regions. 	<ul style="list-style-type: none"> • The level of integration for a company, i.e. highly vertically integrated firms vs lowly vertically integrated firms. • The level of dominance in the vertical chain, i.e. upstream dominant firms vs downstream dominant firms vs highly vertically integrated firms. • The nearer the vertically integrated firm is to the end customer of a particular export region, the more wholesome the adoption of environmental management in the whole chain 	<ul style="list-style-type: none"> • Annual Reports • Interviewing firms
H8: The more local collaboration by the company, the better the environmental performance.	<ul style="list-style-type: none"> • Institutional arrangements • Industrial Networking 	<ul style="list-style-type: none"> • Involvement of parent company-subsidiaries, subsidiary-subsidiary, customers, suppliers and sub-contractors and other parties in joint programmes (managerial/production/ environmental cooperation, marketing, education, etc). 	<ul style="list-style-type: none"> • Literature • Interviewing firms • Annual Reports

From the pilot study, the dependent/outcome variables also known as environmental performance indicators identified are as listed in Table 3.

Table 3 The Dependent/Outcome Variables expressed as Environmental Performance Indicators

Environmental Performance Indicators	Sources
I. Generic Environmental Performance Indicators for all sub-sectors in the palm oil production chain: palm oil milling, palm kernel crushing, refining, oleochemical production and specialty fats production	
<ul style="list-style-type: none"> • ISO 9000series certification • ISO 14000series certification • ISO 18000 series certification 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • In the application process for ISO 9000series certification • In the application process for ISO 14000series certification • In the application process for ISO 18000 series certification 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • Publication of Corporate Environmental Report in the Annual Report 	<ul style="list-style-type: none"> • Interviewing firms • Annual Reports
<ul style="list-style-type: none"> • Air emission as compared to standard • Water emission as compared to standard • Noise level as compared to standard 	<ul style="list-style-type: none"> • Interviewing firms • Independent laboratory reports from the firms
<ul style="list-style-type: none"> • Increasing, constant or decreasing material utilisation per unit of product (qualitative) • Increasing, constant or decreasing water utilisation per unit of product (qualitative) • Increasing, constant or decreasing energy utilisation per unit of product (qualitative) 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • Increasing, constant or decreasing non-hazardous waste generation (qualitative) 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • Wastewater recycling and reuse 	<ul style="list-style-type: none"> • Interviewing firms
II. Specific Environmental Performance Indicators for Palm Oil Milling	
<ul style="list-style-type: none"> • Usage of EFB as fuel for boiler • Usage of shell as fuel for boiler • Usage of fibre as fuel for boiler. 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • Mulching of EFB 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • Usage of fibre for making medium density fibreboard 	<ul style="list-style-type: none"> • Interviewing

	firms
<ul style="list-style-type: none"> • Incineration of EFB 	<ul style="list-style-type: none"> • Interviewing firms
III. Specific Environmental Performance Indicators for Palm Kernel Crushing	
<ul style="list-style-type: none"> • Nil 	
IV. Specific Environmental Performance Indicators for Refining	
<ul style="list-style-type: none"> • ISO 22000 series certification (HACCP) 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • In the application process for ISO 22000 series certification (HACCP) 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • Increasing, constant or decreasing hazardous waste generation per unit of product i.e. spent bleaching earth and spent nickel catalyst 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • Recycling of spent bleaching earth 	<ul style="list-style-type: none"> • Interviewing firms
V. Specific Environmental Performance Indicators for Oleochemical	
<ul style="list-style-type: none"> • Nil 	
VI. Specific Environmental Performance Indicators for Specialty Fats	
<ul style="list-style-type: none"> • ISO 22000 series certification (HACCP) 	<ul style="list-style-type: none"> • Interviewing firms
<ul style="list-style-type: none"> • In the application process for ISO 22000 series certification (HACCP) 	<ul style="list-style-type: none"> • Interviewing firms

Statistical Tools

Correlation Analysis

In this research, the relationship between the environmental performance and the G-I variables, and the I-I variables will be analysed via Spearman rank correlation analysis. The correlation coefficient ranges from +1 to -1 and it indicates the presence, strength and direction of a linear relationship between two variables. The positive sign indicates a positive relationship and vice versa, whilst the absolute size indicates how strongly the two variables are related. A higher correlation coefficient indicates a higher relationship between the two variables. On the other hand, a lower correlation coefficient indicates a lower relationship between the two variables. Table 4 shows the Rules of Thumb to determine the strength of association (Burns and Bush, 1998).

TABLE 4 Rules of Thumb about Correlation Coefficient Size

Correlation Range	Strength of Association*
±0.81 to ± 1.00	Strong
±0.61 to ± 0.80	Moderate
±0.41 to ± 0.60	Weak
±0.21 to ± 0.40	Very Weak
±0.00 to ± 0.20	None

* Assuming the correlation coefficient is statistically significant

Source: Burns and Bush, 1998: 552.

The usage of this statistical tool can be illustrated via an example. Let's use H1 as an example. In the case of H1 i.e. the more the industry is involved in the policy formulation and implementation, the better the environmental performance (column 1 in Table 2), there are two independent variables (Column 3 i.e. operationalization of variables in Table 2) and they are as follows:

- The influence of industry representatives in national councils and government institutional committees that are involved in shaping macro-policies for the sector (policy formulation).
- Policies implemented and policies that have environmental management as a central concern and their effectiveness (policy implementation).

The first independent variable is used to illustrate the point in case. To determine whether the correlation coefficient is statistically significant at the 0.01 level, we hypothesized the relationship and then test the hypothesis at the 0.01 level of significance. For example, the relationship between the environmental performance and the influence of industry representatives in national councils and government institutional committees that are involved in shaping macro-policies for the sector can be tested by formulating a null hypotheses (H_0) and an alternative hypothesis (H_a), as expressed below:

H_0 : There is no relationship between the environmental performance and the influence of industry representatives in national councils and government institutional committees that are involved in shaping macro-policies for the sector

H_a : There is a relationship between the environmental performance and the influence of industry representatives in national councils and government institutional committees that are involved in shaping macro-policies for the sector.

These hypotheses will be tested at a two-tailed level of significance(α) of 0.01. If the significance level (indicated by the SPSS output) is less than 0.01, H_a is accepted while H_0 is rejected (Burns and Bush, 1998). This indicates that there is a significant relationship between the two variables, or, alternatively it "means that the relationship between the two variables is significantly different from zero." (Bailey, 1978: 332).

This would be repeated for the other independent variable in H1. If, for example, the correlation coefficients of the two independent variables with Y are significant at $\alpha=0.01$, and if the correlation coefficient of the first independent variable is higher than the second, the conclusion is that the first independent variable has a higher relationship with Y as compared to the second independent variable.

This will also be repeated for all the other hypotheses (H2 to H8 in Table 2) and the associated independent variable/s (under the column Operationalization of Variables).

Multiple Regression Analysis

The relationship between a dependent variable (Y) and the independent variables (Xs) can be analysed via multiple regression analysis. The multiple regression equation can be expressed as follow:-

$$Y_{\text{epopc}}' = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \dots + b_nX_n \quad \dots(1)$$

where

Y_{epopc} : Environmental performance indicator for the entire palm oil production chain

$X_1 \dots X_{10}$: (G-I variables as indicated in Table 2 (a) above)

$X_{11} \dots X_{20}$: (I-I variables as indicated in Table 2(b) above)

The coefficient of multiple determination is denoted by R^2 (Churchill, 1976). For example, if R^2 is 0.80 (usually obtained in the Model Summary in the SPSS output), this indicates that 80% of the variations in the dependent variable are due to the independent variables specified in the model. The effect of each independent variable on the dependent variable, with the effects of all other independent variables in the equation controlled for, is indicated by each of the regression coefficients ($b_1, b_2, b_3, b_4, \dots b_n$). The directions and the strengths of the relationships between the dependent variable and the independent variables are indicated respectively by the signs and values of the regression coefficients in the regression model (Bailey, 1978).

In this research, the overall Y (dependent/outcome variable) for a particular sub-sector is the average of all the Generic Environmental Performance Indicators (EPIs) and Specific Sub-sectoral EPIs (as listed in Table 3).

For example, in the palm oil milling sub-sector, the value of the overall Y (Y_{pom}) is :

$$Y_{\text{pom}} = \frac{(Y_1 + Y_2 + Y_3 + Y_4 + Y_5 + Y_6 + Y_7 + Y_8 + Y_9 + Y_{10} + Y_{11} + Y_{12} + Y_{13} + Y_{14} + Y_{15} + Y_{16} + Y_{17} + Y_{18} + Y_{19} + Y_{20} + Y_{21})}{22}$$

where

Y_{pom} : Overall Y for palm oil milling sub-sector

Y_1 : ISO9000 series certification (if relevant)

Y_2 : ISO14000 series certification (if relevant)

Y_3 : ISO18000 series certification (if relevant)

Y_4 : In the application process for ISO9000 series certification (if relevant)

Y_5 : In the application process for ISO14000 series certification (if relevant)

Y_6 : In the application process for ISO18000 series certification (if relevant)

Y_7 : Publication of Corporate Environmental Report In the Annual Report

Y_8 : Air emission as compared to standard

Y_9 : Water emission as compared to standard

Y_{10} : Noise level as compared to standard

Y_{11} : Increasing, constant or decreasing material utilization per unit of product (qualitative)

Y_{12} : Increasing, constant or decreasing water utilization per unit of product (qualitative)

Y_{13} : Increasing, constant or decreasing energy utilization per unit of product (qualitative)

Y_{14} : Increasing, constant or decreasing non-hazardous waste generation (qualitative)

- Y₁₅ : Wastewater recycling and reuse
- Y₁₆ : Usage of EFB as fuel for boiler
- Y₁₇ : Usage of shell as fuel for boiler
- Y₁₈ : Usage of fibre as fuel for boiler
- Y₁₉ : Mulching of EFB
- Y₂₀ : Usage of fibre for making medium density fibreboard
- Y₂₁ : Incineration of EFB

This will be repeated for the other individual sub-sectors in the palm oil production chain, namely the overall Y for palm kernel crushing sub-sector (Y_{pkc}), overall Y for refining subsector (Y_r), overall Y for oleochemical production sub-sector (Y_{ocp}) and overall Y for specialty fats production subsector (Y_{sfp}).

This can also be extended for the entire palm oil production chain. The overall Y for the entire palm oil production chain (Y_{epopc}) is the average of all the overall Ys for each particular sub-sector, as expressed below:

$$Y_{epopc} = \frac{Y_{pom} + Y_{pkc} + Y_r + Y_{ocp} + Y_{sfp}}{5}$$

where:

- Y_{epopc} : Overall Y for the entire palm oil production chain
- Y_{pom} : Overall Y for the palm oil milling sub-sector
- Y_{pkc} : Overall Y for the palm kernel crushing sub-sector
- Y_r : Overall Y for the refining sub-sector
- Y_{ocp} : Overall Y for oleochemical production sub-sector
- Y_{sfp} : Overall Y for specialty fats production sub-sector

This statistical method also allows for a comparison between the highly vertically integrated firms and the lowly vertically integrated firms. In the case of the highly vertically integrated firms, which are involved in palm oil milling, palm kernel crushing, refining, oleochemical production and specialty fats production, the overall Y for the highly vertically integrated firms is the average of all the overall Ys for each sub-sectoral participation as expressed below:

$$Y_{HVI} = \frac{Y_{pom} + Y_{pkc} + Y_r + Y_{ocp} + Y_{sfp}}{5}$$

where:

- Y_{HVI} : Overall Y for the highly vertically integrated firms
- Y_{pom} : Overall Y for the highly vertically integrated firms in palm oil milling sub-sector
- Y_{pkc} : Overall Y for the highly vertically integrated firms in palm kernel crushing sub-sector
- Y_r : Overall Y for the highly vertically integrated firms in refining sub-sector
- Y_{ocp} : Overall Y for the highly vertically integrated firms in oleochemical production sub-sector
- Y_{sfp} : Overall Y for the highly vertically integrated firms in specialty fats production sub-sector

If for example the lowly vertically integrated firms are involved in palm oil milling and palm kernel crushing, the overall Y for the lowly vertically integrated firms is the average of all the overall Ys for each sub-sectoral participation as illustrated below:

$$Y_{LVI} = \frac{Y_{pom} + Y_{pkc}}{2}$$

where:

Y_{LVI} : Overall Y for the lowly vertically integrated firms

Y_{pom} : Overall Y for the lowly vertically integrated firms in palm oil milling sub-sector

Y_{pkc} : Overall Y for the lowly vertically integrated firms in palm kernel crushing sub-sector

Cross Tabulation

The above analysis will be supplemented by cross-tabulation for descriptive purposes.

Cronbach Alpha

In order to ensure reliability, the Cronbach Alpha will be used. The utility of Cronbach Alpha is that it allows for the deletion of items (independent variables) so as to increase reliability. (Coakes and Steed, 2001).

Conclusion

Based on the above discussion, this research methodology will be further refined via the on-going pilot study prior to the research proper itself.

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APPENDIX I
**Types of Manufacturing Activities And The Products Manufactured In The Palm Oil
Production Chain**

Types of Manufacturing Activities	Products
Palm Oil Milling	<ul style="list-style-type: none"> • Crude Palm Oil • Palm Kernel
Palm Kernel Crushing	<ul style="list-style-type: none"> • Crude Palm Kernel Oil • Palm Kernel Meal
Refining	<ul style="list-style-type: none"> • RBD Palm Oil • RBD Olein • RBD Stearin • RBD Palm Kernel Oil • HPK Olein • HPK Stearin • RBD Palm Kernel Olein • RBD Palm Kernel Stearin
Oleochemical Production	<ul style="list-style-type: none"> • Fatty acids • Fatty alcohol • Methylester • Glycerine • Soap noodles
Palm Oil Finished Products (basically from specialty fats)	<ul style="list-style-type: none"> • Shortening • Vegetable ghee/vanaspati • Cocoa butter substitute/replacer/equivalent • Vegetable/dough fats • Margarine • Confectionaries
Other Oil Palm Products	<ul style="list-style-type: none"> • Sludge Oil • Industrial Grade Palm Oil • Palm Fatty Acid Residue • Pitch Oil • Residue • High FFA Acid Oil • Mixed Acid Oil • Mixed Veg. Acid Oil

Source: (1) MPOB 2003(a). *Malaysian Oil Palm Statistics 2002, 22nd Edition.*
(2) MPOB 2003(b). *Review of the Malaysian Oil Palm Industry 2002.*