

CHAPTER 4 - RESEARCH METHODOLOGY

4.1 Introduction

Chapter 2 reviewed the literature on the mode of entry of MNCs into the petrochemical industry in Malaysia and how this relates to the development of local suppliers in the industry. Following that, three research questions were formulated. These research questions were investigated with the help of a mix of quantitative and qualitative methods that is described in this chapter, which has four major sections. The first section defines the term ‘research’ and describes the paradigm that was used to select and justify the mix of quantitative and qualitative methods in the study. The second section provides an overview of research design for quantitative and qualitative methods – the sample techniques, the methods of data collection, and the number of cases and interviews of the MNCs and the local suppliers. The third section describes the methods used in data analysis for both the quantitative and qualitative methods, and the fourth describes the characteristics and preliminary findings of the study. The chapter concludes with a justifications of the methodology used for the research.

4.2 Definition of Research and Research Approaches

According to Hernon (1991:4), research is defined as “an inquiry process that has clearly defined parameters and has as its aim either to discover and create knowledge, or to test, confirm or refute knowledge and to investigate a problem for local decision making.” In another definition, research is an attempt to increase the body of knowledge by discovering new facts or relationships through a systematic inquiry (Macleod and Hockey, 1989).

To answer the questions of the present study requires a design for the research and a research method using a research paradigm. A paradigm can be defined as a set of assumptions linked together in an investigation of the world (Deshpande, 1983). According to Deshpande (1983:102), paradigms “determine both what problems are worthy of exploration and also what methods are available to attack them.” Lincoln and Guba (1985) define a paradigm as a view of the world that cannot be proven or disproven by logic from outside that world-view.

There are numerous paradigms to guide research. In a review of paradigms, Guba and Lincoln (1994) list four that may be used to guide research: positivism, realism, critical theory and constructivism. These four paradigms are summarized in Table 4.1, which describes each of them in terms of its ontology, epistemology and methodology. Bonoma (1985), on the other hand, recognized just two types of inquiry: the qualitative and quantitative paradigms. Parkhe (1993) also divides inquiry into two kinds: inductive and deductive.

Moving to the choice of the methodology that forms part of a paradigm, there are two kinds of methodology used in research: quantitative and qualitative (Zikmund, 1997; Wimmer and Dominick, 1983). This section justifies the use of a mixed quantitative and qualitative research method. It begins by illustrating the characteristics of the quantitative and qualitative methods, and then considers the mixed method.

Quantitative research is essentially a statistics-centric method (Malhotra, 1993:159) in which numerical data are utilized to obtain information about the world (Burns and Grove, 2005). Quantitative data therefore constitute numbers and deal with variables, statistics, hypotheses, replication and scales (Neuman, 1994). The research method is experimental in nature, with the results either supporting or rejecting an explanation. The method is used for large samples, as statistically significant levels provide

generalizability of findings (Zikmund, 1997). Quantitative research is inclined to be deductive in nature.

Qualitative research, on the other hand, is based on ‘world-view,’ which is holistic (Hunter, 2004). Hunter opines that reality is based upon the perceptions of each person within a given situation or context and will change over time. Qualitative research involves the use of qualitative data, such as interviews, documents and participants’ observations, to understand and explain social phenomena. It usually comprises words, sentences, and paragraphs (Neuman, 1994). The qualitative approach to data collection discovers information about the phenomena from the perspective of the interviewee.

Table 4.1: Research Paradigms

	Research Paradigms			
	Positivism	Scientific Realism	Critical Theory	Constructivism
Ontology	An apprehensible reality exists driven by immutable natural mechanisms, and the investigator and reality are independent.	‘Reality’ is imperfectly apprehensible due to human mental limitations and the complexity of the world.	‘Reality’ is shaped by social and other forces, and research should emancipate the perceptions of co-researchers and participants.	‘Reality’ is constructed by people (and a researcher), and therefore there is no ‘truth’.
Epistemology	‘One-way mirror’ observer.	Observer with some level of participation, as dualism cannot be maintained but some objectivity is sought.	Transformative intellectual.	Passionate participant.
Methodology	Survey and experiments.	Case studies, interviews, convergent interviewing.	Action research.	In-depth interviews, participant observation.

Sources: Lincoln and Guba (1985); Guba and Lincoln (1994); and Healy and Perry (2000).

Unlike the statistical findings of quantitative methods, qualitative research findings are used to build a theory for further testing through quantitative or other methods; they are not used to test theories or make generalizations about a population (Marshall and Rossman, 1995; Maykut and Morhouse, 1994). These characteristics of qualitative

research allow for the gathering of deep and rich information that will give a better perspective on and insights into the phenomena being studied (Deshpande, 1983; Maykut and Morhouse, 1994).

The most important difference between quantitative and qualitative research is that qualitative research allows for flexibility in gathering of information and in-depth exploration of issues in a less structured format than that of quantitative research, and with a smaller number of respondents (Bellenger et al., 1989; De Ruyter and Scholl, 1998). Many policy makers, academics and business give low credibility to studies based only on the qualitative approach (McDaniel and Gates, 1993; Easterby-Smith et al., 1991). They are reluctant to base important decisions on a very small sample that relies mainly on the interpretation of the researcher, compared to one based on a large sample with a statistically significant level of quantitative research (McDaniel and Gates, 1993). However, Creswell (2003:208) states that “with the development of both quantitative and qualitative research in the social and human sciences, mixed methods research, employing the data collection associated with both forms of data, is expanding.” Quantitative and qualitative research methods are often used to complement each other (Brewer and Hunter, 1989; Creswell, 1994; and Tashakkori and Teddlie, 1998) – for example, they may be applied in different phases of a research project (Zikmund, 1997; Bellenger et al., 1989; De Ruyter & Scholl, 1998). Flexibility in the number of respondents allows qualitative research to be used sometimes in the inductive parts of quantitative research (Bellenger et al., 1989; McDaniel and Gates, 1993; Malhotra, 1993). Therefore, more studies are now making use of mixed methods in studying social phenomena.

Several sources identify the evolution of mixed methods in psychology (Creswell, 2003). Many different terms – such as integrating, synthesis, multi methods, or

‘quantitative and qualitative methods’ – are used for this approach, but the most recent writings call it ‘mixed methods’ (Tashakkori and Teddlie, 2003). Creswell (2003:18) defines the mixed-methods approach as “one in which the researcher tends to base knowledge claims on pragmatic grounds (e.g., consequence-oriented, problem-centered, and pluralistic). It employs strategies of inquiry that involve collecting data either simultaneously or sequentially to best understand research problems. The data collection also involves gathering both numeric information (e.g. on instruments) as well as text information (e.g., on interviews) so that the final database represents both quantitative and qualitative information.” Table 4.2 summarizes the three methods – quantitative, qualitative and mixed – in terms of the full range of possibilities for data collection in any study.

Table 4.2: Quantitative, Qualitative and Mixed Methods Procedures

Quantitative Research Methods	Qualitative Research Methods	Mixed Methods Research
Predetermined instrument-based questions. Performance data, attitude data, observational data, and census data. Statistical analysis.	Emerging methods. Open-ended questions. Interview data, observation data, document data, and audiovisual data. Text and image analysis.	Both predetermined and emerging methods. Both open-ended and closed-ended questions. Multiple forms of data, drawing on all possibilities. Statistical and text analysis.

Source: Creswell (2003:17)

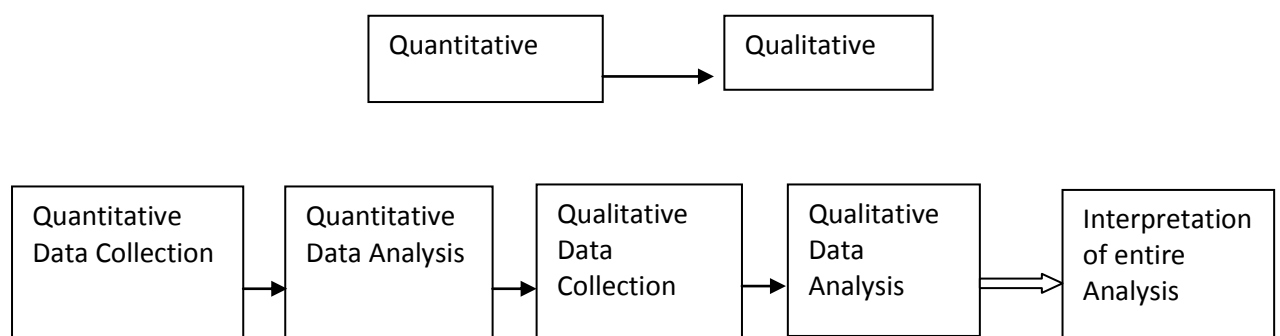
4.3 Choice of Research Method

Choosing the right research approach is essential in research. The research approach to be used depends on the nature of the investigation and the type of information that is available or required (Naoum, 1998).ⁱ The present research on linkage capabilities in

Malaysia's petrochemical industry is rather exploratory, in that it aims to discover something of interest and to give directions for future research. To the best knowledge of the researcher, no study on linkage capabilities between foreign or local contracting companies and MNCs in the petrochemical industry has been done before in Malaysia. The research methodology of this study is based on a mixed-methods approach and uses a case study strategy with a comparative approach.

This study uses mixed methods in a single paradigm. Specifically, the study follows Creswell's (2003:215) sequential explanatory strategy, which is characterized by two stages: a survey questionnaire that is collected and analyzed quantitatively, and the collection and analysis of qualitative data. The priority in such a strategy is typically given to the quantitative data, but the results of the two methods are integrated during the interpretation phase of the study. The steps of the strategy are illustrated in Figure 1.1 (see Chapter 1). The purpose of the twofold strategy is to use qualitative results to assist in explaining and interpreting the findings of the quantitative study. The two methods are used to establish the similarities, differences and complementariness of the assumptions under study.

Figure 4.1: Sequential Explanatory Design



Source: Creswell (2003:213)

4.4 Conceptual Development – Case Studies

There are various classifications in qualitative research methodology. For example, Whitman and Woszczyński (2004) classify qualitative research methodology into five areas, as follows: action research, case study, ethnography, grounded theory and narrative inquiry. Case studies involve examination of a phenomenon in its natural setting (Pinsonneault and Kraemer, 1991: 10). As an observer, the researcher has no control over the phenomenon but can control the scope and time of the examination. Furthermore, the researcher may or may not have clearly defined independent and dependent variables. Case studies are most appropriate when the researcher is interested in the relation between context and the phenomenon of interest.

The case-study method is deemed appropriate to answer the research questions presented in Chapter 2. This is in line with the recommendation by Yin (1994) that case studies are appropriate in situations where the research question involves a ‘how,’ ‘why’ or exploratory ‘what’ question. Yin (1989:23) also submits that “a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used.” In case studies, the researcher explores a single entity or phenomenon (the case) that is bounded by time and activity (a program, event, process, institution or social group) and collects detailed information by using a variety of data gathering procedures during a sustained period of time (Creswell, 1994).

Yin (1989:21) also introduced a distinction between analytical generality and statistical generality. He admitted that a case study is like an experiment, that it does not represent a ‘sample,’ and that the investigator’s goal is to expand and generalize theories (analytic generalization) and not to enumerate frequencies (statistical

generalization). Moreover, studies are multi-perspective analyses, which means that the researcher considers not just the voice and perspective of the actors, but also those of the relevant groups (Feagin et al., 1991) of actors and the interaction between them. This seems appropriate for the present research because several respondents in this research were not willing to discuss subjects regarded as confidential by the organizations concerned. The researcher was of the opinion that the case-study approach might uncover several issues during interviews with the respondents, since this research deals with an under-researched area in Malaysia and investigates a build-up of trends in inter-organizational linkages.

Based on the above arguments, the author was of the opinion that an approach involving both quantitative methods and qualitative methods and a case study was best suited for this research.

4.5 Judging the Quality of the Case Study

Creswell and Miller (2000) argue that although validity, credibility and reliability are commonly associated with quantitative research, case studies also require qualitative research to ensure their quality and validity. This section discusses the criteria used in the research for the case study to establish its validity, credibility and reliability.

Construct validity

Construct validity is concerned with the ability of a measurement instrument to measure for the concepts under examination (Cooper and Emory, 1995 and Aaker and Day, 1990). It is a question of whether the research is measuring what it is intended to measure. Construct validity may be achieved in three ways for case-study research: using multiple sources of data during data collection, establishing a chain of evidence

in the data collection, and detecting any inconsistencies and ambiguities. Any such inconsistencies detected in the course of the present study were clarified with the respondents during the data analysis and report writing stages (Riege and Naire, 1996; and Miles and Huberman, 1984).

For this research, concepts were operationalized on the basis of constructs discussed in the literature review chapter. The three ways of achieving construct validity were also applied. Firstly, multiple sources of evidence were used. For this purpose the study used a literature review, case research interview protocols, and documents collected during the case interviews. By using multiple sources of evidence, it was possible to clarify concepts and triangulate evidence from the data sources. The interviews were designed to engage various types of data sources from the industry. Secondly, to ensure proper management of the data collected, an individual file was created for data keeping. Lastly, any inconsistencies and ambiguities were clarified with the respondents. Peer review was done by the researcher's supervisor and other researchers.

Credibility/Internal validity

The next criterion in judging case-study research is credibility and internal validity. Credibility is about establishing whether the findings reflect the reality of the phenomenon under investigation (Tsoukas, 1989; and Gummerson, 1988). Establishing credibility can be achieved using several methods, such as triangulation and pattern matching, within-case analysis, cross-case analysis and verification of findings (Miles and Huberman, 1994), and by asking interviewees to state whether the findings and conclusions drawn from the interviews reflect what was meant by the interviewees (Burns, 1994; Gabriel, 1990; and Hirschman, 1986).

In this research, credibility was achieved by using all the three methods, as in the construct of the data analysis chapter.

Transferability/External validity

External validity or transferability is “the extent to which causal relationships can be generalized to and across different times, settings, persons and measures” (Lincoln and Guba, 1985: 22). That is, it is the generalizability of qualitative research. In quantitative research, for example, external validity is achieved using simple random sampling or by controlling the sample size to draw a sample that is truly representative. According to Yin (1994), the issue of external validity is a major stumbling-block in case-study research. It is difficult to generalize from a single case study.

The present research is a multi-case study. The aim here is to generalize to certain theories rather than to a larger population (Miles and Huberman, 1994). Some tactics recommended by Tsoukas (1989) on theoretical and literal replications were used in cross-case analysis of the study by comparing the research findings to the extant literature (Miles and Huberman, 1994). See the final chapter for this comparison.

Reliability

Reliability refers to the consistency of results produced by a measuring instrument when it is applied a number of times in similar situations (Yin, 1994). To achieve reliability, researchers must use instruments that are stable and consistent (Hirschman, 1986). In qualitative research, however, it is the researcher who is the instrument. This raises the question of whether the same study can be replicated to get the same results

using the same methods as were used previously (Gabriel, 1990 and Gummerson, 1988).

Three procedures were developed to ensure the reliability of the findings in the multi-case study. Firstly, the procedures or techniques used in the research process were consistent (Riege and Nair, 1996). This was achieved by using a case research protocol that outlined the whole process of data collection and the procedures to be followed (Yin, 1994), as shown in Table 4.3. Secondly, in accordance with the protocol, data was collected systematically during the interviews by using a set of prescribed questions. Thirdly, a case research database (Yin, 1994) was maintained to preserve a copy of all important documents and evidence.

Table 4.3: Case Study Protocol Elements

Protocol Elements	Essential components
Overview of the case study project	<ul style="list-style-type: none"> • Project objectives and auspices. • Case study issues. • Relevant readings about the topic being investigated.
Field procedures	<ul style="list-style-type: none"> • Credentials and access to the case study site. • General sources of information. • Procedural reminders.
Case study questions	<ul style="list-style-type: none"> • Specific interview questions. • Potential sources of information for answering each question.
A guide for the case study report	<ul style="list-style-type: none"> • Outline. • Format for the narrative and specification of any bibliographical information. • Other documentation.

Source: Yin (1994)

4.6 Research Design

This study employs a mixed-methods approach to collect and analyze quantitative and qualitative data on inter-organizational linkages between MNC subsidiaries and their suppliers. Quantitative methods can be used to test hypotheses or to replicate findings based on the quantitative data, whereas qualitative methods allow the understanding of a phenomenon from the point of view of the researcher. The combination of both methods can yield more useful, rich and valid data for the phenomena under study. A case study with a comparative approach is undertaken for the qualitative study because a case study can be done on any system in social units that can be compared for a desired outcome (Yin, 1989).

In view of the advantages of the mixed-methods approach, the methodology adopted in this study combines the quantitative and qualitative techniques of data collection. Specifically, the study utilizes the sequential explanatory strategy model developed by Creswell (2003:215), which is characterized by the collection and analysis of the survey questionnaire based on a quantitative approach, followed by the collection and analysis of qualitative data (Creswell, 2003:213). Furthermore, the study uses mixed methods in a single paradigm, under which the qualitative data collection originates from the responses given in the quantitative data collection. The procedures developed for this research are shown in Figure 4.1. Each step is reported in turn in the following sections.

The Role of Prior Theory

The first step in research is to clarify the area of interest and the rationale for choosing the topic. This is followed by a review of the literature and secondary documents to identify research issues. The formulation of a defined research question will guide and

drive the data collection process and the analysis of the data. It follows that prior theory must be taken into account in designing the research process (Eisenhardt, 1989) and guiding the data collection and analyzing it (Yin, 1994).

Research Design Process

Once the research question is identified, the next step is the formulation of the hypothesis. The research instrument is then developed, based on the literature review. For quantitative methods, the research instrument is a questionnaire, while for qualitative methods it consists of structured interview questions. The mixed-methods approach of the present research involved both the questionnaire survey and structured interview questions, conducted one after the other, as shown in STEP 1 in Figure 1.1. The quantitative methods approach is indicated as ‘Approach I’ and the qualitative methods approach is indicated as ‘Approach II.’

The mixed-methods design derives from a technique pioneered by Campbell and Fiske (1959). Their technique relied on triangulation, which is defined as a combination of methodologies in the same study of the same phenomena (Denzin, 1978; Creswell, 1994; Robson, 1999). According to Denzin (1978:6), there are four different forms of triangulation: 1) data triangulation; 2) investigator’s triangulation; 3) theory triangulation; and 4) methodological triangulation. The use of several different methods for a study should give greater validity and reliability than using a single method (Denzin, 1978 and Creswell, 1994). A number of researchers argue that quantitative and qualitative research methods, when taken together as ‘mixed methods,’ are complementary rather than rival (Creswell, 1994; Robson, 1999; and Tashakkori and Teddlie, 1998).

4.6.1 Quantitative Design - Approach 1

The main goal of the empirical part of the present research was to collect information from a sufficient number of respondents (MNC subsidiaries and local suppliers) to obtain detailed quantitative and qualitative information about them. For Approach I, the survey questionnaire was centered on the following: 1) whether the corporate strategies of MNC subsidiaries based on their mode of entry affect the form and quality of backward linkages; 2) whether, when other factors are made constant, external factors affect the quality of backward linkages; 3) whether the technological capability of local suppliers has been developed; and 4) whether there is any depth and breadth in the backward linkages formed between local suppliers and their customers. The results were to show, among other things: 1) whether there are differences in the learning processes of either MNC subsidiaries or their suppliers; 2) whether there are differences in the depth and breadth of backward linkages; 3) whether MNC subsidiary typology affects the formation of technological knowledge among local suppliers; 4) the factors that contribute to higher levels of technological capability and depth of backward linkages; and 5) how the technological capability of local suppliers is upgraded.

Methods of Data Collection

There are various possible instruments, such as a mail survey, an Internet survey, a telephone interview or a face-to-face interview, that are used in data collection. All of these methods use a questionnaire that may be closed-ended, open-ended or a mix of both. The questionnaire used in this study is semi-structured. The responses are quantitative and qualitative in nature and are restricted to binary, duration and four- or five-point Likert scale measurements, depending on the nature of the questions. Two sets of survey questionnaires were designed for the study, as shown in appendices III

and IV. The questionnaire instrument was designed to accommodate responses from MNC subsidiaries as well as their local suppliers. Thus, the result would overcome the biases that might result from relying wholly on the perspective of the MNC subsidiaries, or that of the suppliers. The questionnaire used direct interviews with managers in the purchasing and marketing departments and also with company directors. The two sets of questionnaires were used i) to analyze MNC subsidiaries' production and purchasing strategies; ii) to analyze the nature of local suppliers' technological learning from their customers; and iii) to provide insights into the depth and breadth of the backward linkages.

The questionnaire for the MNC subsidiaries included sections on the following:

- I. The general background of the respondents and their firms, including the firm's activity in the petrochemical industry.
- II. The firm's external linkages: this section deals with the mode of entry strategy of the subsidiary, its purchasing activity and its level of imports and export.
- III. Types of backward linkage: this section asks about the types of backward linkage that have been provided to the local suppliers, namely product-related linkages, process linkages, training linkages, innovation linkages, managerial linkages and other forms of provided linkages.
- IV. Costs and benefits of backward linkages: this section addresses the issue of whether the linkages to the local suppliers have helped the development of the local suppliers.
- V. MNC subsidiaries' autonomy: this section asks the autonomy level of the subsidiary. The responses from this section together with the mode of entry strategy in the second section are analyzed to make judgments in the

development of backward linkages in the petrochemical industry in Malaysia.

The questionnaire for local suppliers included the following sections:

- I. The general background of the respondents and their firms, including the firm's activity in the petrochemical industry.
- II. The firm's external linkages: this section deals with the firm's customers and supplying activity, including distribution inside and outside of Malaysia.
- III. Types of backward linkage: this section asks about the types of backward linkage that local suppliers receive from MNC subsidiaries, namely product-related linkages, process-related linkages, training-related linkages, innovation linkages, managerial linkages and other forms of provided linkages.
- IV. Benefit of backward linkages: this section addresses the issue of whether the linkages received by local suppliers have helped them develop their technological capability.

4.6.2 Qualitative Design - Approach II

After going through the semi-structured questionnaire as shown in Approach I, the researcher could not obtain the desired number of responses from the respondents. Time constraints on participants meant that in-depth information regarding some important issues for the study could not be obtained. Also, the nature of the semi-structured questionnaire did not require the participants to answer the questions in great detail. As a result, a case study was designed, as shown in Approach II. The case-study design comprised the following processes: 1) justification for the type of case

study, whether single case or multiple case; 2) case selection; 3) data collection procedures; and 4) the case study protocol.

Types of Case Studies

According to Yin (1994), there are four types of case-study research design to choose from. They are shown in Table 4.4. Type 1 comprises of a single-case design with a single unit of analysis (column 1, row 1). Type 2 is a single-case design with multiple units of analysis (column 1, row 2). Type 3 and Type 4 are multiple-case designs with, respectively, a single unit of analysis (column 2, row 1) and multiple units of analysis (column 2, row 2). In selecting a research design for a case study, the choice of a unit of analysis is essential.

Table 4.4: Types of Design for Case Studies

	Single-case design	Multiple-case design
Holistic (single unit of analysis)	Type 1	Type 3
Embedded (multiple unit of analysis)	Type 2	Type 4

Source: Adapted from Yin (1994:39)

Should the case research design be holistic or embedded? A case is considered holistic if it contains only one unit of analysis, and is considered embedded if it contains multiple units of analysis (Yin, 1994). The unit of analysis is what constitutes the case. For example, the unit of analysis can be individuals, organizations or phenomena (Yin, 1994 and Hussey and Hussey, 1997). The selection of the unit of analysis will guide the sample selection and sampling strategy to be used in the data collection process

(Patton, 1990). For this research, the unit of analysis is the firm. Thus this research uses a single unit of analysis.

Should the case study be single or multiple? Research can use a single case, but it is very rare or extreme to do so, and it is only done when finding other cases is unlikely (Yin, 1994). As enlargement of the field of observation provides rich data sources, which in turn enhance the explanatory power for the phenomena under study (Dogan and Pelassy, 1984), the present research employs different types of firms and their inter-organizational relationships with other firms in the industry for its observation. For the MNC subsidiaries, there are five types of firms in the population, whereas in the local suppliers' typology there are two types to be examined. This research is therefore considered to be a multiple-case study.

Selection of Cases

From the above discussions, a multiple-case, holistic research design was identified for this research.

Patton (1990) identified two types of logic for the selection of cases: sampling logic and replication logic. Replication logic is a purposive sampling selection, whereas sampling logic is a random sampling selection. According to Patton (1990), purposive sampling should be used for multiple case studies, because relevance rather than representativeness is the criterion for case selection (Stake, 1994). Purposive sampling also means that it is important to get data from sources that are most relevant for providing rich information to address the research problem (Lincoln and Guba, 1985; and Patton, 1990).

The selection of cases is carried out to achieve both theoretical and literal replication (Eisenhardt, 1989; Perry, 1998; and Yin, 1994). Theoretical replication is where cases are selected to produce contrary results for predictable reasons, whereas literal replication is where cases are selected to produce similar results for predictable reasons. Therefore, if random sampling is used for the collection of data, it would miss its intended purpose. As pointed out by Eisenhardt (1989:537), “random selection of cases is neither necessary, nor even preferable.”

This research tries to achieve theoretical replication by aiming to investigate whether different types of firms develop different inter-organizational linkages with their suppliers. The factors were identified through the literature review and it was suggested that there are differences in the depth and breadth of linkages formed between MNC subsidiaries and their local suppliers.

Based on this, the research aimed to achieve theoretical replication by selecting cases or firms that would differ from one another. Therefore theoretical replication required cases to be gathered for each set of MNC subsidiaries and each set of local suppliers.

Number of Cases and Interviews

There is no precise guide to the selection of right number of cases for a case study (Perry, 1998). Eisenhardt (1989) suggested that one should stop adding cases when there was no new information to be derived from additional cases, while Miles and Huberman (1994) pointed out that to keep a study from becoming unwieldy, the number of cases should not exceed fifteen. Perry (1998) and Hedges (1985) both suggested that two cases should be acceptable for a minimum number, but four to six cases would be considered reasonable for a serious project. However, the sample size

should be judged depending on the purpose of the research, the reason behind the inquiry, the intended use of the findings and most importantly the resources and time available (Eisenhardt, 1989; Parkhe, 1993; and Yin, 1989).

Accordingly, for this study five cases of MNC subsidiaries and two cases of local suppliers were chosen.

In addition to determining the number of cases to be included, a study should also determine the number of interviews to be conducted. Although there are no specific rules as to the number of interviews, five in-depth interviews or structured interviews with representatives of MNC subsidiaries, in addition to nine semi-structured interviews from Approach I, were conducted for the MNC subsidiaries part. Two in-depth interviews or structured interviews with representatives of local suppliers, in addition to 18 semi-structured interviews from Approach I, were also conducted. (For the five in-depth interviews with MNC subsidiaries and the two in-depth interviews with local suppliers, the interviewees were chosen from among the firms that participated in Approach I).

These case numbers of Approach II complement the results obtained in Approach I to address the main research question.

Data Collection Procedures

There are three procedural areas in collecting data: 1) the researcher's actions during the interview; 2) the case study protocol; and 3) the data collection instruments (Yin, 1994).

In this research, an interview protocol is used to ensure that all aspects of the topic are covered. However, a certain degree of flexibility is required in probing interviewees

and managing the interviews (Master, 2000; and Teale, 1999). For example, some interviewees may use different terminology from the researcher's. The interviewees may use terms such as 'contractors' when the researcher is using the term 'suppliers.' The researcher needs to adapt to the interviewees' terminology so as not to disrupt the sharing of thoughts and opinions during the conversation.

Case Study Protocol

The case-study protocol is an essential element for a case study (Yin, 1994) for three main reasons: 1) it allows the researcher to plan the data collection procedures systematically and provides the researcher with focus and direction (Perry, 1998); 2) it provides guidance for another researcher to repeat the procedures (Burns, 1994), and hence 3) it is important to achieve reliability for the study (Cooper and Emory, 1995; and Yin, 1989). The case-study protocol contains the data-gathering instrument as well as the procedures and general rules to be followed.

A case-study protocol requires an overview, field procedures, guide, and case-study questions (Yin, 1989). The elements of the protocol for this study are shown in Table 4.5. The first of these elements, the project objectives and auspices, was covered in chapters 1 and 2. The second element refers to the field procedures used to gain access to collect the data in the selected firms, as described in Chapter 3. For the third element, the case-study questions are detailed in appendices VII and VIII. Lastly, after the collected data are analyzed, the outcome of this study is a guide for the case-study report.

Table 4.5: The Research Case Study Protocol Elements

Protocol Elements	Essential Components and Relevant Chapters in this Dissertation
Overview of the case study project	<ul style="list-style-type: none">• Project objectives and auspices (Chapter 1).• Case study issues (Chapter 2 and Chapter 3).• Relevant readings about the topic (Chapter 2 and Chapter 3).
Field procedures	<ul style="list-style-type: none">• Credentials and access to the case study site (Chapter 3).• General sources of information (Chapter 2 and Chapter 3).• Procedural reminders (Chapter 4).
Case study questions	<ul style="list-style-type: none">• Specific interview questions (appendices VII and VIII).• Potential sources of information for answering each question (Chapter 2 and Chapter 3).
A guide for the case study report	<ul style="list-style-type: none">• Outline for the report (Chapter 5 and Chapter 6).• Format for the report (Chapter 5 and Chapter 6).

Source: Based on Yin (1994:64)

Data collection instruments

Structured interviews are interviews in which the questions are based on an extensive review of the literature, complemented by the results obtained from the research questions in the questionnaire survey. The structured interview approach is preferred, since the interviewer remains in control throughout the interview process (Robson, 1999). In a structured interview, a set of predetermined questions is asked and the responses are recorded on a standardized schedule or under headings relating to a subject (Robson, 1999; and Creswell, 1994). The most important precaution to be taken in this approach is that the interviewer should be in control, so that the interviewee gives information based on the structured questions with certain modifications made by the interviewer along the way in the interview session.

The objective of the structured interview for Approach II is to analyze and complement the questionnaire survey, as in Approach I. The set of structured interview questions

was as shown in appendices VII and VIII. The primary aim of Approach II was to be able to utilize the case-study protocol in using non-directive and open-ended questions in the form of ‘why’ and ‘how’ to gain real, rich and deep data.

Sample Design – Selection of Respondents

The petrochemical industry is a complex cluster industry, since the output from one firm becomes the input of another firm. As the focus of this research is on inter-organizational linkages between MNC subsidiaries and their local suppliers, the selection of MNC subsidiaries or petrochemical firms for Approach I was made from the following secondary data:

- i) Federation of Malaysia Manufacturers Directory 2007, 38th Edition
- ii) The list of companies in the Petrochemical Sector in Malaysia (MIDA, 2007)
- iii) Directory of Approved Companies in Production by Industry Group (MIDA, 2007)
- iv) www.petronas.com.my

Petrochemical firms were identified and selected from the three main regions in Peninsular Malaysia: Kertih, Terengganu; Gebeng, Kuantan; and Pasir Gudang, Johor (see Table 3.2 for a list of the MNCs in the three regions). However, it was found that most of the petrochemical firms in Kertih, Terengganu belong to Petronas, and requests for interviews at the Petronas Integrated Petrochemical Complex were turned down. Thus, the selection was limited to firms from the other two regions, Gebeng and Pasir Gudang.

As the presence of inter-organizational linkages was an important concern of the research, the sample of local suppliers was comprised of firms that had producer-

supplier relationships with MNC subsidiaries. During the interviews, the researcher asked subsidiary representatives to mention three of their suppliers in each of the four categories given in Chapter 2: 1) raw material suppliers; 2) basic suppliers; 3) advanced engineering suppliers; and 4) licensors. Local suppliers listed in the Petronas Vendor Development Program (VDP) could have been approached, but their numbers were limited and their main client was Petronas. Moreover, not all subsidiaries use the Petronas VDP list as their suppliers' list. After starting the interviews proper, another category of supplier was introduced as another important supplier to the subsidiaries.

For Approach I, a total of twenty-seven participants were approached from the list of MNC subsidiaries located in Gebeng, Pahang and Pasir Gudang, Johor. From this number, nine completed questionnaires were obtained. As for the local suppliers' side, a total of eighty participants were approached. From this number, only eighteen completed questionnaires were obtained.

For the selection of firms in the structured interview in Approach II, the aim was to obtain access to personnel from the higher levels of decision making in the company. Several companies were approached. The respondents for Approach II were chosen from among the firms that had participated in Approach I. A total of five in-depth interviews or structured interviews from MNC subsidiaries and two in-depth interviews or structured interviews from local suppliers were obtained.

4.7 Questionnaire Survey Procedure of Approach I

The interviews for the questionnaire survey for Approach I began in January 2008 and involved four phases. The first phase involved pre-testing of the questionnaire, which was modified based on a study by Iguchi (2007) on backward linkages in Malaysia's electronics and electrical equipment industry. With both questionnaires, several

academics and engineers from petrochemical firms were consulted prior to the pre-testing to guarantee clarity and to ensure that appropriate terms and questions were used in the interview. The second phase involved the pilot interview with MNC subsidiaries, which involved a sample of four subsidiaries. Some questions in the questionnaires for both MNCs and local suppliers were modified as a result. During the pilot interview, the researcher was advised that to secure an interview, it is best for the questionnaire to be addressed to the firm's purchasing manager. This advice was acted on, but the researcher found that different organizations had different ways of entertaining a researcher. As the interview questionnaire required information from several departments in the organization, finding the right person as the contact point for making an appointment was quite challenging. Furthermore, it was found during this phase of data collection that only two of the four categories of local suppliers defined in the literature review had linkages with MNC subsidiaries. This phase of study was also able to pinpoint another category of supplier – the consultancy supplier – to be added to the number of potential local suppliers to MNC subsidiaries (however, no consultancy supplier was able to participate in the questionnaire survey for Approach I). The pilot study phase also added another category to the range of MNC types in Malaysia, namely, local firms that do not belong to Petronas.

For the third phase of the interview process, several methods – telephone, e-mail and post – were used to make appointments. As most of the firms required the questionnaires to be given to them prior to the interview, they were sent via e-mail or by post, together with the letter of introduction (Appendix I). Since the researcher used one-to-one interviews, most of the questions were answered, but some were not, for reasons of confidentiality. In accordance with the research protocol, the questions that were not answered were not pursued with the interviewee concerned.

For the fourth phase of the interview process, the MNC subsidiaries were asked to name their local suppliers. The local suppliers were then contacted by phone and e-mail and an appointment was made for an interview through each firm's contact person. A letter of introduction (Appendix II) was sent, together with the set of questionnaires for the suppliers, to gain the respondents' informed consent to carry out the interview. All nine responses from MNC subsidiaries were given at their respective firms. Six of the interviews with local suppliers took place at their offices, and the other twelve were conducted during the Oil and Gas Exhibition, which was held in the Kuala Lumpur Convention Center between the second and the fourth of June, 2009.

Among the reasons given for non-participation were: 1) it was the parent company's policy; 2) confidentiality of information; 3) officers too busy; 4) not related to their business; and 5) there are so many requests from researchers.

4.8 Structured Interview Procedure of Approach II

After the data from the questionnaire surveys of MNC subsidiaries and local suppliers was obtained, in-depth interviews were initiated with the heads of the firms that had participated in the data collection in Approach I. A letter of introduction (Appendix V) was sent to the MNC subsidiaries and local suppliers, together with the set of structured interview questions (as per Appendix VII), in order to gain respondents' informed consent to carry out the interview. The managing directors of three of the five specified types of MNC subsidiaries in the study consented to participate in the interview, while for the other two types, the Director of Technology and Assistant Department Manager agreed to be interviewed, as shown in Table 4.6. The managing directors of the two categories of local suppliers in the study also agreed to participate, as shown in Table 4.7. All the interviews with the managing directors, the Director of Technology and the Assistant Department Manager for the MNCs were held at the firms' office

headquarters, while the interviews with the managing directors of the two suppliers were held during the Oil and Gas Exhibition at the Kuala Lumpur Convention Center between the second and the fourth of June, 2009. Table 4.8 gives some background information about the MNC subsidiaries, and Table 4.9 gives information about the local suppliers.

Table 4.6: Position of the Respondent for the MNC

Company	Position
LOP	Managing Director
LOM	Managing Director
JVAM	Director of Technology
JVGP	Managing Director
FOJ	Assistant Department Manager

Table 4.7: Position of the Respondent for the Local Suppliers

Company	Position
SA1	Managing Director
SB1	Managing Director

Table 4.8: Background Information on MNC Case Study Companies and their Groups

Information	LOP	LOM	JVAM	JVGP	FOJ
Year established/ began production	1992	1969	1989	2000	1997
Ownership Structure	Local- owned 100%	Local- owned 100%	Joint- venture 70:30	Joint- venture 60:40	Foreign-owned 100%
Number of employees	53	250	1163	600	247
*Activities/Stage of production	Stage 2	Stage 3	Stage 1, 2, 3	Stage 3	Stage 2
Origin of parent company	Malaysia	Malaysia	United States & Malaysia	Germany & Malaysia	Japan
Plant location	GIPC	Pasir Gudang, Johor	Pasir Gudang, Johor	GIPC	GIPC
Products produced	LDPE, HDPE, PP and other monomers	PVC and PVC compound	Polymers such as PP and PE	Propylene derivatives	Polyoxymethylene, polybutylene terephthalate
% Exports	MITCO	30 %	30%	80%	83%

*For Activities/Stage of production, see Table 4.14, subsidiary categorization by Stage of Production.

Table 4.9: Background Information on Supplier Case Study Companies and their Groups

Information	SA1	SB1
Year established	1996	2003
Status	100% local company	100% local company
Number of employees	20	32
Activities	Supplies basic items/parts that use standardized technologies and meet customers' spec. and delivers services to customers.	Produces chemical products for corrosion inhibitors, emulsifiers and offers various technical services.
Ownership structure	100 percent local-owned	100 percent local-owned
Firm location	Petaling Jaya , Selangor	Gebeng, Kuantan
Paid-up capital	RM 1 million	RM 2 million

4.9 Data Analysis

There are two kinds of data analysis for this study: quantitative and qualitative. Both types use interview data from subsidiaries and suppliers, and both are analyzed in three categories in accordance with the literature review in Chapter 2. The three categories are: 1) the MNC corporate strategy; 2) the depth and breadth of the backward linkages present; and 3) the local suppliers' technological capability. Through these categories, the research analyzes the factors that affect the technological capability of local suppliers and those that affect the intensity of the backward linkages.

In examining the research questions and hypotheses, the researcher's focus is on both quantitative and qualitative analysis. The answers to the research questions are analyzed using whichever method is appropriate. Each method has its own strength, and each complements the other. The process of analysis in the quantitative and

qualitative approaches is discussed below. Analysis of descriptive statistics of both MNC subsidiaries and local suppliers is provided in Chapter 5. The descriptive statistics results obtained in Chapter 5 are then discussed by comparing them with prior theory (Miles and Huberman, 1994) in Chapter 6. The results of both the quantitative and the qualitative analysis are provided in chapters 5 and 6. Chapter 7 presents the conclusion of the study.

4.9.1 Quantitative Methods: Questionnaire Data Analysis

The data analysis for the quantitative approach was carried out using the “Statistical Package for the Social Sciences” or SPSS, Version 17. The output included descriptive statistics. Non-parametric tests were used as the main statistical procedure to test the hypotheses identified in Chapter 2. Among the reasons for adopting the non-parametric statistical technique were: 1) the small sample size ($n < 30$); 2) to compare three or more independent groups of sample data; 3) the hypotheses made no assumption about the distribution of the population; and 4) they can test the null hypotheses of the backward linkages. Furthermore, with the small sample size, non-parametric tests make no assumptions about the distribution of the data (normality) and the tests are useful when the assumption of normality or equality of variance is not met.

Two tests were performed: the Mann-Whitney U Test and the Kruskal-Wallis H Test. The Mann-Whitney U Test is used to examine for significant differences on non-parametric continuous data between two levels of a categorical variable. The Kruskal-Wallis H Test is a logical extension of the Mann-Whitney U Test and is used to compare three or more samples. It is used to test the null hypothesis that all populations have identical distributions function against the alternative hypothesis and that at least two of the samples differ only with respect to median. The hypothesis also

makes no assumption about the distribution of the population. These hypotheses are sometimes written as testing the equation of the central tendency of the population (SPSS, 2001). The Kruskal-Wallis H Test was also used to establish whether the factors and elements identified in this study were significant and important for backward linkages in the petrochemical industry. The Mann-Whitney U Test was employed to indicate whether there was any significant difference between the elements identified in the backward linkages of the MNC subsidiaries and the suppliers.

Before analyzing the questionnaire survey data, the researcher constructed a backward linkages index. This index measured the extent of interaction between MNC subsidiaries and local suppliers, and the mutual effects of these interactions. The index was modified based on the measurement by Iguchi (2007) of backward linkages in the electronics and electrical equipments industry.

Derivation of the Backward Linkages Index (Iguchi, 2007)

The backward linkages (BL) index was derived based on the components of 38 potential backward linkages that were surveyed in the questionnaire in Approach 1. This index was used to examine the extent of interaction between MNC subsidiaries and local suppliers, who were (it was assumed) affected by beneficial spillovers from subsidiaries. The BL index is calculated based on the potential backward linkages.

Backward Linkages Index:

$$B_{ij} = \frac{A_{ij}}{n_j}$$

n_j is the number of types of potential linkages that could be established in category j .

B denotes the backward linkages index.

A denotes the actual number of activities in which linkages are observed.

i denotes firms ($i = 1$ to m for each grouping of surveyed firms).

j denotes a category of activity
(a grouping of activities in each of which linkages may occur).

m denotes the total number of firms under consideration in each context.

For the aggregate of all activities, we have:

$$B = \frac{\sum_{ij} A_{ij}}{m \sum_j n_j}$$

4.9.2 Qualitative Methods: Procedure in Analyzing Structured Interview Data

In qualitative data analysis, the analysis of data is not a discrete stage of the research process. It is an ongoing process that occurs simultaneously with the data collection process and remains active throughout the research process (Marshall and Rossman, 1998). Yin (1994:102) defines it as consisting of “examining, categorizing, tabulating, or otherwise recombining the evidence to address the initial propositions of a study.” Yin also states that there is no well-developed technique for data analysis in case studies in general. Successful analysis therefore depends on the researcher’s creativity and rigorous thinking. In this study, semi-structured interview data was analyzed together with the structured interview data. The analysis was based on guidelines suggested in the literature and used the research questions in this study as its guiding principle.

The transcribed interview data from both the MNC subsidiaries and the local suppliers was first analyzed following Eisenhardt’s (1989) suggestion of a within-case analysis for each case, and then by a cross-case analysis. The final stage of data analysis is comparison with prior theory. The processes are explained in the following section.

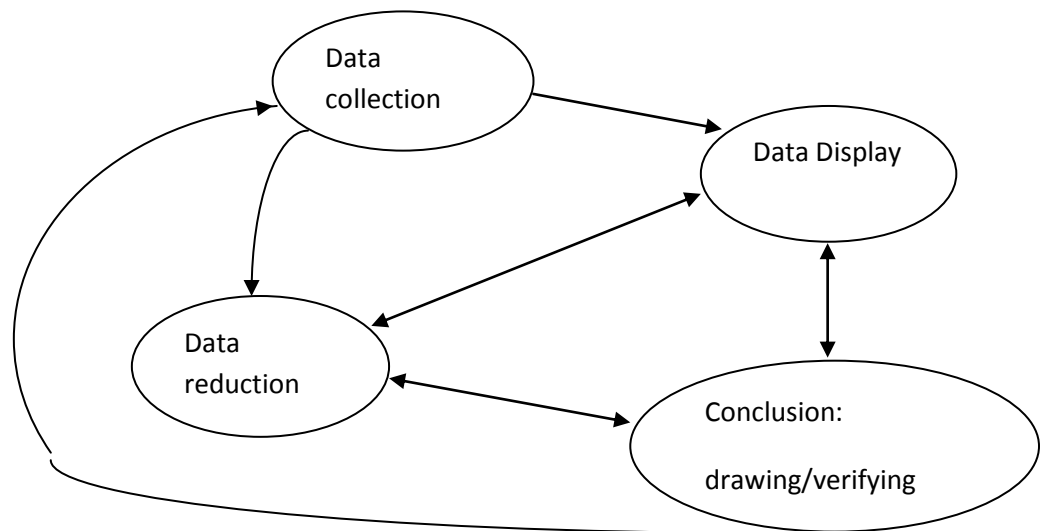
a) Within-case Analysis

The data analysis at this stage aims to develop a typology of categories or themes that summarizes the collected data. It involves breaking down the data into manageable units, synthesizing it, searching for patterns, discovering what is important and deciding what to tell others (Bogdan and Bicklen, 1982). This was done in line with Miles and Huberman’s (1984) interactive model, as shown in Figure 4.2. According to the model, there are four components to the data analysis process: 1) data collection; 2) data

reduction; 3) data display; and 4) conclusions: drawing/verifying. After the data collection, the data needs to be reduced and some will need to be removed as being unnecessary (Williamson and Bow, 2000). According to Miles and Huberman (1984: 21), data reduction refers to “the process of selecting, focusing, simplifying, abstracting, and transforming the data that appears in written-up field notes or transcription.” The data reduction process condenses the data to a manageable level. It also involves the uncovering of themes, which takes place through the identification of conceptual categories with close ties to the research problem under investigation (Yin, 1994).

In the present research, the collected data from each case were reduced by using the themes as identified according to the categories in the quantitative survey: 1) MNC corporate strategy; 2) the depth and breadth of the backward linkages presence; and 3) the local suppliers’ technological capability. Secondary data sources were also included under the allocated themes. The reduced data were then displayed in organized, easily comprehensible formats such as tables, figures of results and diagrams, making it possible to draw conclusions for each case (Miles and Huberman, 1984). The conclusion involved extracting meaning from the displayed data of the cases under investigation (Miles and Huberman, 1984). This was done by performing a cross-case analysis among 1) the MNC subsidiaries (five cases), and 2) the local suppliers (two cases).

Figure 4.2: An Interactive Model of Data Analysis



Source: Miles and Huberman (1984:12)

b) Cross-case Analysis

Patton (1990:377) defined cross-case analysis as “growing together answers from different people to common questions or analyzing different perspectives on central issues.” This analysis is normally applied after a within-case analysis (Patton, 1990; Perry and Coote, 1994). Comparing different cases enables the detection of patterns of similar categories (Lewis, 1998). In conducting cross-case analysis, the researcher examines similarities between and differences in relationships within the data, and also investigates general statements and comments about relationships through the development of categories of triangulated data and their subsequent examination (Marshall and Rossman, 1998). Therefore the data analysis in the case study emphasizes reasons why differences occur, with an explanation of why a difference was found. Quotations from interviews are used to justify conclusions about

differences between cases in the cross-case analysis (Carson et al., 2001; and Perry, 1997).

c) Comparison with Prior Theory

The final step in the data analysis process is to build conceptual/theoretical coherence through comparisons with the prior theory discussed in Chapter 2 and to consider instances where these research findings are capable of replication (Miles and Huberman, 1994). In providing answers as to ‘how’ and ‘why’ linkages capability is present or absent in the development of the petrochemical industry in Malaysia, the study uses as a basis of comparison the existing literature on 1) the mode of entry of MNC companies through foreign direct investment and 2) the upgrading of local suppliers’ technological capabilities through the use of backward linkages.

4.10 Sample Characteristics and Preliminary Findings of the Study

The empirical study was conducted to obtain an understanding of the current state of the petrochemical industry in Malaysia. It was first intended to be a census survey, but due to difficulties in making appointments for interviews, a sample size of only nine MNC subsidiaries from a total of 27 approached was obtained (based on the estimated total number of petrochemical firms present at the two locations of Gebeng, Pahang and Pasir Gudang, Johor). A sample size of 18 was obtained for local suppliers. The list of MNC subsidiaries and their categorizations is shown in Table 4.10. The interview process succeeded in obtaining information on the three types of mode of entry from the subsidiary sample group, and on the two types of suppliers from the supplier sample group, as discussed in Chapter 2. This section provides the typology of both the MNC subsidiaries and the local suppliers in the two locations. The details of the

characteristics of the samples for both the MNC subsidiaries and the local suppliers are presented in the following tables.

4.10.1 MNC Subsidiaries Sample

The key characteristics of the MNC sample are as follows. The nine samples are big companies that target regional and global markets; they have a high export ratio (mean = 59%), a length of operation long enough to observe the dynamics of MNC strategy in developing linkages with local suppliers (mean = 15.5 years), and a production scale reflecting the type of industry they are in (science, technology and natural resources, with a mean number of employees = 312). The results of the categorization of the subsidiaries are presented in the tables below.

Table 4.10: Results of Subsidiary Categorization by Customers and Percentage Share of Exports

MNC	Customer in Malaysia	% share customer in Malaysia	% Export	Customers outside Malaysia	% share of exports of countries
LOP	MITCO	MITCO	MITCO	MITCO	MITCO
LOM	NA	70	30	India, S'pore, Thai, Aus, Egypt	10, 3, 5
FOJ	NA	17	83	Asean, Taiwan, Korea, Japan, China	40, 5, 3, 5, 30
FOB	NA	60	40	China, Pakistan, S. Africa, Aust	30, 10
FOT	NA	40	60	Indonesia, India, China, Spore, Taiwan	20, 10, 10, 10, 10
JVGP	NA	20	80	China, (Pakistan, Thai, India)	20, 60
JVJG	NA	0	100	Worldwide	100
JVJP	NA	80	20	Spore, others	10, 10
JVAM	NA	NA	30	China, others	30

Table 4.11: Results of Subsidiary Categorization by Mode of Entry, Nationality and Location Distribution

MNC	Type of Company	Nationality	Location	Began Production
LOP	100% Local-owned	Malaysia Petronas	Gebeng	1992
LOM	100% Local-owned	Malaysian	Pasir Gudang	1969
FOJ	100% Foreign-owned	Japanese	Gebeng	1997
FOB	100% Foreign-owned	British	Gebeng	1994
FOT	100% Foreign-owned	Taiwanese	Pasir Gudang	1998
JVGP	Joint venture	German-Malaysia Petronas	Gebeng	2000
JVJG	Joint venture	Japanese-German	Gebeng	2005
JVJP	Joint venture	Japanese-Malaysia Petronas	Pasir Gudang	1997
JVAM	Joint venture	US-Malaysian	Pasir Gudang	1989

LO	Local-owned
FO	Foreign-owned
JV	Joint venture

Table 4.12: Results of Subsidiary Categorization by Ownership, Paid-up Capital, Sales, Number of Employees and Years in Operation

MNC	Ownership	Paid-up Capital	Sales	No. of Expatriates	No. of Employees	Years in Operation up to 2009
LOP	100%	90,000	287,599,228	0	53	17
LOM	100%	15,000,000	220,000,000	0	250	49
FOJ	100%	NA	158,590,091	2	247	12
FOB	100%	360,000,000	1,600,000,000	1	180	15
FOT	100%	40,313,835	152,270,859	0	130	11
JVGP	60:40	3,400,000	1,000,000,000	10	600	9
JVJG	50:50	NA	324,000,000	2	53	4
JVJP	70:30	135,000,000	1,000,000,000	4	132	12
JVAM	70:30	NA	NA	75	1163	20

Table 4.13: Results of Subsidiary Categorization by Mode of Entry and Nationality

MNC	Type of Company	Nationality
LOP	100% Local-owned	Malaysia Petronas
LOM	100% Local-owned	Malaysian
FOJ	100% Foreign-owned	Japanese
FOB	100% Foreign-owned	British
FOT	100% Foreign-owned	Taiwanese
JVGP	Joint venture	German-Malaysia Petronas
JVJG	Joint venture	Japanese-German
JVJP	Joint venture	Japanese-Malaysia Petronas
JVAM	Joint venture	US-Malaysian

LO	Local-owned
FO	Foreign-owned
JV	Joint venture

4.10.2 Findings of the Type of Subsidiaries Categorization

The result of the subsidiaries categorization is presented in Table 4.10, Table 4.11, Table 4.12, and Table 4.13. In the MNC subsidiary sample, based on the MNC subsidiaries typology presented in Chapter 2, the breakdown of the categorization is: two 100% local-owned firms, three 100% foreign-owned firms and four joint-venture firms. Both of the 100% local-owned firms were formerly joint ventures with foreign firms. The local partner in the first firm was Petronas, which now owns it outright, and the second became wholly local through a management buyout. Of the 100% foreign-owned companies, one belongs to a Japanese parent firm, the second is British and the third is Taiwanese. The joint-venture firms are German-Petronas (60:40 equity), Japanese-German (50:50 equity), Japanese-Petronas (70:30) equity and United States-Malaysian (70:30 equity). Five of the firms are located in Gebeng, Pahang, while four are located in Pasir Gudang, Johor.

The three categories of MNC subsidiary used in this study are based on the assumption in Research Question 1 that the role of subsidiaries in the host country will depend on the motives that led their parent firms to enter the country, and that comparisons can be made between local MNCs and foreign MNCs in the linkages they form with their suppliers. The hypothesis is that the different roles played by subsidiaries in accordance with their typology will have different effects on their linkages with suppliers. Among the determinants that affect the role of subsidiaries are: 1) factors concerning the subsidiary, including its autonomy level, its sourcing rate, its length of operation in the host country and its number of employees; 2) MNC group factors, including the nationality of the subsidiary and the number of expatriates it employs; and 3) environmental factors, which include the location of the firm and any government linkages. Only the first two factors will feature in the analysis and discussion chapters, as the third is not covered in this study. Even though this study does not include linkages outside firms, the environmental factor will be touched upon in the course of qualitative analysis.

Factors concerning the Subsidiary

With factors concerning the subsidiary, it is assumed that length of operation is crucial for developing linkages with the local suppliers. Some MNCs, especially US firms, have operated in Malaysia for a very long time. It was a US firm that constructed Malaysia's first petrochemical plant in 1969, and the first firm to be invited by the government of Malaysia to build an integrated petrochemical plant was JVAM, a US-Malaysian joint venture. The United States is still the largest source of investment in Malaysia's petrochemical industry, followed by Japan, the United Kingdom, Germany and Taiwan (MITI, 2005).

Table 4.14 (below) shows that MNC subsidiaries are more involved in Stage 2 and Stage 3 production of petrochemicalsⁱⁱ, while Table 4.15 shows the relationship between subsidiary typology and the company's date of entry into the Malaysian petrochemical industry. It can be assumed that the longer the subsidiary is in the host country, the more knowledge it will accumulate about the operations in that country. However, Table 4.15 shows that only one firm began operating in Malaysia prior to the start of the country's rapid industrialization.

Table 4.14: Result of Subsidiary Categorization by Stage of Production

MNC	Stage of Production ⁱⁱⁱ
LOP	Stage 2
LOM	Stage 3
FOJ	Stage 2
FOB	Stage 2
FOT	Stage 4
JVGP	Stage 3
JVJG	Stage 3
JVJP	Stage 2
JVAM	Stage 1, 2, 3

Stage I: The company produces basic materials such as ethylene, propylene, benzene and butadiene by distilling or cracking petroleum.

Stage II: The company produces intermediate materials such as low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), acrylonitrile monomer and caprolactum by polymerizing or cracking the basic materials.

Stage III: The company uses intermediate materials such as LDPE, HDPE and PP and processes them into synthetic resins, synthetic fibers, synthetic rubber and other petrochemical products.

Stage IV: The company produces and sells *other* petrochemical products (derivatives).

Table 4.15: Results of Subsidiary Categorization by Date of Entry

2003-2009							X		
1995-2002			X		X	X		X	
1991-1994	X			X					
1988-1990									X
1981-1987									
1978-1980									
1969-1977		X							
1957-1968									
	LOP	LOM	FOJ	FOB	FOT	JVGP	JVJG	JVJP	JVAM

MNC group/parent factors

Looking at the MNC group/parent factors, it was found through interviews that most subsidiaries take expatriates from their home country in their early stages of production. However, with longer years of operation in the host country, the number of expatriates becomes minimal compared with when the plant was first commissioned. This is because operation of the plant becomes routine, while years of on-the-job training enable local engineers to take over. In Table 4.12 the number of expatriates for LOP and LOM is zero; for FOJ, FOB and FOT, they are respectively 2, 1, and 0. Among the joint ventures, the number of expatriates for JVGP, JVJG, JVJP and JVAM are 10, 2, 4 and 75 respectively. Table 4.13 shows the subsidiary categorization by nationality ownership: two are wholly local-owned; three are wholly foreign-owned by Japan, the United Kingdom and Taiwan; and the other four are joint ventures between

Germany and Malaysia's Petronas; Japan and Germany; Japan and Malaysia's Petronas; and the United States and a Malaysian equity firm.

Environmental factors

In this sample there are five MNC subsidiaries based in Gebeng, Pahang and four in Pasir Gudang, Johor. Based on the number of petrochemical firms listed in Table 3.2, there are eighteen firms in Gebeng and nine in Pasir Gudang. Thus, it seems that Gebeng has twice as many petrochemical plants in as Pasir Gudang, and therefore there is more petrochemical activity in Malaysia's East Coast region than in the southern region. Even though this study does not include linkages outside firms, environmental factors will be touched on when the data are analyzed using the qualitative analysis approach.

4.10.3 MNC Subsidiaries and Linkages Effects on Local Suppliers

During the interview process, respondents were asked two sets of questions in regard to the subsidiaries' potential linkages with two types of local suppliers: the basic local suppliers and the advanced local suppliers. With the data on the potential linkages between two groups (MNC subsidiaries and basic suppliers, and MNC subsidiaries and advanced suppliers), the Mann-Whitney U Test was conducted to test for differences between the two independent groups on a continuous measure. This test is the non-parametric alternative to the t-test for independent samples for parametric tests. Table 4.17 shows the output from the Mann-Whitney U Test. The test indicated no significant differences between the two groups where the probability value (p) is less than or equal to 0.05 in any of the potential linkages. As shown in Table 4.16, the p

values are: Product (0.856), Innovation (0.926), Process (1.000), Training (1.000), Others (1.000), and Management (0.888) linkages.

The result of the Mann-Whitney U Test shows that there is no significant pattern of backward linkages between MNC subsidiaries and their typology of local suppliers. This is because there are three categories of MNC subsidiaries. Each category would provide a different priority in their type of backward linkages with their local suppliers.

Table 4.16: Result of Mann-Whitney U Test for Potential Linkages for Two Groups: MNCs and Basic Suppliers versus MNCs and Advanced Suppliers

	Product	Innovation	Process	Training	Others	Management
Mann-Whitney U test	38.500	39.500	40.500	40.500	40.500	39.000
Asymp. Sig. (2-tailed) p =	0.856	0.926	1.000	1.000	1.000	0.888

Significant difference when $p < 0.05$.

4.10.4 Summary of Initial Findings from Results of Categorization of MNC

Subsidiaries

From these descriptive statistics, the nine MNC subsidiaries sampled seem representative of the study's categorization of petrochemical industry firms in Malaysia. But since the total sample was too small to do robust statistical analysis, a qualitative methodology was used to arrive at a comprehensive view of the state of linkages between the MNCs and their local suppliers. Of the nine subsidiaries, five were approached to obtain a structured interview with the most senior personnel of the firms. An analysis of this qualitative approach is presented in Chapter 6.

4.10.5 Local Suppliers Sample

A total of 18 responses from the local suppliers sample was obtained. The responses were carefully examined in order to show that they did indeed have buyer-supplier relationships with MNC subsidiaries in Malaysia. The Mann-Whitney U Test was conducted to test for differences between the two independent groups on a continuous measure. This test is the non-parametric alternative to the t-test for independent samples for parametric tests. Table 4.17 shows the overall output of the Mann-Whitney U Test. Table 4.18 shows that in the output from the Mann-Whitney U Test, only two categories of linkages were found to be significant. With a probability value (p) less than or equal to 0.05, the test indicated significant differences between the two groups in the Process and Management linkages (0.038 and 0.008 respectively), but not in the Product (0.108), Innovation (0.167), Training (0.059) or Others (0.263) categories of potential linkages.

Table 4.17: Result of the Overall Mann-Whitney U Test for Potential Linkages for MNCs and Basic Suppliers versus MNCs and Advanced Suppliers

	Product	Innovation	Process	Training	Others	Management
Mann-Whitney U Test	22.000	24.000	16.000	18.000	27.000	9.5000
Asymp. Sig. (2-tailed) p=	0.108	0.167	0.038	0.059	0.263	0.008

Significant difference when $p < 0.05$.

Table 4.18: Result of Mann-Whitney U Test for Potential Linkages for MNCs and Basic Suppliers versus MNCs and Advanced Suppliers

	MNCs and basic suppliers vs. MNCs and advanced suppliers in process linkages	MNCs and basic suppliers vs. MNCs and advanced suppliers in management linkages
Mann-Whitney U Test	16.000	9.500
Asymp. Sig. (2-tailed) p=	0.038	0.008

Significant difference when $p < 0.05$.

Following the Mann-Whitney U Test, the local suppliers were categorized according to the supplier typology discussed in Chapter 2. The eighteen samples were divided into two categories: 1) basic suppliers and 2) advanced suppliers. There were seven suppliers in the basic category level, and eleven in the advanced category. Table 4.19, Table 4.20, and Table 4.21 present the list of local suppliers according to their technological level categories. The size of the local-supplier firms varies from four employees to 500 in the basic product category and from ten to 700 in the advanced product category. The length of operation of local suppliers varies from 13 years to 29 years for the basic product category (mean = 18 years) and from 3 years to 27 years for the advanced product category (mean = 12.6 years). The mean year of 18 years for the basic products firms and 12.6 years for the advanced products firms is sufficient to allow observation of aspects of the technological capability building of the local suppliers. Eleven firms from the sample are located in the Klang Valley (in the State of Selangor, and Kuala Lumpur), six are on the East Coast of Peninsular Malaysia, and one is in Johor.

As Table 4.21 illustrates, most of the firms did not provide information for the total percentage of their exports. This implies that the export propensity of the suppliers is low, which also means that most of the firms concentrate their output on the domestic market. However, of the firms that did provide export figures, there were some that did

export their products or services, such as SA3 (90 percent) and SA7 (45percent) in the basic product supplier category, and SB1 (10 percent), SB4 (5 percent) and SB7 (30 percent) in the advanced product supplier category. Table 4.22 shows the categorization of local suppliers according to technological level and the strength of linkages formed with MNC subsidiaries. This will be discussed further in chapters 5 and 6.

Table 4.19: Categorization of Local Suppliers by Size, Length of Operation and Ownership

Firm Symbol	Year Established	Length of operation up to 2009	Ownership 1- 2- 3-	No. of Employees	No. of Foreign Employees
SA1	1996	13	3	20	0
SA2	1987	22	1	100	0
SA3	1989	20	3	500	100
SA4	1997	12	4	4	1
SA5	1980	29	3	60	0
SA6	1994	15	3	20	0
SA7	1994	15	3	103	1
SB1	2003	6	3	32	0
SB2	1982	27	3	13	1
SB3	2006	3	3	10	0
SB4	1999	10	3	33	0
SB5	2002	7	3	15	0
SB6	1997	12	3	16	0
SB7	2002	7	3	63	0
SB8	1995	14	3	17	0
SB9	1990	19	3	700	10
SB10	1995	14	3	30	0
SB11	1989	20	3	30	2

Table 4.20: Categorization of Local Suppliers by Location, Sales, Paid-Up Capital and Sales

Firm Symbol SA=Basic SB=Advanced	Location: 1=Klang Valley 2=East Coast 3=Johor	Paid-up Capital	Sales	Terms of Agreement 1-subcontracting 2-informal agree 3-others
SA1	1	1,000,000	24,000,000	2
SA2	3	1,240,000	89,000,000	NA
SA3	3	114,000,000	195,000,000	NA
SA4	1	200,000	1,135,000	3
SA5	1	100,000	9,738,000	2
SA6	1	100,000	6,000,000	3
SA7	1	2,500,000	90,000,000	2
SB1	1	2,000,000	90,000,000	1
SB2	1	NA	4,200,000	1
SB3	3	500,000	5,000,000	1
SB4	1	1,000,000	15,000,000	2
SB5	1	600,000	5,600,000	2
SB6	1	700,000	10,000,000	NA
SB7	3	NA	32,000,000	3
SB8	1	2,000,000	7,500,000	3
SB9	3	7,500,000	433,000,000	1
SB10	3	3,000,000	2,000,000	2
SB11	2	NA	25,000,000	NA

Table 4.21: Categorization of Local Suppliers by Export and Customer Profile

Firm Symbol	% share of customers in Malaysia	(%) Share	Type of customer in Malaysia	Customers Outside Malaysia	% Export	Began business by supplying to oil & gas business
SA1	NA	NA	4	NA	NA	Yes
SA2	NA	NA	1,2,3,4	NA	NA	Yes
SA3	0	10	1,2,3,4	0	90	Yes
SA4	NA	NA	4	NA	NA	Yes
SA5	NA	NA	4	NA	NA	No
SA6	NA	NA	1,2,3,4	NA	no exports	No
SA7	NA	55	1,2,3,4	Korean, American	45	Yes
SB1	NA	90	1,2,3,4	0	10	No
SB2	NA	NA	4	NA	NA	Yes
SB3	Korean, European, JV	30,30,40	2	NA	NA	Yes
SB4	NA	95	1,2,3,4	China	5	Yes
SB5	NA	NA	1,2	NA	NA	Yes
SB6	NA	NA	2	NA	NA	Yes
SB7	JV	NA	2	NA	30	NA
SB8	NA	NA	2	NA	no exports	Yes
SB9	NA	NA	1	NA	NA	Yes
SB10	NA	NA	1,2,4	NA	no exports	Yes
SB11	NA	NA	2	NA	NA	Yes

Types of customers in the petrochemical industry:

- 1- Customers produce basic materials such as ethylene, propylene, benzene and butadiene by distilling or cracking petroleum;
- 2- Customers produce intermediate materials such as low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), acrylonitrile monomer and caprolactum by polymerizing or cracking the basic materials;
- 3- Customers use intermediate materials such as LDPE, HDPE and PP and process them into synthetic resins, synthetic fibers, synthetic rubber and other petrochemical products.
- 4- Customers produce other petrochemical products than the above.

Table 4.22: Categorization of Local Suppliers by Technological Level and Strength of Linkages with MNC Subsidiaries

New Sign	Old sign	Tech Level	Product	Innovation	Process	Training	Others	Management	Location
SA1	C2	1	0.83	0.20	0.60	0.80	0.60	0.57	1
SA2	A4	1	0.00	0.00	0.00	0.00	0.20	0.00	3
SA3	A5	1	0.50	0.00	0.50	0.00	0.40	0.00	3
SA4	A3	1	0.83	0.40	0.00	0.20	0.00	0.00	1
SA5	B3	1	0.50	0.00	0.00	0.00	0.20	0.00	1
SA6	B7	1	0.83	0.20	0.50	0.80	0.60	0.14	1
SA7	B1	1	0.00	0.00	0.00	0.20	0.40	0.14	1
SB1	A2	2	0.83	0.40	0.90	0.40	0.60	0.43	1
SB2	C5	2	0.83	0.20	0.50	0.60	0.40	0.57	1
SB3	C1	2	0.83	0.20	0.50	0.80	0.40	0.86	3
SB4	C3	2	0.50	0.00	0.20	0.40	0.20	0.71	1
SB5	C4	2	0.83	0.20	0.80	0.80	0.40	0.29	1
SB6	C7	2	0.83	0.40	0.50	0.60	0.40	0.57	1
SB7	A1	2	0.67	1.00	0.60	1.00	0.80	0.57	3
SB8	A6	2	0.67	0.20	0.60	0.60	0.40	0.14	1
SB9	B4	2	0.83	0.80	0.30	0.40	0.40	0.14	3
SB10	B2	2	0.67	0.00	0.80	0.60	0.40	0.43	3
SB11	B5	2	1.00	0.00	0.40	0.40	0.80	0.29	2

Technological Level/main area of business:

1 - Basic Items Suppliers: the company supplies basic items/parts such as nuts and bolts that use standardized technologies and meet customer specifications, and delivery services. It may supply many industries.

2 – Advanced Engineering Suppliers: the company supplies highly specialized products and services and continuously acquires and evolves new ways to solve process and product problems.

3 - Technology and Engineering Consulting Services: the company offers knowledge-intensive professional services. (No firm from this category agreed to participate).

4.10.6 Results of the Local Supplier Typology

This section briefly presents the characteristics of the sample results of the local supplier categorization.

Basic Product Suppliers Category

Of the basic product suppliers, two firms are located on the East Coast and five are located in the Klang Valley. Table 4.23 shows the result of the basic product suppliers' establishment period. From Table 4.21, of the seven sample firms from this category, five began by supplying the oil and gas business before venturing into the petrochemical business, while two began by supplying the petrochemical business. All of their customers in Malaysia are involved in all stages of petrochemical production, except for three that concentrate on firms in the higher end of the petrochemical production. Table 4.20 shows that three firms acknowledge having informal agreements with customers, while four do not specify the kind of agreement they have with their customers. The average sales figure is RM 59 million. The suppliers' businesses range from fitting manufacturer, to equipment and component distributor and supplier, to maintenance and fabrication services. In order to supply customers, the suppliers use their own existing technology, together with the technology of their partners. The firms are involved in adding value to the components that they sell to customers and are also involved in after sales service. Hence these suppliers' business linkages go beyond arm's length, one-off buyer-supplier transactions as defined by UNCTAD (2001). From Table 4.23, it is clear that most of the sampled suppliers established themselves after Malaysia had begun developing its petrochemical industry in the early 1980s.

Table 4.23: Results of Basic Product Supplier by Establishment Period

2003-2009							
1995-2002	X			X			
1991-1994						X	X
1988-1990			X				
1981-1987		X					
1978-1980					X		
1969-1977							
1957-1968							
	SA1	SA2	SA3	SA4	SA5	SA6	SA7

Advanced Product Suppliers

Of the advanced product suppliers, four firms are located in Johor, six are located in the Klang Valley and one is on the East Coast. Table 4.24 shows the results of the advanced product suppliers' establishment period. Most of the sampled advanced suppliers established themselves after 1995. From Table 4.21, of the eleven sample firms from this category, nine began their businesses by supplying to the oil and gas business before venturing into petrochemical business, while one began by supplying to the petrochemical business. Another firm did not respond to the item. Only two of the firms are involved in supplying to customers that operate in all stages of petrochemical production. Five firms are involved only in Stage 2 petrochemical production, one is involved only in Stage 4, two are involved in stages 1 and 2 only, and one is involved in supplying customers in stages 1, 2 and 4. In terms of agreement with customers, three firms acknowledge having informal agreements and four specify that they have

subcontracting agreements with customers, while another four do not specify the kind of agreement they have with their customers. The average sales figure is RM 57 million. The businesses of these advanced product suppliers range from engineering and services, to maintenance and plant services, plant design, equipment and instrumentation fabrication, and distribution of equipment and instruments. Like the basic product suppliers, the advanced product suppliers use their own existing technology in collaboration with their partners to supply their customers. The firms are involved in adding value to the components that they sell to customers and are also involved in after sales service. Like those of the basic product suppliers, the business linkages of the advanced suppliers go beyond arm's length, one-off buyer-supplier transactions between as defined by UNCTAD (2001).

Table 4.24: Results of Advanced Local Supplier by Establishment Period

2003-2009	X		X								
1995-2002				X	X	X	X	X		X	
1991-1994											
1988-1990									X		X
1981-1987		X									
1978-1980											
1969-1977											
1957-1968											
	SB1	SB2	SB3	SB4	SB5	SB6	SB7	SB8	SB9	SB10	SB11

4.10.7 Summary of Initial Findings from Results of Categorization of Local Suppliers

The number of samples from the local suppliers is considered too small for one to do robust statistical analysis using OLS or regression. However, some non-parametric analysis using the Mann Whitney U Test was performed on the sample. The analysis of local suppliers is presented further in chapters 5 and 6. The two levels of categorization are representative of the categorization of the petrochemical industry supplier firms in Malaysia as discussed in chapters 2 and 3.

Since the sample number is too small to do robust statistical analysis, qualitative approach methodology was used to give a comprehensive view of the state of linkages between the MNCs and the local suppliers. Out of the seven basic product suppliers and eleven advanced product suppliers, one firm from each category was selected for an in-depth interview on the linkages forged between the local firms and MNC subsidiaries. The interviews with the two senior personnel at Managing Director level were used to analyze the technological assistance that had developed between the suppliers and the subsidiaries. An analysis of the outcome of this qualitative approach is presented in Chapter 6.

4.11 Conclusion

This study uses a mixed-methods approach of quantitative and qualitative research to achieve the objectives of the research. Qualitative data were collected after the collection of the quantitative data using the sequential explanatory strategy model, which is characterized by the collection and analysis of a survey questionnaire based on quantitative approach followed by the collection and analysis of qualitative data. Analysis of the qualitative data is used to support and complement the data obtained from the questionnaire survey.

Analysis of the qualitative and quantitative data is expected to show whether there are any differences, similarities or complementarities in the approaches taken by different categories of MNC firms to support the development of local suppliers and how local suppliers upgrade their technological capabilities in the petrochemical industry. In order to provide this representation, this study measures the extent of interaction or ‘intended upgrading effects’ between MNC subsidiaries and local suppliers, and the mutual effects of these interactions, by examining the breadth or diversity of backward linkages between them. Two sets of questionnaires were designed for this purpose; one for the MNC subsidiaries and the other for local suppliers. To quantify the extent of the interaction or the ‘intended upgrading effects’ between MNC subsidiaries and local suppliers and the mutual effects of this interaction, a backward linkages index (BL index) was constructed. In constructing this index, six different categories of backward linkages (in the form of product, process, innovation, training, management and others linkages) were used. In each of these categories, a subset of categories relating to knowledge flows was also used. A total of 38 potential backward linkages were used to make up the BL index (see Section 2.7.1).

In this study, the BL index measures the diversity (breadth) of linked activities between MNC subsidiaries and local suppliers. The study is of the view that the wider the breadth of linkages formed, the more benefits will accrue via intended and unintended technological upgrading of local firms.

ⁱ Naoum, S.G. (1998), *Dissertation Research and Writing for Construction Students*, Butterworth-Heinemann, Oxford.

ⁱⁱ The stages are as described in UTM (University of Technology Malaysia) (2006). *Fundamentals of the Petrochemical Industry*, Kuala Lumpur: UTM City Campus.

ⁱⁱⁱ Stages of petrochemical production.