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The Development of Subsidiary Technological Capability: Network Linkages and Subsidiary Autonomy

by

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LIST of ABBREVIATIONS

AP	Asia Pacific
ACI	Advance Capability Index
BIOS	Basic Integrated Operating System
BGA(s)	Ball-Grid Arrays
BU(s)	Business Units
CFT	Centre for Industrial Technology
CMOS	Complementary Mental Oxide on Silicon
COF	Chip-on-Film
COM	Chip-on-Image
CPI/CPK	Capacity Production Index
CS	Communication System(s)
EA	East-Asia or EastAsia
EPZ	Export Processing Zones
ERSO	Electronics Research and Services Organisation
FAE	Field Application Engineering
GPN(s)	Global Production Networks
H	High
High-Tech	High-Technology
HK	Hong Kong
HQ	Headquarters
HR	Human Resources
HSIP	Hsinchu Science-Based Industrial Park
IB	International Business
IC	Integrated Circuits
IDB	Industrial Development Bureau
IPM	International Product Management
ISO	International Organization for Standardization
ITRI	Industrial Technology Research Institute
L	Low
LCD	Liquid Crystal Display
LCM	Liquid Crystal Molds
LED	Light-Emitting Diode
LSI	Large Scale Integration
M	Moderate
MNE(s)	Multinational Enterprise(s)
MOEA	Ministry of Economic Affairs

Neg.	Negligible
NIE	Newly Industrial Economics
NO	National Organisation
NSC	National Science Council
NTUT	National Taipei University of Technology
ODD	Optical Driver Device
OEM:	Original Equipment Manufacturer
PC	Personal Computer
PD(s)	Product Divisions
R&D	Research and Development
RHQ(s)	Regional Headquarters
RSO(s)	Regional Sales Office(s)
SA	Subsidiary Autonomy
SoC(s)	System-on-Chips
SRAM	Standard RAM
TC(s)	Technological Capability/Capabilities
TSMC	Taiwan Semiconductor Manufacturing Company
ULSI	Ultra Large Scale Integration
UMC	United Microelectronic Corporation
USAID	United States Agency for International Development
VLSI	Very Large Scale Integration
WEF	World Economic Forum
WTO	World Trade Organisation

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"A journey of a thousand miles begins with a single step." Lao Tzu

The one who has endured the process of PhD learning pathway reflecting to the extent of that Einstein stated, "The state of mind which enables a man to do work of this kind…is akin to that of the religious worshipper or the lover; the daily effort comes from no deliberate intention or programme, but straight from the heart." Naturally, this thesis represents a fraction of the fruits of my PhD journey.

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Jung-Li Wang

June, 2006

The University of Warwick, WBS

DECLARATION

This is to declare that:

- I am responsible for the work submitted in this thesis.
- This work has been written by the author.
- All verbatim extracts have been distinguished and the sources specifically acknowledged.
- During the preparation of this thesis a number of papers were prepared as listed below. The remaining parts of the thesis are unpublished.

1. Conference Publications:

2006 Learning Network and Technological Capability at the Subsidiary Level, Academy of International Business Annual Conference, Beijing, China, by Jung-Li Wang and Simon Collinson.

2006 Subsidiary-Specific Advantages: Capability and Autonomy in Taiwan Based MNE Subsidiaries, Academy of Management Annual Conference, Atlanta, USA, by Simon Collinson and Jung-Li Wang.

2003 Subsidiary Autonomy and Innovative Capability: A Pilot Case Study of Philips Semiconductor Plant in Taiwan, British Academic Management Annual Conference Proceedings, Britain, by Jung-Li Wang and Simon Collinson

2003 Innovation Capability in the MNE: Focus on the Subsidiary Level, BAM Doctoral Symposium, Leeds, Britain, Presented by Jung-Li Wang

2. Seminar/Workshop Presentations:

2004 The Degree of Subsidiary Autonomy and Technological Capability: Relations in the Multinational Enterprise Network, EDEN Doctoral Seminar in Strategic Management, Barcelona, Spain, Presented by Jung-Li Wang

- This work has not previously been submitted within a degree programme at this or any other institution.

Signature: *Jung-Li Wang*

Date: 19/06/2006

ABSTRACT

This research contributes to the literature on subsidiary evolution by exploring the developments of subsidiary technological capabilities. It has been widely acknowledged that subsidiaries have unique in-house capabilities that are embedded in two contexts: 1) the internal technology sources including the headquarter ("HQ") and affiliated-units, such as the research and development ("R&D") centres; 2) the external technology sources comprised of local, regional or global entities, such as local universities. This study examines the relationship between subsidiary capability and autonomy and the mediating effects of communication systems, by linking internal and external networks through which the subsidiary both exploits and creates particular technological capabilities, and through which the parent company HQ, exercises its control.

Through a synthesis of the international business and innovation management literature review, a set of measures of technological capability, autonomy and communication have been drawn. A capability taxonomy configured for the semiconductor industry by Ernst et al. (1998) was adapted to specifically examine integrated circuit ("IC") design, production and marketing capabilities amongst five different Taiwan-based foreign wholly-owned subsidiaries in the electronics industry (particular in the integrated circuits sector). These are compared using quantitative and qualitative measures on factors such as the types and levels of technological capabilities, the degree of autonomy and the intensity of communication they have developed.

The findings demonstrated that the heart of subsidiary technological-capability creating lies in exploiting the parent company's core-competitive assets and capabilities and creating its capability development using local knowledge systems, and regional and global cooperative partners. The extent to which such developments of subsidiary technological capabilities are dispersed throughout and leveraged on the multinational enterprise ("MNE")'s differentiated network, depends on the intensity of internal and external communication systems for assimilating information or knowledge. Moreover, single subsidiaries have different degrees of decision-making autonomy, which influence both the nature of the internal MNE network, and the extent of influence of the internal and external network linkages on the developments of subsidiary technological capabilities. Overall, this research concludes that subsidiary autonomy is a cyclical process between the parent company and subsidiary, which is affected by the development of a subsidiary's technological capability. The capability-creating of a subsidiary is driven by the interactions between internal and external leverages which broaden the level and types of technological capabilities (namely, marketing-, design-and production-related) in terms of the scope of responsibility, in-house capability and the capacity for assimilation and creation of 'new' technology.

Keywords: subsidiary technological capability, subsidiary autonomy, subsidiary communication systems, network linkages

CHAPTER ONE

INTRODUCTION

1.1 Research Rationale

Researchers in international business management have long recognised the association between technology and multinational enterprises (MNEs). With respect to conventional innovation development in the MNE, scholars have viewed certain innovation capabilities as being retained at the HQ, which limits the approach to technology in the subsidiaries of MNEs to the application of centrally generated technology. However, this view has been challenged by a number of scholars focusing on the way in which multinational subsidiaries facilitate their own resources and capabilities to create innovative activities to respond to the needs of the local environments (e.g. Bartlett and Ghoshal, 1986; 1989; Birkinshaw, 1996). According to this alternative viewpoint, a number of studies highlight the growing importance of research and development (R&D) activity outside the country of origin, suggesting that multinational subsidiaries play an increasingly important role in the generation of new competences in the MNE (Cantwell and Mudambi, 2005; Dunning, 1994; Papanastassiou and Pearce, 1994; Cantwell, 1989; Pearce, 1989). Technological capabilities have also been identified by a variety of authors as being particularly important for economic growth at the macro-level, and for competitive advantage in manufacturing at the micro-level (Asakawa, 2001; Bartlett and Ghoshal, 1990; Chesnais, 1988; De Meyer, 1992; Dosi *et al.*, 1988; Mansfield, 1968; Pearce, 1994). Combining these perspectives, the role of the subsidiary as a creator as well as exploiter of technological capabilities and a net contributor to MNE-wide innovation effort is becoming increasingly important.

The subsidiaries of the MNE have unique access to specific resources or capabilities from two technology sources and network linkages. First, subsidiaries are dispersed parts of the MNE that have the capability to disperse technology and disseminate knowledge across its affiliated units (Bartlett and Ghoshal, 1986; 1989). Second, subsidiaries in host countries performing specific value-adding activities are fundamentally 'embedded' in the host country regions' knowledge development systems (Cantwell, 1995; Rugman and Verbeke, 2001). In particular, subsidiaries can pursue their developments, which are driven by HQ assignment, subsidiary choice and/or local environment determinism (Birkinshaw and Hood, 1998b), in association with those two technology sources/linkages, thus strengthening or enhancing their capabilities.

In this research, we position ourselves in the literature on subsidiary evolution (Birkinshaw and Hood, 1998b), confining the study to the development of subsidiary technological capability and not contemplating the issue of capability depletion. Of central importance to subsidiary development is the 'innovative activities' that can be pursued by the subsidiary initiatives (Birkinshaw *et al.*, 1998; Birkinshaw, 2000). However, subsidiaries are a part of the MNE that has formal/legitimate relationships with the parent company, HQ or RHQ encountered in the management of subsidiary technological innovations or initiatives.[1] Indeed, the relationship between parent company HQ and subsidiaries, namely, subsidiary autonomy, is associated with subsidiary initiative (Birkinshaw *et al.*, 1998; Birkinshaw, 2000). In addition, with regard to the management of subsidiaries' innovative capabilities, communication systems have long been regarded as a key determinant of the organisation's effectiveness in creating and diffusing innovation (Gupta and Govindarajan, 1991). It provides a multitude of functions in the management of the MNE differentiated network, and is recognised as a fundamental requirement for the effective management of international research and development and cross-border innovation (Zander and Sölvell, 2000). Despite this acknowledgement, there have been relatively few empirical studies (e.g. Almeida and Phene, 2004; Frost, 2001; Birkinshaw *et al.*, 1998) of how a particular subsidiary leverages both internal and external links for developing technological and innovation-related capabilities. As a result, in this research, we explore the development of subsidiary technological capability in conjunction

[1] In this research, although subsidiary technological innovation and subsidiary initiative are considered interchangeably, some circumstances particular to each concept will be specified.

with innovation-related capability, as well as draw on different aspects of subsidiary autonomy and communication systems through systematic empirical examination.

1.2 Research Objectives and Research Questions

Literature in this field highlights the importance of subsidiaries as locations where innovation-related capabilities can be developed via both internal (MNE) and external (local region) linkages. The MNE network, coordinated from the centre, can access and combine different kinds of resources, capabilities and knowledge as required via subsidiaries that are more or less linked into regional sources of these attributes (e.g. Almeida and Phene, 2004; Frost, 2001). However, given the complexity of the overall MNE network, the successful monitoring and development of local technological resources leads MNEs to encourage localisation of technology development. In this context, subsidiaries seek network linkages with research-active host institutions to take advantage of local ideas and products, as well as to continuously develop and share resources and knowledge with sister-units of the MNE.

Our approach reflects the well-established characterisation of capability/competence-exploiting and capability/competence-creating activities at subsidiary level (Cantwell and Mudambi, 2005, p.1110). However, the technological capabilities literature suggests that firms often both exploit and create capabilities simultaneously when working in collaborative partnerships with internal and external specialists. In light of this, rather than considering a trade-off between internal and external linkages, we focus on the way subsidiaries combine both sets of networks to develop in-house capabilities which enhance their own innovative capacity and subsidiary specific advantage. In addition, the research explores the complex relationship of subsidiary capability and subsidiary autonomy, particularly in terms of the HQ-subsidiary relationship.

The objective of the present study is to provide new insights into the development of subsidiary capability. In particular, this study focuses upon the wholly-owned multinational subsidiary as the main unit of analysis to examine the development of technological innovation-related capabilities via both internal and external network linkages. Our main research aims are: 1) to examine the source of these capabilities, particularly by adopting a network approach, focusing on the range of internal (MNE) and external (local, regional or global) linkages through which subsidiaries 'explore and exploit', both leveraging existing/routine capabilities and accessing or co-developing/non-routine new capabilities; 2) to develop a more precise set of measures for empirically examining specific levels and types of technological capability at the subsidiary level. For this, we draw on studies outside the international business sphere that seek to understand the development of indigenous technological capabilities in firms in emerging and developing countries; (3) to investigate a set of characteristics and dimensions of subsidiary autonomy taken from previous work (e.g. Birkinshaw *et al.*, 1998;), focusing on the range of operational and strategic decision-making, and indicate a set of communication systems adapted from previous studies (e.g. Birkinshaw *et al.*, 1998; Gupta and Govindarajan, 1991), drawing upon the intensity of the subsidiary communication. In addition, we reflect on the extent to which autonomy and communication effects are associated with the development of subsidiary technological and innovation-related capability.

Building on the above-mentioned objectives, the purpose of the research is to establish the relationship between subsidiary capability and autonomy and the mediating effects of the communication system by linking the internal and external networks through which the subsidiary accesses and leverages particular technological capabilities, and through which the parent company HQ exercises its control. The central research questions of this study concern:

1. How, and under what conditions, a subsidiary develops its technological capability through internal and external network linkages;
2. What relationships determine the degree of subsidiary autonomy and why;
3. The nature of the relationship between the development of subsidiary technological capability, subsidiary autonomy and communication systems.

1.3 Central Concepts in the Research

Some of the most important concepts in the research have already been highlighted. The following section specifies the concepts of the MNE differentiated network, technological capability (including market-related, design-related and production-related capabilities), autonomy and communication system at the subsidiary level.

The MNE Differentiated Network

Although a network coneptualisation of MNE originates in social exchange theory, it has been employed in subsidiary-level research. It differs from a market or hierarchical network in its heavy reliance on reciprocity, collaboration, complementary interdependence, reputation, relationship basis for communication, and an informal climate oriented toward mutual gain. In this study, the concept of the MNE differentiated network denotes two major network linkages: 1) internal network linkage including the HQ and affiliated sister-units/sister-subsidiaries, such as R&D centres; 2) external network linkage comprised of local, regional/global entities, such as the host country's universities or research institutions. These two distinct network linkages are those in which subsidiaries are simultaneously embedded. Subsidiaries facilitate these network linkages to exploit and/or explore the internal and external technology sources during the process of technological innovation.

Technological Capability (TC)

The concept of technological capability used here refers to the subsidiary's ability to make effective use of technological knowledge in efforts to assimilate, use, adapt and change existing technologies. It also enables the subsidiary to create new technologies and/or to develop new products and processes in response to business opportunities or changes in economic environment (e.g. Bell and Pavitt 1992; 1997; Ernst *et al.*, 1998). Technological capability at the subsidiary level is not only a single action, but also a long-term process consisting of multi-level interactions. In particular, subsidiary technological capability is achieved through internal and external technological linkages. The taxonomy of technological capability adapted from UNCTAD in a study of some East and South East Asian countries (Ernst *et al.*, 1998) is applied to explore each subsidiary's capabilities. This leads the research to focus on three specialist technological capabilities: marketing-related, design-related and production-related in the sample subsidiaries. Each of the technological capabilities is underpinned by the following key mechanisms: 1) the capacity for specific (functioning) value-added activity; 2) internal and external linkages capability; 3) learning capability (detailed in Figure 7.2). This allows for a more detailed analysis of the dynamic processes of capability-building, based on narratives provided by respondents focusing on very specific projects, collaborations and learning experiences. Different combinations of all these mechanisms underlie the development of all three types of capability in the subsidiaries. These capabilities reflect subsidiary specific value-added activities, particularly in terms of functional proprietary assets and capabilities.

Subsidiary Autonomy (SA)

The term subsidiary autonomy refers to a subsidiary's ability to make decisions in its own interests on issues that remain at a higher level in a comparable organisation (e.g. Brooke, 1984; Young and Tavares, 2004). The notion of autonomy is multidimensional in nature and presents a relative concept between the HQ and subsidiary that underlies local embeddedness and the HQ's central integration (e.g. Andersson and Forsgren, 1996; Birkinshaw and Morrison, 1995). In this study, a number of dimensions of subsidiary autonomy taken from previous studies are used to identify autonomy according to subsidiary operational and strategic decision-making in relation to value-added activities. These measures reveal relative levels of independence across subsidiaries and therefore, provide an additional indication of in-house capabilities. This allows us to draw attention to the relationship between parent company and subsidiary assessed in the context of subsidiary capability-creating or exploiting. We also assume that subsidiary initiative (e.g. Birkinshaw, 1999; 2000) takes subsidiary autonomy to the extreme.

This is reflected in the extent to which the business activity/scope of responsibility of the subsidiary; and assigned/assumed autonomy is allied with a subsidiary.

Communication Systems (CS)

Communication systems is a term used to cover the communication capacity across the focus subsidiary to influence the relationship of the differentiated MNE networks in terms of technological innovation (e.g. Gupta and Govindarajan, 1991; Nohria and Ghoshal, 1997). In this research, the concept of communication systems distinguishes between internal and external communication capacities, reflecting the subsidiary's embeddedness in two contexts of technology sources. This study conceptualises the intensity of communication, adapted from previous studies (e.g. Nobel and Birkinshaw, 1998; Gupta and Govindarajan, 1991), with respect to internal and external technology sources. This leads us to sketch some interesting patterns of variation across the types and levels of technological capabilities in relation to subsidiary autonomy.

1.4 The Research Setting

The increasing importance of internationalisation of production and innovation in respect to technological changes in the environment involves functional integration between internationally dispersed economic activities (Chesnais, 1992; Dicken, 2003). In this process, the operation of MNEs is the most important force creating international changes in the nature and location of economic activity, as well as a new international division of labour.

The MNE is defined as a firm with value-added activities in at least two countries. It begins with Vernon's (1966) product life-cycle model, continuing with the work of Stopford and Wells (1972) on questions of strategy and structure in MNEs. The strategies and operations of MNEs, and the resulting map of international production, operation and investment are much influenced by technological change. The effects of technology on the changing patterns in this regard have important implications for the acquisition of valuable resources from the environment and/or selective development of the environment for knowledge

(Andersson *et al.*, 2001; Sölvell and Zander, 1995). The MNE started its R&D functions abroad mainly for the adaptation of products developed in the home country to local tastes or customer needs, and the adaptation of processes to local resource availabilities and production facilities. A long-running assumption underlying the early research is that subsidiary capabilities are an inferior sub-set of capabilities transferred from the HQ, and that subsidiaries have a limited degree of freedom to shape their own interests.

With the increasing competitive advantage in innovation of the host country, some subsidiary R&Ds have created new technology in association with specific innovative counterparts from the host country (Cantwell and Mudambi, 2005; Pearce, 1999; Zander, 1999). Subsidiaries are increasingly seen as a source of unique capabilities, partly as channels by which MNEs can tap into local knowledge and expertise as well as resources. As such, they can be sources of local variation in the globalisation process (Belanger *et al.*, 1999). Birkinshaw's work on subsidiary initiative, subsidiary evolution and entrepreneurship is amongst the most prominent of these new approaches (Birkinshaw, 2000; Birkinshaw *et al.*, 1998; Birkinshaw and Hood, 1998b).

The major purpose of the research is to investigate internal and external network linkages with respect to technology sources explored and/or exploited by subsidiaries during the process of development of subsidiary capability. In similar vein to the previous studies (e.g. Birkinshaw, 2000; Birkinshaw *et al.*, 1998; Birkinshaw and Hood, 1998b; Cantwell and Mudambi, 2005), we specifically target foreign-owned subsidiaries from different MNE networks in the same location/host country (Taiwan). As well as controlling for location, we select subsidiaries in the same industry to control for industry effects. In this study, we have selected a sample of five Taiwan-based subsidiaries from MNEs in the integrated circuits (IC) sub-sector of the electronics industry. The five case study subsidiaries are all part of the IC supply chain, which extends from the design and production of silicon wafers, to IC design, production, testing and packaging, to the sales and servicing of 'systems solutions' to client companies. It is an R&D-oriented set of operations in a high-technology sector. Competition in business places a premium on innovation in design, production and customer-led systems solutions.

1.5 Outline of the Thesis

Following this introduction, Chapter 2 provides theoretical and empirical evidence of multinational enterprise (MNE) management and innovation management. It begins with an overview of the historical evolution of the MNE and the evolution of its international organisational structures-strategies, as well as the conceptualisation of the differentiated network. It also gives a presentation of the internationalisation of technological developments in the MNE. It continues with the central focus of interest on various aspects of multinational subsidiary management. The presentation concentrates on the types and character of the subsidiary role and subsidiary development, as well as on subsidiary evolution. Particular emphasis is placed on what is known about the concept and characteristics of subsidiary autonomy. There follows a review of innovation management. The literature centres around which technological development evolves at the subsidiary level, and what is known about the development of technological activity in the subsidiary. The scope of the relevant literature is broad, but this is necessary for the formulation of the research questions and development of the research instrument. Accordingly, the research propositions and conceptual framework derived from this chapter shape the basis of the research instrument.

Chapter 3 presents the scope of the research, and details how the research was conducted. We first present a graphical overview of the thematic framework of the research methodology, used as a guide to flow through the chapter. It departs from the main philosophical and methodological issues leading to the choice of methodology. The research strategy then explains the reasons for using the case study of Eisenhardt's (1989) approach, and discusses issues about case study quality. Case study design is explained, consisting of the importance of context, the unit of analysis, and a sample selection of the case studies, as well as the criteria and process. The data collection process, including a pilot case study and the data analysis, comprised of within-case and cross-case analysis, are also described.

Chapter 4 details the research setting in the Taiwan electronics industry including the semiconductor sector. It demonstrates the global implications for Taiwan's electronics industry of repeated restructuring of the industry. The role of the nation is examined, as an agent of both industrial restructuring and of production location. It also shows that the trajectory of development of the electronics sector in Taiwan is a function of global forces as refracted through the prism of a national strategy. This elaboration departs from the specific assemblage of characteristics of individual nations - particularly in Taiwan, and of local counterparts; likewise, Taiwan's research institutions not only influence how globalising processes are experienced, but also have an impact on the nature of those processes themselves.

Chapter 5 explores the cases of five Taiwan-based multinational subsidiaries, namely, PH, RS, ST, MT and HT. It draws attention to the description and analysis of the five Taiwan-based multinational subsidiaries; in particular, it gives a general description of the cases, presenting the process through which the five subsidiaries evolved their capabilities by means of internal and external network linkages. The case of PH is of particular interest because it illustrates a gradual process of subsidiary change and the development of technological capability. The presentation of each case begins with a generic introduction to the whole picture of the MNE. The subsidiary's background, role and development then are described in more detail. The empirical framework employed in this study follows with generic sections comprised of subsidiary decision-making autonomy, subsidiary technological capability and subsidiary communication systems.

Chapter 6 presents comparisons across the five cases made to examine similarities and differences in the relationships between subsidiary technological capability and subsidiary autonomy, in association with internal and external MNE networks. It presents the thematic framework (see Figure 6.1), providing a mechanism for analysing the specific themes of subsidiary autonomy, technological capability and communication systems to speculate about the meaning of these relationships and to make conjectures about the significant patterns. In particular, great emphasis is placed on examining which characteristics determine the degree of subsidiary autonomy, the taxonomies of technological innovation to assess the complexity of the technological capability, and how and what types of internal and/or external communication systems tend to be used and are evolved in subsidiary capability.

Chapter 7 discusses the evidence gathered, and presents a further analysis and discussion of subsidiary technological capability, the interaction with the internal and external MNE network and the formal (legitimate) relationship with the parent company encountered in the management of subsidiary technological innovations or initiatives. It also compares some of the results to other empirical studies and wider literature in order to raise the theoretical level and sharpen the definition of the capabilities-building and/or exploiting and subsidiary autonomy evolved by subsidiaries. In addition, it conceptualises the relationship between subsidiary capability, subsidiary autonomy and communication system; in addition, it summarises the phenomenon of the development of subsidiary technological capability and sketches a framework (In Figure 7.3) for interpreting the cyclical process of that development.

Finally, in Chapter 8, the various strands of the argument of this study are woven together within a discussion of the key features, embracing the perspective of subsidiary evolution. In particular, it highlights the contributions, in both theoretical and empirical terms, of the study to the current understanding of the development of subsidiary technological capability and subsidiary specific advantage. In addition, it highlights the limitations of the study and avenues for further research. Some implications and recommendations for the subsidiary and the MNE are also articulated in this chapter.

CHAPTER TWO

LITERATURE REVIEW

This chapter presents an examination of the literature and situates my research in the content of this literature. Initially, this section will review the two main bodies of knowledge - international business and innovation management. Particular emphasis is placed on literature related to the MNE management and the way in which technological development evolves at the subsidiary level. It is also important to clarify the structure (formal/internal) and social networks (informal/external) that determine the direction and degree of technological development in the local/host country context. These fields of knowledge are drawn together to give an understanding of innovation activities in the MNE network, and to demonstrate how it deploys and integrates technological developments across geographical borders.

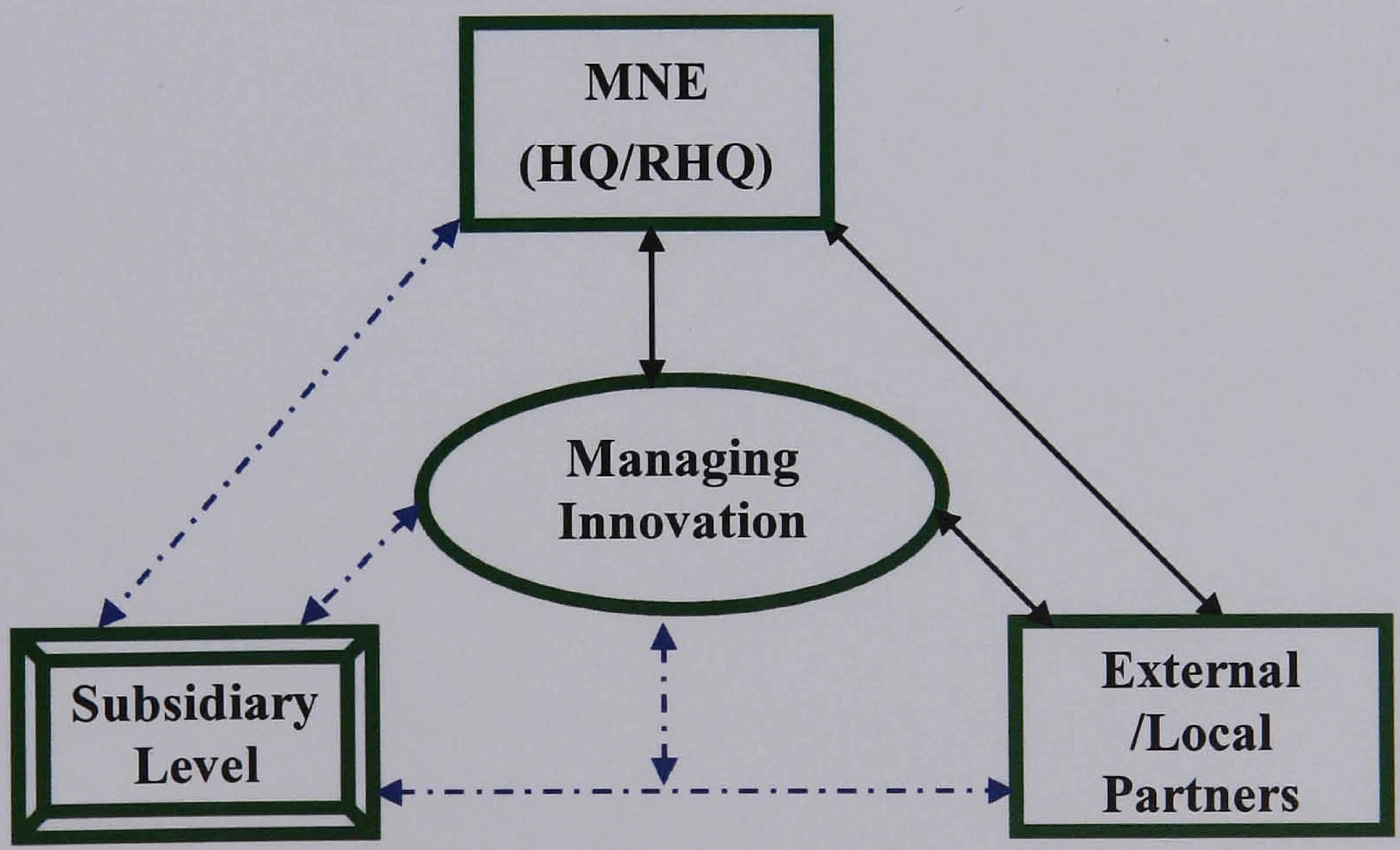

Figure 2.1 The Research Position in the Literature Review

The two bodies of literature review in this research are international business and innovation management. In particular, the review will focus on the internal (the MNE-subsidiary level) and external (the MNE-outside firms-subsidiary) linkages of the MNE. In addition, various theories and ideas rooted in the study of economics, strategy development, and industrial organisation are examined.

This review will also consider several key concepts, factors and/or dimensions that will feature in the subsequent analysis. A summary of the key issues raised in each part of the literature review will be provided such that gaps of theoretical understanding will be identified and filled. It puts forward specific propositions relating to the relationship of the contextual factors to the development of subsidiary capability. This chapter is arranged as follows: 2.1 Overview of Research on MNEs, 2.2 Managing Subsidiaries, 2.3 Managing Innovation, and 2.4 Summary: Research Propositions and Conceptual Framework. In particular, the conceptual framework of subsidiary capability will be laid the foundations for achieving our research propositions and questions throughout the remaining chapters.

2.1 Overview of Research on MNEs

The field of multinational management had its origins in the work of Vernon's (1966) product life cycle model, and expanded on the work of Stopford and Wells (1972), the focus of which was on the questions of strategy and structure in MNEs. To some extent, research on corporate-level strategy and structure has evolved over the years based on a conventional hierarchical model of the MNE (Chandler, 1962; Egelhoff, 1982). This body of research expanded to examine headquarters-subsidiary relationships with questions of subsidiary autonomy, formalisation of activities, and coordination and control mechanisms. Research in this vein was based on the view of the MNE as a hierarchical organisation in which the subsidiary is subordinate to, and interacts with, its parent company (Gates and Egelhoff, 1986; Poynter and Rugman, 1982). However, this approach failed to fully explain the reality and complexity surrounding MNEs. Subsidiaries were shown not only to engage in communication with their parent company, but also to develop networks of relationship with other subsidiaries around the world.

The body of research gradually evolved new ways of investigating MNEs as heterarchical, transnational and multifocal types of organisations (Bartlett and Ghoshal, 1986, 1989; Hedlund, 1986, 1994; Prahalad and Doz, 1981). In particular, Ghoshal and Bartlett (1990) modelled the MNE as an interorgansiational network. Following this, Nohria and Ghoshal (1997) proposed the conceptual model of the MNE as a differentiated network to provide a holistic picture of the MNE. Specifically, this line of research considered the subsidiary as a distinctive unit of analysis. In an early stage of this trend, there was the attempt to identify different strategic roles of subsidiary in association with certain structural/environmental patterns (Bartlett and Ghoshal, 1986; Ghoshal and Nohria, 1989; Gupta and Govindarajan, 1991; Jarillo and Martinez, 1990; White and Poynter, 1984). Furthermore, there developed discussion as to how subsidiaries change their roles over time (Rugman and Bennett, 1982; Birkinshaw, 1996) in conjunction with consideration of the standard dimensions of subsidiary roles (Taggart, 1996, 1997). At the same time, the research indicated trajectories of development in subsidiaries in terms of initiating innovative activities, and creating and transferring knowledge across borders in the MNE (Birkinshaw, 1997; Kogut and Zander, 1992, 1995). The present research is undertaken at the subsidiary level of analysis and adopts a differentiated network approach to the MNE to investigate the differences between internal and external linkages to the MNE.

2.1.1 Evolutionary Theories of MNEs

Most scholars trace the first attempt to systematically explain the early evolution of the MNE organisation to Vernon's life-cycle model (1966). Vernon suggests that as the products developing from the home country become standardised and/or reach a degree of maturity, and the threat of competition from foreign firms becomes more pronounced, production facilities may be shifted abroad. His work identifies the structure of the MNE, leading to the emergence of the structural evolution approach. In this evolution phase, the key structural decision confronting MNEs is their expanding international operation.

With regard to this issue, Stopford and Wells (1972) propose the different stages model through which the MNE evolves, initiated from Chandler (1962): the three-stage model of evolution of domestic firms, in which the MNE is depicted as beginning its international expansion, limited in sales and product diversity, and managing its international activities through an 'international division'. Subsequently, the MNE moves either to the 'area division' or the 'worldwide product division' driven by increasing sale or growing product diversity. Finally, while both foreign sales and product diversity are high, the MNE applies the 'global matrix' structure. In parallel with the structure of the international division, the 'mother-daughter' structure (Franko, 1976) and the 'worldwide functional organisation' (Dymsza, 1972) also exist at the first stage of the structural evolution of the MNE.

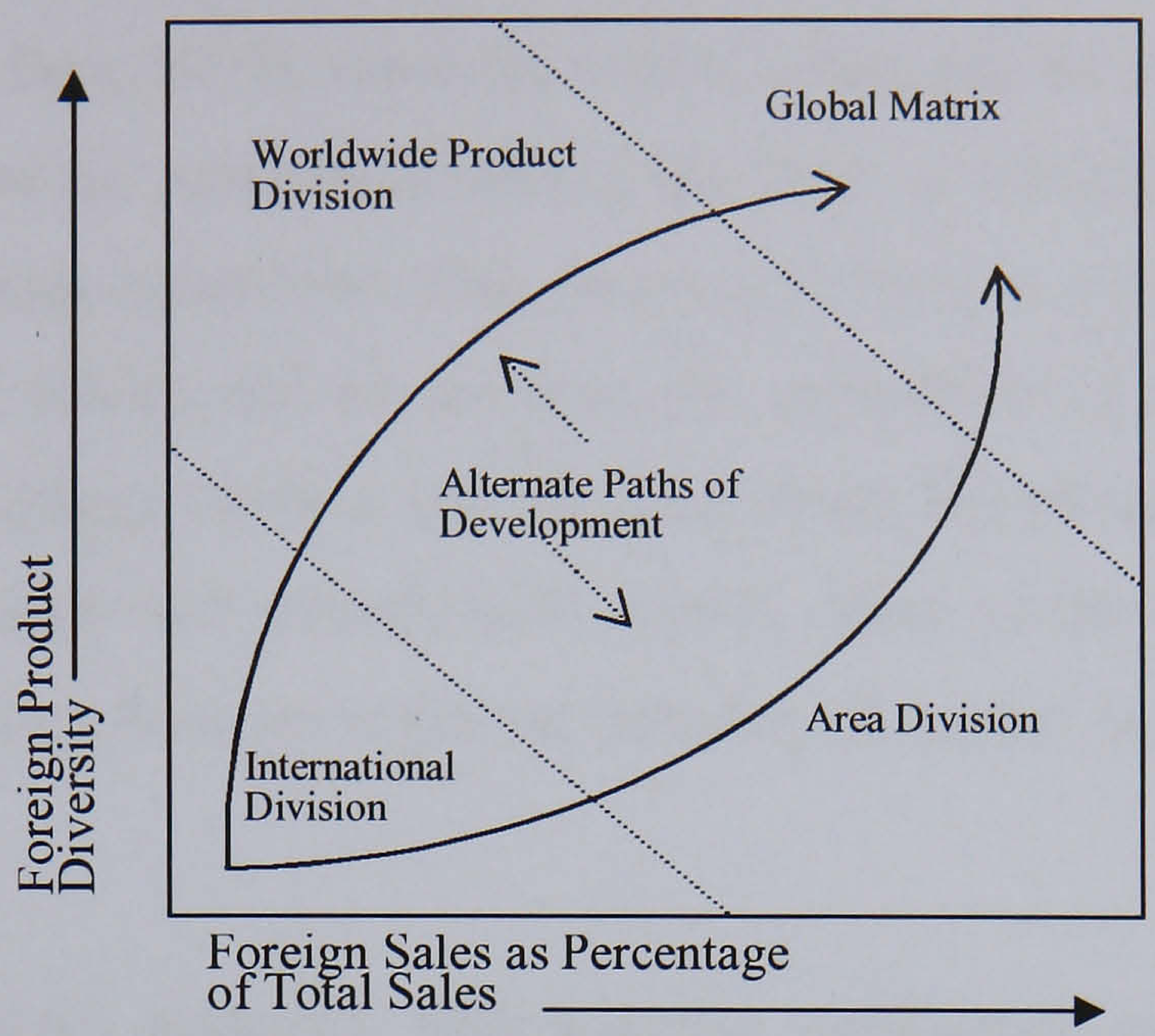

Figure 2.2 Stopford and Wells's Model of MNE Organisations
Source: Stopford, J. M. and Wells, L. T. (1972)

Bartlett (1979) argues against Stopford and Well's model of MNE evolution, and supports Prahalad and Doz's (1981) view that the environment is an influential mechanism for thinking about the evolution of MNEs. They advocate that the MNE often pushes for global integration (strategy and operation integration) and for local responsiveness (customers, markets, competitors and government integration) that are not only external environmental forces, but also the very nature of the MNE internalised. These two dimensions are somewhat in line with the contingency theory of Lawrence and Lorsch (1967), which regards the MNE as a balance of both integration and responsiveness, thus requiring the MNE to tune the decision-making processes, the perception of each unit managers and the composition of political conditions by designing a variety of linking mechanisms.

The 'transational' or 'multi-focus' MNE is designed to cope with the dilemma of high global integration and high local responsiveness. An alternative terminology for the MNE is 'heterarchy', as suggested by Hedlund (1986), who invokes the importance of multiple centres integrated by cross-unit ties uninvolved with the HQ, the importance of integration through governance and shared experience and internal differences. The evolutionary phase is thereby moved to investigate inside the MNE, for instance, the evolution of the MNE value-adding activities (Egelhoff, 1982, 1988a; Kogut, 1985a, b) and HQ-subsidiary relations management (Bartlett, 1986; Prahalad and Doz, 1987). Here, the central issues pertain to various control mechanisms imposed on subsidiaries and to the ways of leveraging the globally dispersed value-adding capabilities. One theme is to look at change over time in the organisation of MNEs and to examine the integration of the internal and external drivers of change (Nohria and Ghoshal, 1994; Sölvell and Zander, 1995; Malnight, 1996; Zaheer and Mosakowski, 1997). Most of the research in this direction places greater focus on empirical research, discussed in detail in Section 2.1.2.

Much of the literature explicitly addresses the managerial challenges of the integrated network MNE arising out of the complexity of the MNE organisation and its interaction with the environment (location)/host countries. This necessites more complex control and coordination systems and a refined subsidiary autonomy (Doz and Prahalad, 1984; Prahalad and Doz, 1987; Bartlett and Ghoshal, 1989; O'Donnell, 2000). Also challenging for MNEs is the internationalisation of production to the development and transfer of technology at the network organisation of MNE. In this approach, MNEs specifically use international networks for innovation to enhance organisational competences.

In this respect, the most notable theory is 'the differentiated network' proposed by Nohria and Ghoshal (1994, 1997), who link organisation theory (social network theory) and the study of the MNE to emphasise the value-adding capabilities in the international network of the MNE organisation. The network conceptualisation of the MNE leads to the expression of the evolution of subsidiary strategy, role and development. At the same time, the ever-increasing number of studies at multinational subsidiary level have been evolving, for instance, subsidiary innovation, subsidiary embeddedness and subsidiary social network (Andersson, 1997; Birkinshaw and Hood, 1998b; Birkinshaw, 1994; Forsgren *et al.*, 1995; Gupta and Govindarajan, 2000; Taggart, 1997). The present research is positioned at the multinational subsidiary level in the context of the MNE network.

2.1.2 Empirical Justifications of MNEs

Ghoshal & Bartlett (1990) define the MNE as a group of geographically dispersed and strategic goal-disparate organisations including its headquarters and the different national subsidiaries. More specifically, the MNE consists of a number of national subsidiaries, each of which is located in a particular national environment. To a certain extent, early research into the MNE focused on the HQ's control related to centralisation or decentralisation of decision-making on financial, personnel, marketing, R&D and technological issues (Perlmutter, 1969; Brandt and Hulbert, 1977; Picard, 1977; Young *et al.*, 1985). There is some evidence of greater centralisation among subsidiaries with exports to other groups, revealing low levels of intra-network autonomy for some subsidiaries (Hedlund, 1981).

Moreover, each subsidiary may share a number of characteristics with other national environments or the home country as a result of interdependencies and cross-linkages. At the same time, subsidiaries may also possess other characteristics that are distinctive. Such a MNE is internally differentiated in complex ways, and integrates to respond to the interdependencies across the different organisational subunits. The complexity caused by such differentiation and interdependence have been a central focus of research in international business management, in a drive to understand how a MNE manages complex control and coordination systems (Doz and Prahalad, 1984; Prahalad and Doz, 1987; Bartlett and Ghoshal, 1989).

The study of complex MNEs has had a long history, the earliest and the most influential school of thought on MNEs having been driven by the economics paradigm (Dunning, 1997; Casson, 1987). In this school, the parent company is viewed as exploiting its firm-specific advantages across national borders through the overseas subsidiaries as the consequence of market failure or imperfection. Subsequent studies have suggested that the parent company initiates the firm-specific advantages and disperses across borders, which may be replaced by emergent advantages generated by the multinational network (Buckley and Casson, 1976; Dunning, 1981; 1989; Kogut, 1983; Rugman, 1981).

Another approach is attempted utilising the structure-strategy paradigm by means of the explicit adoption of a contingency model of MNE organisation (Chandler, 1962; Prahalad and Doz, 1987). In this approach, the strategy and structure of MNEs are regarded as a response to global integration-local responsiveness.[1] Bartlett (1981, 1986) suggests that subsidiaries focus on their local markets, carry out production and marketing activities locally and have significant degrees of autonomy from the HQ; at the same time, the parent company concentrates its production and administrative activities on the home country[2] in order to gain the advantage of economies of scale. This stream of work has led to the development of a number of phenomena: 1) Technological innovation in the MNE is dispersed across subunits and the MNE is recognised as a 'multifocus' organisation (Prahalad and Doz, 1987). 2) The MNE subunits are dependent on each other as well as on the HQ by means of cross-flows of labour, technology and products, generating a so-called integrated network or heterarchy structure (Bartlett, 1986; Hedlund, 1986). 3) The MNE response fosters competitive advantage, which requires a tight coupling of subunits with close communication and coordination (Doz and Prahalad, 1981; Bartlett and Ghoshal, 1989). 4) The integrated network MNE is able to transfer/learn innovations to/from other subunits, and to adapt and improve them in the process (Bartlett and Ghoshal, 1989; Birkinshaw *et al.*, 1995). 5) Formal structure is less important than informal mechanisms, such as the shared values and perspectives of top managers at the HQ and the subsidiaries (Hedlund, 1986; Bartlett and Ghoshal, 1989; Egelhoff, 1991; O'Donnell, 2000).

Taken together, this early research generates an overview in which cross-border economic activity seems to dramatically increase with the global markets for many goods, services, and factors of production, including capital, technology and

[1] Prahalad and Doz (1987) articulated the global integration-local responsiveness model, through which the MNE is perceived as commencing limited choices in terms of structural adaptation to conflicting demands of product diversity and geographical spread.
[2] Kogut (1985a, b) identifies MNE production as being concentrated in the home country, leading to unpredictable variation in costs relative to revenues.

labours. These flows are, to a large extent, managed through the MNE alongside the global network. It also shows that although the structure in the MNE is a crucial vehicle for the implementation of strategy, the process is also equally important. As a consequence, the study of the MNE is multidimensional and complex. The complexity of coordination within the MNE is increased by the explosion of technological diversity. As technology intensifies, the MNE engages in activities for which technologies are involved in different subunits. The resulting complexity requires a collaborative, iterative interaction among the overseas units and the HQ (Medcof, 2001).

2.1.3 The Location Sources to MNEs

Conventional international business schools (e.g. Ricardo's comparative advantage) explain international trading patterns began with the country's relative advantage which a particular production factor existing in the one country gave this country a specific advantage for the manufacturing of products and making an intensive use of the plentiful production factor. In particular, an increase in a specific production factor does not lead to a homogeneous expansion of the country's output; rather, it shifts production and trade toward products that make the most intensive use of the expanding factor, thus strengthening the country's apparent advantage for that product. The explanation of early international trading based on the comparative, macro-level advantage of countries in terms of the availability of technology or production factor abundance has undoubtedly proven useful in explaining trading patterns between countries at very different levels of economic development (Rugman and Verbeke, 2003).

International economics scholars have shifted their focus from analysing the comparative advantage of countries toward the analysis of across-country and industry levels, and even firm-level, location advantages (e.g. Cox and Harris, 1985; Smith and Venables, 1988). The key conclusion of this literature is that product differentiation is associated with the obtaining of scale economies and imperfect competition. Subsequently, it has also developed substreams of research that give the MNE a critical role in the analysis (Cantwell, 1994; Ethier, 1986; Helpman and Krugman, 1985; Markusen, 1984). More specifically, the various international activities performed by the MNE are related to dispersal of R&D and other upstream activities which are initiated from, and reliant upon, the home country. As a result, much of the internationalised business resulting from MNE activity is driven by differences in national innovation systems (Dosi, *et al.*, 1990). MNEs may also sustain their competitive advantage through reciprocal spill-over effects, with the national innovation system and industrial clusters (Porter, 1990, 1998) to leverage its resources and capabilities.

In the MNE context, Vernon's (1966) product cycle focuses on home country specific advantages in technological innovation and the resulting proprietary resources at the MNE level. MNEs are also recognised as being capable of linking their firm specific advantage with specific location advantages of host counties as the maturing and/or standardisation of products occurs (Rugman, 1999). In this sense, foreign direct investment (FDI) may also be a mechanism through which firms seek to develop their resources and capabilities (Kogut and Chang, 1991; Teece, 1992); however, subsidiary innovation and knowledge-seeking FDI has been slow to progress. As a result, the phenomenon of this area of study has tended to proceed through the accumulation of anecdotes (Frost, 2001). In addition, the study of location advantages has long regarded subsidiaries as existing to extend abroad the firm-specific advantage of the parent company and is arranged, therefore, according to the R&D of their parents (Rugman, 1981: 216). However, such centralised R&D activity is no longer adequate. Several researchers have pointed out that a source of competitive advantage for MNEs is the capacity of their foreign subsidiaries to generate innovations based on stimuli and resources residing in the heterogeneous host country environment in which they operate (Bartlett and Ghoshal, 1989; Cantwell, 1992, 1993; Nobel and Birkinshaw, 1998; Nohria and Ghoshal, 1997). Therefore, we assume that host country specific advantage offers an innovative opportunity to the subsidiary which resides within the external network and is distinct from the parent company. The external technology sources, particularly host country technological innovation systems, are utilised by subsidiaries during the process of technological capability development. In this sense, the present study seeks to examine the source of these capabilities, focusing on the range of internal and external linkages through which subsidiaries 'explore and/or exploit', both leveraging existing, and developing new, capabilities.

2.1.4 MNEs as Differentiated Networks

The Network Conceptual Model has been explicitly applied to the MNE for the last fifteen years (Ghoshal and Bartlett, 1990; Forsgren and Johanson, 1992), despite the fact that it originated in social exchange theory. Network thinking increasingly has been applied to subsidiary-level research (e.g. Birkinshaw and Hood, 1998a; Gupta and Govindarajan, 2000). The advantage of the network perspective is that it regards the MNE as a competitive and cooperative environment with both external and internal components (Birkinshaw, 2000). Based on a network perspective, the analysis starts with the MNE network, of which the subsidiary is a part, and focuses upon the position of the subsidiary within the network. In particular, it can elucidate the subsidiary practicalities with links to external (e.g. local environment) and internal (e.g. HQ and sister units) actors, rather than treating the subsidiary as a subordinate entity within the MNE hierarchy.

Powell (1990) adopts the Social Exchange Theory and defines a network perspective by means of a set of descriptive characteristics and critical components. It is distinct from market or hierarchical arrangements in its heavy reliance on reciprocity, collaboration, complementary interdependence, reputation, and relationship basis for communication, and an informal climate oriented toward mutual gain. According to Powell *et al.* (1996), firms more likely to engage in network arrangements are those needing to exchange difficult-to-codify, knowledge-intensive skills that are transferred through processes of collaborative information sharing. In contrast to the economic perspective, the MNE is distinct from international trade among independently owned businesses located in different countries. In particular, the MNE predominantly calls for internal knowledge/innovation transfers (Caves, 1982; Teece, 1976) which can be transferred more effectively and efficiently; by contrast, external transfers are influenced by several market imperfections and inefficiencies.

Recently, the literature on MNEs has aggregated the characterisations of the MNE, making it possible to describe it as a network organisation (Nohria and Ghoshal, 1997; Birkinshaw and Hood, 1998a; Birkinshaw, 2000). This is due to the MNE's connection to internal and external relations, with which different units of the MNE interact. In the most general sense, the MNEs can be regarded as a network of exchange relations among the headquarters, subsidiaries, suppliers, customers and competitors, both inside and outside the MNE. Each unit has a different impact on the structure and strategy formulation and decision-making of the MNE. This perspective is in line with the conceptions of the inter-and intra-organisational MNE. Furthermore, the resource based view (RBV) of the firm has appeared to offer great potential to the study of the MNE in conjunction with network thinking. The RBV argues that under certain conditions, a firm's unique bundle of resources and capabilities can generate competitive advantage (Barney, 1991). It provides a stage for the MNE to broaden the level of analysis by examining at the HQ, RHQ and/or at a subsidiary level in order to explore the development of different resources and capabilities.

Empirically, Gupta and Govindarajan (1991) view MNE network thinking and its resources and capabilities in terms of three types of inter-subsidiary transactions: 1) capital flow is the corporate investments repatriated into various subsidiaries; 2) product flow is the corporate exports to, or imports from, various subsidiaries; 3) knowledge flow is the corporate transference of technology or skill to and from various subsidiaries. They provide a multi-dimensional network perspective which facilitates the study of the question of internal differentiation in subsidiary strategic roles and coordination and control mechanisms within the MNE.

Nohria and Ghoshal (1997) proposed four typologies (Table 2.1) of the MNE network in order to elaborate different resources and capabilities generated at the

MNE. They are: 1) Centre-for-global: subsidiaries are tightly controlled from the headquarters; 2) Local-for-local: subsidiaries enjoy relationships with the headquarters more akin to an equal partnership; 3) Local-for-global: some units are at the centre of a dense inter-subsidiary relationship; 4) Global-for-global: some subsidiaries are independent units. Based on the above characteristics, it considers the 'position'[3] of the MNE at the internal network level. The internal network reflects the growth and decline of valuable and distinctive resources in the subsidiary. In particular, the development of subsidiary capability is constrained by the natural rate of growth of assets and by the actions of the headquarters that use its relative governance to enforce its will on the subsidiary.[4] Not only can its allocation of capabilities and resources be explored by the headquarters, but its innovative capability can also be created, adopted or diffused by its sister subsidiaries. By contrast, at the external network level, the headquarters or subsidiaries may choose to collaborate with the local research institutions, including universities, local industry and/or high-quality innovative firms to develop its specific capabilities.

Table 2.1 Typologies of Innovation Processes in MNEs

Innovation Process	Configuration of Assets and Slack Resources	HQ-Subsidiary Relations
Centre-for-global	Centralised at HQ	Subsidiaries dependent on HQ
Local-for-local	Dispersed to Subsidiaries	Subsidiaries independent of HQ
Local-for-global	Dispersed to Subsidiaries	Subsidiaries independent of HQ but mutually dependent on one another
Global-for-global	Distributed, specialised	HQ and subsidiaries mutually dependent on one another

Source: adopt from Nohria and Ghoshal (1997, p.32)

Birkinshaw (2000) extended the work of Nohria and Ghoshal (1997) and, using the network conceptualisation (figure 2.3) and the RBV, suggests that the subsidiary positions itself in three markets: 1) the local market, customers,

[3] Teece *et al.* (1997): 'position' refers to the firm's current specific endowment of technology, intellectual property, complementary assets, customer base, and its external relations with suppliers and complementors.

[4] Birkinshaw and Hood (1998) proposed this argument, which is based on the resource-based perspective, but here is based on dynamic capability.

suppliers and the like; 2) the internal market, other subsidiaries and divisions within the multinational network; and 3) the global market, which comprises any other customers or suppliers not covered in the first two groups. Each of these markets represents a set of opportunities for the subsidiary which develops a new set of capabilities for managing effectively, such as working with external partners, transferring capabilities between subsidiaries, or building an information technology infrastructure that fits the needs of both internal and external parties. This study builds on, but goes beyond, Birkinshaw's conceptual framework of the national subsidiary by setting out the position of a subsidiary in the MNE network and discussing how a subsidiary develops its technological capability through leveraging both internal and external MNE networks.

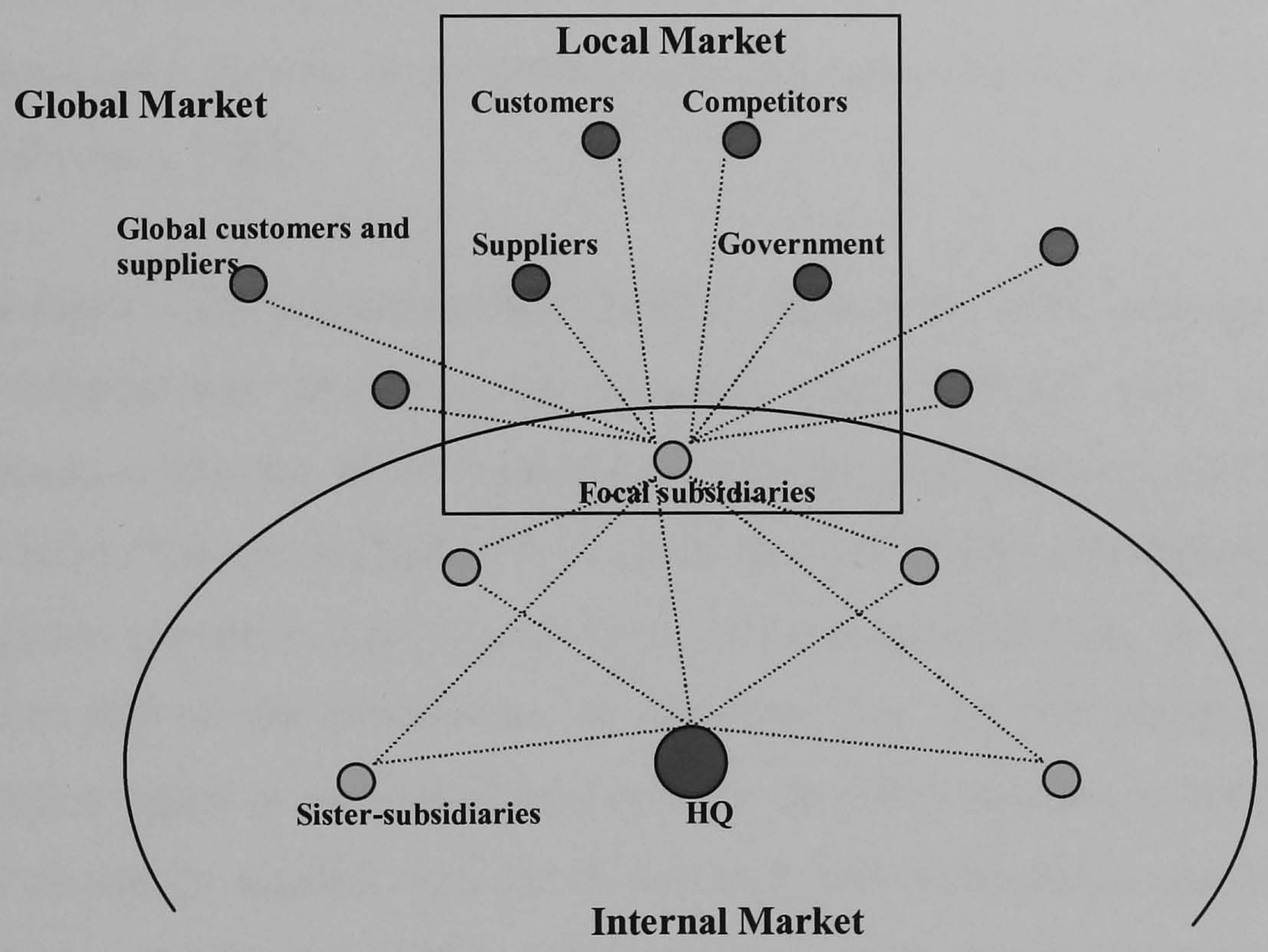

Figure 2.3 Conceptual Framework of the National Subsidiary
Source: Birkinshaw, J (2000)

2.1.5 The HQ-Subsidiary Relationship

The initial purpose of this section is to ascertain how multinational subsidiaries are connected to the headquarters (HQ) and/or regional HQ. Explicit attention is paid to multinational subsidiaries, and their prominence is illustrated. Early research in this area of literature concerns the centralisation, formalisation of decision-making, and control and coordination across subsidiaries (Cray, 1984; Garnier, 1982; Gates and Egelhoss, 1986; Hedlund, 1981; Otterbeck, 1981). This focus of investigation on the HQ-subsidiary relationship is consistent with the view of MNEs as hierarchical and centralised at the HQ. In the very early phase of the MNE, subsidiaries are limited to local sales and manufacturing, rather than to value adding; implicitly, this perspective assumes that subsidiaries are engaged in a dyadic relationship with their HQs only, rather than as part of the MNE network at the same time, subsidiaries are regarded as instruments of the parent company, rather than as autonomous units (Birkinshaw and Hood, 1998a). Furthermore, the literature recognises the different types of HQ control mechanisms and the distinction between formal and informal control; however, the mechanisms for control have become more sophisticated and more difficult to enforce (Kim and Mauborgne, 1993).

The HQ's control becomes more difficult because the MNE is composed of a set of differentiated structures and processes, each of which exists in one of the subunits within the MNE organisation (Ghoshal and Westney, 1993). This leads the HQ to become ineffective in the making of all decisions in the MNE because it does not possess extensive knowledge of the subsidiaries and, as a consequence, has to rely on the subsidiaries. At the same time, the HQ cannot relinquish all decision rights to the subsidiaries because the local interests of subsidiaries may not always be aligned with the HQ or the MNE (Birkinshaw and Hood, 1998a; Nohria and Ghoshal, 1997). This poses a classic control problem, which has spawned literature on how HQ-subsidiary relationships should be governed, and especially on the degree of decision-making autonomy that the subsidiaries should have (e.g. Egelhoff, 1988a, b). This study considers the complexity of subsidiaries' circumstances and the levels/types of resources and capabilities possessed by subsidiaries in which they operate. In particular, it examines the degree of subsidiary decision-making autonomy for preserving their own interests in developing specific capabilities for MNEs.

2.1.5.1 Communication Systems (CS)

Due to the geographically dispersed subsidiaries of the MNE, extensive inter-unit coordination[5] and integration are required (Prahalad and Doz, 1987). Inter-unit communication is a key mechanism for achieving this integration and a key source of the MNE's ability to develop, share and leverage knowledge (Nohria and Ghoshal, 1997). Communication is often seen as a means of control and support in multinational subsidiaries, as well as having long been regarded as a key determinant of the organisation's effectiveness in creating and diffusing innovation (Tushman, 1977; Van de Ven, 1986; Gupta and Govindarajan, 1991). Research into MNEs suggests that centralisation may influence interunit communication in MNEs (Nohria and Ghoshal, 1997). It has shown that frequent contact between the units involved in problem-solving activities lead to faster and more effective solutions (Allen, 1986; Bastien, 1987; Carter and Miller, 1989). Gupta and Govindarajan (1991) conclude that more intense communication patterns create higher information processing capability, and these patterns become especially desirable in contexts where such capabilities are required. The network scholars paint a holistic picture of CS between decision-makers. They suggest that the links of the network can be formal and/or informal because communications through the social network allow different decision-makers to coordinate their decisions. Coordination within a firm involves the internal network, which often takes a hierarchical (and formal) form, whereas coordination between firms involves external network, which typically is a 'flatter' (and informal) form (Buckley and Casson, 2001: 90).

CS have been recognised as a multidimensional phenomenon that can be conceptualised and measured across a number of attributes, including frequency, mode, informality, openness, density and directionality (Gupta and Govindarajan, 1991). In particular, a means of communication is the exchange of information through various media, including face-to-face visits, letters/reports, telephone calls and electronic mails. Communication provides a multitude of functions in

[5] Coordination is also frequently used in association with communication (Nobel and Birkinshaw, 1998)

the management of the MNE, but the advantage of communication within the geographically dispersed network is identified as a fundamental requirement for the effective management of international research, development and cross-border innovation (Zander and Sölvell, 2000). Nobel and Birkinshaw (1998) empirically studied more detailed descriptions of the communication patterns in international R&D units. They categorise four types of CS: 1) the vertical line of communication with entities in the HQ; 2) the lateral line of communication with other international R&D units; 3) the lateral lines of communication to other functions; 4) the line of communication to external entities, such as customers, suppliers and local universities. Their study demonstrates the nature of the relationships between different types of R&D units and various entities in the HQ and external network.

Given that the CS may vary across the different subsidiaries to influence the relationships of the MNE network and the extent of technological innovation, the approach adopted in this study is to investigate the intensity of the subsidiary communication systems, particularly in terms of the frequency, modes, informality, openness, density, and reciprocal involvements (e.g. Ghoshal *et al.*, 1994; Gupta and Govindarajan, 1991) during the process of subsidiary capability development between internal and external network linkages.

2.2 Managing Subsidiaries

This section is concerned explicitly with the level of analysis in the MNE, moving from the HQ down to the subsidiary, focusing on the various aspects of multinational subsidiary management (Birkinshaw and Morrison, 1995; Birkinshaw and Hood, 1998b). The early main issue of such research was the different roles of the subsidiary in relation to its HQ and/or sister subsidiary and subsidiary development (e.g. Bartlett and Ghoshal, 1986; Ghoshal and Bartlett, 1988; Gupta and Govindarajan, 1991; Jarillo and Martinez, 1990; White and Poynter, 1984). All early studies assume that the subsidiary is not just a function of the HQ, but has a certain degree of freedom/autonomy in shaping its own interests.

More recent studies in the management of subsidiaries show how relatively autonomous host country subsidiaries can be influenced by the local environment and thus are sources of local variation in the globalisation process (Belanger *et al.*, 1999). Those subsidiaries are able to develop more initiative-taking roles in the MNEs (Birkinshaw, 2000) and to further subsidiary evolution and entrepreneurship within the MNEs (Birkinshaw and Hood, 1998b; Birkinshaw, 2000). This stream of subsidiary studies focuses on the subsidiary's unique access to specific resources or capabilities, remaining consistent with the local environmental determinations, while at the same time, considering social and communication issues over other sister-units in the MNE (Birkinshaw and Hood, 1997, 1998a).

It is significant that most literature in multinational subsidiaries focuses either on the internal or external relationship in the MNE, rather than emphasing the reality of the subsidiary's circumstance. However, little explicit attention has been paid to the question of how a particular subsidiary facilities its internal and external relationships for developing technological capability to strengthen or enhance the specific advantages for the MNE. In part, this lack of attention suggests that the subsidiary has a critical role to play in the MNE (e.g. Birkinshaw *et al.*, 1998; Birkinshaw and Hood, 1998b), in terms of both marketing the MNE's products internationally and the undertaking of high value-added activities, for instance R&D activities. In addition, the subsidiary's capability may be acquired from the HQ (Birkinshaw and Hood, 1998a) or co-developed with local innovative partners situated in the strategic importance of the local environment (Bartlett and Ghoshal, 1986). In view of this, the present research focuses on the wholly-owned multinational subsidiary as the main unit of analysis to examine the development of innovation-related capabilities through both internal and external network linkages.

2.2.1 Subsidiary Roles

A substantial body of literature is concerned with various aspects of the role of the multinational subsidiary. In particular, the pioneering work of White and Poynter (1984) provided an explosion of studies focused on the specialised roles of subsidiaries (e.g. Bartlett and Ghoshal, 1986; Birkinshaw *et al.*, 1998; Birkinshaw and Hood, 1998a; Gupta and Govindarajan 1991; Jarillo and Martinez, 1990; Taggart, 1997). The common approach is that subsidiaries have differentiated roles evolved from autonomous subsidiaries to product specialists and world mandate types (Birkinshaw and Morrison 1995; Jarillo and Martinez 1990; Roth and Morrison 1992; White and Poynter 1984). Ghoshal (1986) investigates not only the way in which the dynamics of structure and strategy of the HQ affect the subsidiary's role and its capability development, but also typologies of the subsidiary's role as implementer, contributor and innovator. The aim of this approach is to regard a subsidiary as a semi-autonomous entity that is capable of determining its own strategy and developing its capabilities. This area of research also appears to be based upon the assumption that the subsidiary's role is rooted in the HQ only.

Birkinshaw and Hood (1998a) extend Nohria and Ghoshal's (1997) differentiated network approach to elucidate three roles of the subsidiary evolution: HQ assignment, subsidiary choice and local environment determinism, which have some impact on the set of activities undertaken by subsidiaries. Such an approach differs from most research in this field, which tends to focus on one set of factors (Birkinshaw *et al.*, 1998). One line of thought links the different factors - subsidiary, HQ's and local environment interests in innovation activities – so as to gain a total picture of the subsidiary's specific role, which has been extended to become a centre of excellence (e.g. Frost, *et al.*, 2002) and to undertake specific value-adding activities. Moreover, subsidiaries can play important roles in the creation and maintenance of subsidiary-specific advantage (e.g. Birkinshaw *et al.*, 1998; Rugman and Verbeke, 2001), as well as acting as leaders of innovation projects (Andersson and Forsgren, 2000; Fratochii and Holm, 1998; Holm and Pedersen, 2000; Surlemont, 1998). Of central importance to this vein of literature is the idea that the subsidiary's evolutionary role can be driven from subsidiary interest, the HQ or local forces. The most common findings in those studies that discuss this issue from the HQ's perspective is the tendency to assume that the HQ drives the subsidiary role (Birkinshaw, 2000; Chang, 1995; Malnight, 1996), whereas those investigated from the subsidiary perspective place emphasis on subsidiary initiative in combination with the HQ's requirements (e.g. Birkinshaw, 1999, 2000; Birkinshaw and Hood, 1997, 1998a).

It is acknowledged that rationalised subsidiary roles directly assigned by the HQ tend towards the least autonomous types; in particular, subsidiaries have the strategic sensitivity of knowledge-related activities leading to tighter control by HQs (Bartlett and Ghoshal, 1989). In contrast, subsidiaries possessing specific resources, in particular, subsidiaries with significant R&D capabilities (such as world product mandates or centres of excellence), may be less technologically dependent on the HQ (Papanastassiou and Pearce, 1999; Pearce, 1999; Taggart and Hood, 1999), seem to gain greater autonomy and, in turn, undertake more initiatives. A change in subsidiary role evolves over time, leading to the issue of subsidiary development, which will be explicated in the following section.

2.2.2 Subsidiary Developments

The literature on subsidiary developments is derived from three main drivers of subsidiary evolutionary roles[6] and builds on the network perspective of MNEs. At the same time, it adds in an explicit resources and/or capability component to emphasise subsidiary-specific advantage. It has been argued that there are three interactive mechanisms to determine the role of a subsidiary at any given point in time, and that it is a cyclical process of action which constitutes subsidiary development (e.g. Birkinshaw and Hood, 1998a; Hood and Taggart, 1999). The research in subsidiary developments mainly focuses upon the way in which a subsidiary evolves to accumulate valuable capabilities and/or to change its charter or mandate through its network relationships (e.g. Birkinshaw and Hood, 1998b; Papanastassiou and Pearce, 1994; Taggart, 1998). Birkinshaw and Hood (1998b) attempted to model the five generic processes of subsidiary evolution. The combination of three capability changes in charter revolve around subsidiaries, as shown in Figure 2.4.

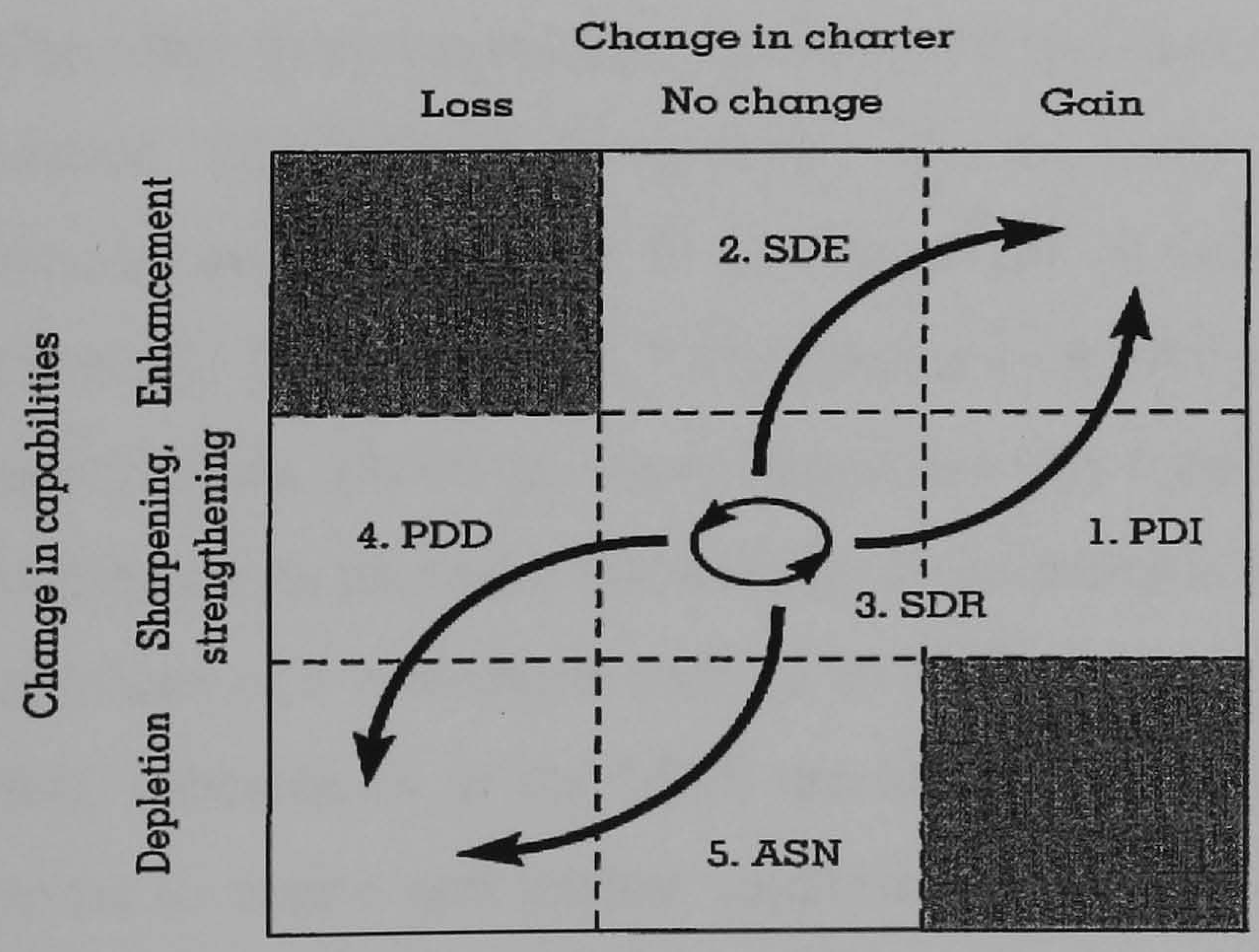

Figure 2.4 Subsidiary Evolution as a Function of Capability and Charter Change
Source: Birkinshaw and Hood (1998b)

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6 Three main drivers of subsidiary evolution roles are proposed by Birkinshaw and Hood (1998b). For further information, see 2.2.1 subsidiary roles.

One stream of the subsidiary development study is based on the assumption of subsidiary preference and local environment. The stock of available factors owned or controlled by the subsidiary and the capabilities existing in the subsidiary are critical (Amit and Schoemaker, 1993). To a certain extent, some empirical evidence shows that subsidiary development is also dependent on its embeddedness in the local network, e.g. local customers, suppliers, research institutes, and competitors (e.g. Andersson, 1997; Andersson and Forsgren, 1996), in order to acquire cutting-edge knowledge and technology from it (e.g. Asakawa, 2001; Cantwell and Hodson, 1991; Manolopoulos *et al.*, 2005; Phene and Almeida, 2003). According to this perspective, the subsidiary with the local network adapts and diffuses its resources and routines over time, and then learns more tacit knowledge (Polanyi, 1966). Subsequently, the subsidiary builds its source of knowledge or technology and facilitates its resources and organisational processes to achieve growth of subsidiary development. The degree of autonomy of a subsidiary with a long-term local network may be affected (Manolopoulos *et al.*, 2005); moreover, if the subsidiary possesses more radical competences, they may stimulate the subsidiary to initiate distinctive capabilities, leading to the building of its empire (Birkinshaw and Ridderstråle, 1999).

The other line of subsidiary development gravitates towards corporate investment and/or international integration. In the very early literature, subsidiary development is regarded to be determined principally by the HQ (Bartlett and Ghoshal, 1989; Hedlund, 1986) because the HQ often identifies key businesses and markets. However, many businesses and markets are not located in the home country, with the result that substantial investments are made in the key innovative activities of a subsidiary, such as an R&D centre (Bartlett and Ghoshal, 1989). In fact, subsidiaries in the MNE are likely to have differentiated roles when they come to create and exploit capabilities (Ghoshal and Nohria, 1989; Holm and Pedersen, 2000). More specifically, some subsidiaries may have a contributory/mandatory role in creating new products and processes for the rest of the MNE, while other subsidiaries are the recipients of capabilities, functioning as implementers for the MNE (Bartlett and Ghoshal, 1986; Hedlund, 1986). Internal benchmarking, in turn, pushes the HQ to consider which subsidiaries are most effective, encouraging a process of internal competition and specialisation. Thus, the empowerment movement encourages subsidiaries to take the initiative in the development and selling of their own distinctive capabilities, facilitating greater autonomy (Birkinshaw and Hood, 1998b). Nevertheless, Verbeke and Yuan (2005) argue that the successful development of a subsidiary's autonomous activities in MNEs requires specific governance mechanisms to reduce rationality constraints faced at the corporate level.

In short, subsidiaries can either function as sales units or be merely engaged in implementing the HQ's strategies created elsewhere in the MNE (Bartlett and Ghoshal, 1986, 1989), or even function as centres of excellence (Holm and Pedersen, 2000; Frost *et al.*, 2002). Of central importance to subsidiary development is the idea that it can be driven from the subsidiary initiative itself, the mandate from the HQ, and/or local environment, as well as in a combination of all three aspects (e.g. Birkinshaw, 2000; Cantwell and Mudambi, 2005). Explicitly, this study investigates what drives subsidiary developments and how the development of subsidiary technological capability is undertaken through internal and external MNE networks.

2.2.3 Subsidiary Autonomy (SA)

The autonomy concept has been identified as one of the critical contemporary issues for international business researchers and managers (Paterson and Brock, 2002). Many early studies regarded autonomy as a decision-based process that evolves by bargaining between centre and periphery within the MNE (Aylmer, 1970; Alsegg, 1971; Peccei and Warner, 1976; Taggart, 1997). Expanding on this, the research related to this subject discusses the centralisation-decentralisation of decision-making from the HQ's perspective (Bartlett and Ghoshal, 1986; Prahalad and Doz, 1981). This aspect is also carried out by Garnier (1982), Hedlund (1981), Kagono (1981), and Picard (1977), respectively. Brooke (1984) terms autonomy 'in which units and sub-units possess the ability to take decisions for themselves on issues which are reserved to a higher level in comparable organisation'. Young and Tavares (2004) define autonomy as 'the constrained freedom or independence available to or acquired by a subsidiary, which enables it to take certain decisions on its own behalf'. These definitions imply that power relates to the ability to influence a situation, in contrast with the formal authority to make decisions. In particular, autonomy is derived from the perception of the HQ-subsidiary continuum as a cycle and a multidisciplinary perspective, a perception of autonomy which differs from that viewed by the HQ as opposed to subsidiaries; in other words, the idea that autonomy is a relative concept, involving centre and periphery units that facilitate bargaining power and many types of autonomy time after time (Brooke, 1984).

Empirical literature evaluating autonomy is categorised into process and decision-making approaches. The process approach is concerned with the extent to which a multi-business MNE controls the activities, roles and strategies of its subsidiaries (Prahalad and Doz, 1981). The principal idea is that regional and/or global subsidiaries integrate MNE strategies with more complex control and coordination systems (Doz and Prahalad, 1984; Prahalad and Doz, 1987; Bartlett and Ghoshal, 1989). In fact, this approach contrasts subsidiaries as the quasi-autonomous nationally responsive MNE objectives over resources and strategies control. However, it is likely to require adjustment, especially when strategic imperative requires increasing local responsiveness on the part of the subsidiary (Prahalad and Doz, 1987:15). Nohria and Ghoshal (1997) indicate that greater environmental complexity enhances the value of the subsidiary's local knowledge and hence, calls for the subsidiary to be granted greater autonomy and flexibility, a view in accord with the findings of Birkinshaw *et al.* (1998), namely, that subsidiaries do not only contribute to firm-specific advantage creation, but also drive the process.

An alternative approach to autonomy focuses on specific aspects of decision-making. It regards such autonomy as the resultant of a constant bargaining process that goes on between the HQ and subsidiary. Hedlund (1981) identifies the subsidiary and HQ influence on the different types of decision-making, showing that lower autonomy is related to high intra-network products transfers. Rugman and Bennett (1982) propose that increased SA is a necessary condition for the adoption of a world product mandate. Garnier (1982) also develops the concept of a global index of autonomy, indicating that some decisions made by subsidiaries have a major impact on corporate objectives and strategic interests; in turn, the level of autonomy is determined by a variety of factors involved in MNE philosophy, operating characteristics of the affiliate and perceptions of the local environment. Gate and Egelhoff (1986) identify HQ influences on the level of SA. Ghoshal and Bartlett (1988) further examine the impact of increased SA on innovation, concluding that local resources tend to facilitate creation and diffusion. Moreover, for local autonomy, this seems to have a positive effect on innovation creation. Other empirical researchers (e.g. Martinez and Jarillo, 1991; Roth and Morrison, 1992; Taggart and Hood, 1999; Young *et al.*, 1988) have investigated different types of local decision-making and their linkages with the MNE, to some extent, to corroborate the strategic sensitivity of knowledge-related activities leading to tighter control by the HQ. In summary, decision-making autonomy appears to be a strategic dimension with close linkages to the MNE network characteristics, role and policies.

Moreover, autonomy requires resources, which may take various forms, including managerial, technological and financial resources, but also including information availability (Young and Tavares, 2004). The complexity of the notion of autonomy and its multidimensional nature present a dilemma with regard to the managing of the HQ's governance and the subsidiary's independence or freedom. Autonomy is a relative concept resting on the subsidiaries local embeddedness and the HQ's central integration (Andersson and Forsgren, 1996; Birkinshaw and Morrison, 1995; Garnier, 1982; Harzing, 1999; Hedlund, 1981; Van den Blucke and Halsberghe, 1984). The different degrees and types of autonomy are the central focus of investigation into the relationship of SA and subsidiary roles and developments. This research considers the different degree of SA in respect to independent decisions made by the subsidiary. Furthermore, the degree of SA in association with strategy and decision-making is shown to revolve around subsidiary evolution, including development and depletion, which are driven by the parent company HQ or RHQ, subsidiary and/or local environment (e.g. Birkinshaw and Hood, 1998b).

2.2.3.1 The Characteristics and Dimensions of SA

The characteristics of autonomy are derived from empirical research into the decision-making approach. The principal line of thought in this respect is that decision-making is the result of a constant bargaining process that goes on between the HQ and subsidiary in the internal MNE network. Hedlund (1981) initially identifies the subsidiary and HQ influences on the different types of decision-making, for instance, central resources, the result of long-term obligation, and decisions involving standardisation and organisational routines and practices. Garnier (1982) develops a global index of autonomy, in which he identifies factors increasing SA, namely, the serving of a largely local market, membership of a small group, minimal interchange of products with the rest of the group and the sharing of common values with local investors. Ghoshal and Bartlett (1988) evaluate the linkage between SA and innovation, finding that SA facilitates the creation and diffusion of locally developed innovations. Young *et al.* (1988) emphasise the importance of the subsidiary's ability to make important strategy-supportive decisions. At the same time, other literature shows that the association between subsidiary size and autonomy is not straightforward (Andersson and Forsgren, 2000). Some studies find a negative relationship between size and autonomy (Hedlund, 1981; Picard, 1977), while others have identified a positive association (Gates and Egelhoff, 1986; Harzing, 1999). Taggart and Hood (1999) tested distinct proxies for subsidiary size alongside employment and sales. Their outcomes showed a positive relationship between employment and autonomy and a negative association between sales and autonomy. Garnier (1982) and Harzing (1999) suggest that a financial resource is crucial to the subsidiary for the expansion of its operation and/or development of innovative activities. However, a dilemma arises between the parent company and the subsidiary with regard to decision-making conflict in relation to manufacturing, financial control, human resource management, marketing, product-related activities, R&D and technological choice (Beechler and Yang, 1994; Brandt and Hulbert, 1977; Levitt, 1983; Picard, 1977; Rosenweig and Nohria, 1994; Van den Bulcke and Halsberghe, 1984; Hewett *et al.*, 2003). In short, most literature has found the financial resource at the subsidiary to be formally deployed from the parent company (Birkinshaw, 2000), although the subsidiary is able to propose its requirements to the parent company. Normally, additional financial support can be authorised for the closed-relationship subsidiary or the high value-adding subsidiary. In addition, if subsidiaries have greater autonomy over decisions within the MNE, they normally have superior information (Edwards *et al.*, 2002).

An alternative view suggests that local responsiveness requires subsidiaries to have greater autonomy in order to meet local market needs in respect of customised legislation or host country demands. External network counterparts, including suppliers, customers, distributors, research institutes, professional organisations and regulators and other policy-makers, may play an important role as sources of innovation and new business ideas. It is difficult for the HQ to govern this knowledge because of information deficiencies, and in turn, SA seems necessary (Birkinshaw *et al.*, 1998; Forsgren and Johanson, 1992; Gupta and Govindarajan, 1991; Nohria and Ghoshal, 1997; Papanastassiou and Pearce, 1999). In this regard, Andersson and Forsgren (1996) adopt the resource dependence perspective and consider the actual configuration of the subsidiary business network, showing that the more embedded the subsidiary is within its local sourcing and linkages with the local or national system of innovation, the lower the level of HQ control. Birkinshaw and Hood (2000) also support the view that subsidiaries in leading-edge industry clusters are more autonomous, more embedded in the local cluster and have greater international market scope than subsidiaries in other industry sectors. Hewtt *et al.* (2003), however, suggest that the cooperation (or intra-organisational association) between the HQ and subsidiary does not constrain SA in terms of undertaking marketing activities, findings which are consistent with those of Roth and Nigh (1992). In addition, Ghoshal and Bartlett (1988) find that normative integration and intra- and inter-unit communication positively impact on the creation, adoption and diffusion of innovations by subsidiaries. Birkinshaw *et al.* (1998) go further and examine the determinants of the contributory role of the subsidiary and subsidiary initiative. They find that a contributory role is strongly associated with SA, and that entrepreneurial culture in the subsidiary is associated with subsidiary initiative.

In sum, although various studies have examined different angles of SA, they tend to be related to the allied distinction between assigned and assumed autonomy (e.g. Birkinshaw, 2000: 19-20; Young and Tavarse, 2004: 228). This issue can be observed through the subsidiary decision-making process across particular value-added activities, and the extent to which it expands the subsidiary's scope of responsibility with/in the internal and external networks of the MNE.

2.2.3.2 Subsidiary Roles & Developments V.S. SA

In international management literature, the terms subsidiary role and subsidiary strategy are often used interchangeably. Subsidiary role suggests a deterministic process whereby the subsidiary fulfils its imposed function; strategy suggests a higher degree of freedom on the part of subsidiary management to define its own destiny (Birkinshaw and Morrison, 1995; Prahalad and Doz, 1981). On this basis, all of the previously mentioned studies focus on subsidiary roles which are explicitly considered in terms of the ability of the subsidiary to take autonomous action (e.g. White and Poynter, 1984). However, Bartlett and Ghoshal (1986) elaborate that each subsidiary has a unique role to play in the MNE. They regard subsidiary strategy as a function of the local environment and the subsidiary's unique capabilities. On this basis, the present study regards the term 'subsidiary role' as pertaining to the subsidiary's unique role in the MNE, and its range of freedom in terms of the local knowledge of subsidiary management to develop and define its interest to contribute to the MNE. Expanding on this, the concept of subsidiary evolution, advocated by Birkinshaw and Hood (1998b), illustrates the process of accumulation of resources/capabilities in the subsidiary over time, in particular, through the development of specialised capabilities (Hedlund, 1986; Prahalad and Doz, 1981), for instance from its product idea, market needs or even from global innovation (Birkinshaw and Ridderstråle, 1999; Pearce, 1999). An important point to underscore here is that the subsidiary's specific capabilities are derived from different sources, such as external relationships (Andersson and Forsgren, 2000) or internal contacts (Papanastassiou and Pearce, 1999), and are distinct from the capabilities of the HQ operation and its sister subsidiaries (Birkinshaw and Hood, 1998b). The subsidiary roles include being a specialised contributor, strategic leader and active subsidiary types (e.g. Bartlett and Ghoshal 1986; Jarillo and Martinez, 1990) as well as a centre of excellence (Andersoon and Forsgren, 2000; Frost *et al.*, 2002), having a world product mandate (Birkinshaw, 1995), and enjoying the autonomy and authority to develop, manufacture and market a product-line worldwide (Crookell, 1987). A high contributory subsidiary role lacks the autonomy, authority and the capabilities to generate independent competencies (e.g. Birkinshaw *et al.*, 1998). Subsidiaries with greater R&D capabilities may be less technologically dependent on the HQ and hence, will have higher levels of autonomy (Pearce, 1999; Taggart and Hood, 1999). On the other hand, the strategic sensitivity of knowledge-related activities leads to strong governance by the HQ (Bartlett and Ghoshal, 1989; Martinez and Jarillo, 1991). Furthermore, subsidiaries close to the local market tend to have great autonomy or a significant influence on the MNE's product and production strategies (Garnier, 1982; Martinez and Jarillo, 1991; Harzing, 1999; Andersson and Forsgren, 2000); in addition, subsidiaries in a multidomestic MNE that adapt to local market needs show a degree of flexibility (Bartlett and Ghoshal, 1989). By contrast, globally integrated subsidiaries tend to have low autonomy (Taggart and Hood, 1999), and subsidiaries interdependent with other units tend to have a reduction in their decision-making power. Nonetheless, subsidiaries with specialised resources seem to confer greater autonomy (Birkinshaw and Morrison, 1995). Accordingly, autonomy has an important influence on the subsidiary role, has a positive effect on a subsidiary's innovation (Young and Tavares, 2004), and in turn, impacts on subsidiary development over time.

2.2.3.3 Different Contexts Influencing SA

The degree of integration is likely to vary according to sector (Young and Tavares, 2004). Empirical evidence shows that worldwide scope and intense inter-dependencies that imply through their operations more globalised industries, such as the automotive and electronics industries, tend to display higher levels of integration (Kobrin, 1991; Makhija *et al.*, 1997; Roth and Morrison, 1992). Birkinshaw and Hood (2000) illustrate that subsidiaries in leading-edge industry clusters are more autonomous, more embedded in the local cluster and have greater international market scope than subsidiaries in other industry sectors. Andersson and Forsgren (1996) also suggest that when a subsidiary is embedded in the local business context, it is more difficult for the HQ to compete with the local context actors in influencing the subsidiary's operations activities. In other words, when a subsidiary has a higher degree of embeddedness in the local business network, there is a greater likelihood of it influencing the corporation's strategic behaviour. Stated simply, in this context, the subsidiary may have greater autonomy for making strategic decisions.

2.2.3.4 Subsidiary Initiatives

The theme of subsidiary initiative has been a major focus of Birkinshaw and associates (1997, 1998, 1999, 2000), who asserted that an initiative is essentially an entrepreneurial process and a series of autonomous actions seeking to develop the international value-added scope of the subsidiary (Birkinshaw *et al.*, 1998: 223). The core concept of subsidiary initiative is '*undertaken with a view to expanding the subsidiary's scope of responsibility in a manner consistent with the strategic goals of the MNE*' (Birkinshaw, 2000: 8). More specifically, subsidiary initiative is regarded as a discrete and proactive activity which a subsidiary can pursue, and through which can advance a new way for the MNE to use or expand its resources (Birkinshaw, 2000: 20). Birkinshaw *et al.* (1998) investigate the factors of subsidiary initiative revealing that are influenced by the following aspects: leadership and entrepreneurial culture, and the business environment, for example, local competition and industry globalisation. This work also indicates the associations between specialised resources, such as firm-specific advantages and subsidiary initiative and contributory role, and concludes that subsidiaries not only contribute to firm-specific advantage creation, but can also drive the process.

Expanding the work of Ghoshal and his associates (1986, 1988, 1989, 1990,1994), Birkinshaw (2000) further discusses different forms of subsidiary initiative - local market initiative, internal market initiative, global market initiative and hybrid initiatives, and the facilitating conditions for these to proceed. He suggests that autonomy is positively associated with local and global market initiatives, and negatively associated with internal market and hybrid initiatives. In addition, he examines structural context variations between subsidiary initiative types; for example, communication between the HQ-subsidiary relationships illustrates high frequency in internal market and hybrid initiatives. By contrast, local and global market initiatives present low frequency. Overall, within the MNE network, subsidiaries may have greater or lesser autonomy, and hence, represent rival sources of power and influence; these, in turn, are potential competitors for subsidiary initiatives (Birkinshaw, 2000). Accepting Birkinshaw (2000) as the definitive work in the initiatives associated with autonomy, this research argues that subsidiary initiative is a manifestation of SA to extreme, resulting from the subsidiary's significant in-house capabilities to explore new business opportunities for the MNE network.

2.3 Managing Innovation

There has been a surge of interest in innovation in recent years. As the managing of innovation is central to achieving sustainable business success, it should be considered as an integral part of business strategy and management. One of the major concerns in innovation studies is the confusion of innovation with invention. Rothwell and Gardiner (1985) consider that innovation does not necessarily imply the commercialisation of a major advance in technology alone, but also includes the utilisation of even small-scale changes in technological know-how. Drucker (1985) defines innovation as the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or service. It is capable of being presented as a discipline, of being learned, and of being practised. Tidd *et al.* (2005) assert that innovation is a process of turning opportunity into new ideas, and of putting these into wide practice. With these definitions, innovation essentially entails several forms of technological change in processes and/or products that can be managed. Clearly, there is a natural link between innovation and technology. Technology is improved continuously through a flow of incremental innovations which construct and shape a technological trajectory (Dosi, 1982). The definition of innovation taken here is in combination with narrow- and broad-definitions. In the narrow-definition provided by Oslo Manual, an innovation is the implementation of a new or significantly improved product or process, new marketing method, or a new organisational method in business practices, workplace organisation or external relations. The broad definition of an innovation encompasses a wide range of possible innovations. An innovation can be more narrowly categorised as the implementation of one or more types of innovation, for instance, product and process innovation (OECD, 2005). Innovation, however, elaborates the whole technological change, representing a shorthand for doing something new, and/or going beyond technology to address the larger scope of change in general. Sometimes, it may evolve with external interactions such as suppliers or customers. This tacit element of technology is embodied in the organisational routines and collective expertise or skills of specific production teams (Nelson and Winter, 1982). Overall, innovation not only signifies changes in product and processes, but also encompasses changes in organisational management. Its changes may combine technological know-how with scientific knowledge to fulfill explicit research and development processes. R&D management has traditionally been concerned with the management of science and technological resources. However, R&D is not the only source of technological improvement and innovation. A firm may generate its own technology through R&D, and may also evolve technological advance through the learning of various kinds of new knowledge, such as manufacturing or marketing. In addition, external or inter-firm relationships, such as suppliers, customers and other forms of collaboration, are now very important sources by which a firm can access new technology and develop its technological capability.

In sum, the nature of innovation consists of technological and non-technological factors. Firms coordinate their managerial mechanisms to more or less efficiently manage technological and non-technological innovations. This study focuses specifically on managing technological innovation at the subsidiary level, considering how subsidiaries exploit and/or explore internal and external linkages to develop technological capability.

2.3.1 Innovation at Firm Level

2.3.1.1 Theoretical Perspective

To be able to innovate, a firm normally needs to combine several different types of knowledge, capabilities, skill, and resources. For instance, the firm may require production knowledge, skill and facilities, market knowledge, a well-functioning distribution system, sufficient financial resources, and so on (Fagerberg, 2005). Innovation is the mechanism by which organisations produce the new products, processes and systems required for adaptation to changing markets, technologies and modes of competition (D'Aveni, 1994; Dougherty and Hardy, 1996;

Utterback, 1994). Innovation is like a core business process and a learned capability, if a firm becomes increasingly focused on innovation; as a result, its performance hurdles for success will increase considerably (Tidd, 2000). A variety of theoretical debates have arisen on the issue of innovation. One economic perspective has mainly focused on the optimising firm, which takes as given technological capabilities and market prices and seeks to maximise profits on the basis of these technological and market constraints (Lazonick, 2005). By comparison, Schumpeter (1934) focuses on the innovative entrepreneur who creates new combinations of existing resources. He also argues that technological progress tends to become more effective and sure-footed through systemisation and rationalisation of research and management, as it is approached as the business of teams of trained specialists who turn out what is required and make it work in predictable ways (Schumpeter, 1950). Nelson and Winter (1982) share the Schumpeterian focus on 'capitalism as an engine of change'. They suggest that firms' actions are guided by routines which are reproduced through practice. They also distinguish an 'innovation regime' in which the technological frontier is assumed to progress independently of firms' own science-based activities, and one in which technological progress is more endogenous and dependent on what the firms themselves do. Another perspective was advocated by Penrose (1959), who conceptualised the modern enterprise as an organisation that administers a collection of human and physical resources to make use of the firm's existing resources. The firm can transfer and reshape its existing resources to take advantage of new market opportunities. Each move into a new product market enables the firm to utilise unused productive resources through both in-house complementary investments in new product development and the acquisition of other firms that have already developed complementary resources (Lazonick, 2005). The resource-based view (RBV) is based on Penrose's work and focuses on the characteristics of valuable resources that one firm possesses and that competitors have difficulty emulating. However, RBV provides no perspective on why and how some firms are able to accumulate valuable and inimitable resources and indeed, what makes these resources valuable and inimitable (Lazonick, 2002). Teece *et al.* (1997) work on the basis of RBV and define dynamic capabilities as the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments. At the same time, they also stress the importance of learning processes that are intrinsically social and collective, and occur not only through the imitation and emulation of individuals, but also through the joint contributions to the understanding of complex problems. Nonetheless, they also argue that firm strategy entails choosing among, and committing to, long-term paths or trajectories of competence development. The dynamic capability perspective provides a platform to understand how a firm, through internal coordination and external reconfiguration, can develop its innovative activities; however, it lacks elaborate social network content (i.e. the MNE network) on how the strategic decisions mobilise innovation and how they initiate technological innovation via internal- and external- network linkages at the subsidiary (sub-firm) level (e.g. Birkinshaw and Hood, 1998b).

2.3.1.2 Empirical Perspective

Innovations vary widely, in scale, nature, and degree of novelty, as do innovating organisations. In particular, the different scenario of each firm fosters different structure, strategy, task complexity and management styles that are important to process innovation management (Tidd *et al.*, 2005). Empirical evidence shows that a number of core elements and processes help more effectively to achieve innovation outcomes at the firm level; for instance, a firm may generate its own technology through its own R&D function and/or generate technological advance through learning of various kinds, design, reverse engineering and imitation. In addition, licensing agreements and collaboration agreements allow firms to innovate locally on the basis of technology generated by other firms. Mowery (1995) investigates eleven US-based industries, purposefully diverse in character and technology but resurgent in the 1990s, observing in every sector increased external sources of R&D, notably collaborations with domestic and foreign competitors, as well as customers in the development of new products and processes. Pavitt (1984) suggests that new process technologies may also be acquired from the suppliers of capital goods. A finding from a set of empirical studies supports the view that internal R&D intensity and technological sophistication are positively correlated with both the number and intensity of strategic collaborations/alliances (Freeman, 1991; Hagedoorn, 1995). The more firms have learnt from interacting with external sources, the more they have accordingly acquired the complexity of the knowledge base necessary for innovation (Granstrand *et al.*, 1997; Powell and Grodal, 2005). Surveys of collaborative/alliance activities in so-called high-technology sectors such as software and automation confirms that access into the technology-aspect of business is the most common motive; in contrast, the market-aspect is a common motive for collaboration in the computer, microelectronics, consumer electronics and telecommunications sectors (Hagedoorn, 1993). The most recent data from the MERIT-CATI database indicate that flexible forms of collaboration such as strategic alliances have become more popular than more formal arrangements such as joint ventures (Tidd *et al.*, 2005). This trend has been most marked in high-technology sectors where firms seek to retain the flexibility to switch technology (Tidd and Trewhella, 1997). Overall, many scholars have pointed out that the network of innovation has become commonplace over the past two decades (Chesbrough, 2003; Powell, 1990; Roberts and Liu, 2001; Rosenbloom and Spencer, 1996). This is reflected in the central concept of dynamic capability, in which a firm evolves its innovation capabilities to leverage its resources and enhance its competitive advantage through internal integration and external collaborations. A discussion of the developments of network innovation is explicated, accordingly.

2.3.1.3 Network Innovation Perspective

The locus of technological innovation resides not only within the boundaries of the innovating organisation, but also outside it, in the 'interstices between firms, universities, research laboratories, suppliers and customers' (Powell *et al.*, 1996). As Mowery (1999) observes, the diversity of institutional actors and relationships in the industrial innovation process has increased considerably. Complex networks of firms, universities, and government labs are critical features of many industries, especially in fields with rapid technological progress, such as computers, semiconductors, pharmaceuticals, and biotechnology. Heterogeneous collaborations allow firms to learn from a wide stock of technology. Firms with broader networks obtain richer experiences, different competencies and added opportunities (Beckman and Haunschild, 2002). As collaborations are deepened, greater commitment and more thorough knowledge sharing result. Firms with multiple and/or multifaceted links to others are likely to have developed better protocols for the exchange of information and the resolution of disputes (Powell, 1998). Most empirical studies show that networks contribute significantly to the innovative capabilities of firms by disclosing them to novel sources of ideas, enabling access to resources and enhancing the transfer knowledge (Powell and Grodal, 2005). Vinding (2002) found that local partners had a greater positive impact on innovative performance in the manufacturing sector. Godoe (2000) suggested that radical innovations were more likely to emerge from intimate and prolonged interaction with international telecommunications associations. Shan *et al.* (1994) also offered the finding that biotechnology startup firms' collaborative relationships increased innovation. Furthermore, Esienhardt and Schoonhoven (1996) studied the population of semiconductor firms and found that the greater the risk in a company's strategy, the more alliances a company formed. Rosenkopf and Tusham (1998) examined the role of technical communities in the flight simulation industry, where cooperative technical organisations play a critical role in developing standards and advancing technological innovation. Overall, the relevant importance of these different sources or network links depend upon the nature of the firm, its industrial sector and its technological base. Scholars have often argued that the sharing of complex information is enhanced by embedded ties, which suggest that informal links have the potential to make a contribution to innovation. Ghoshal and Bartlett (1990) and Hansen (1999) suggested that the informal network in MNEs had a positive influence on the innovation process. Tsai and Ghoshal (1998) also found that social ties led to a higher degree of trustworthiness among business units, which increased resource-exchange and combination, and contributed to product innovation.

Taken together, there is debate in the literature as to whether formal or informal relationships provide greater opportunities for innovation (Ahuja, 2000; Ruef, 2002). Clearly, variation in network types or structures is associated with different content and context in relationships. In particular, the research in the international business context has gravitated towards a network conceptualisation of the MNE, and has been explicitly applied to the MNE for the last fifteen years (Forsgren and Johanson, 1992; Ghoshal and Bartlett, 1990; Nohria and Ghoshal, 1997). This conceptualisation is an extension of social exchange or social network theory (Burt 1992; Emerson 1962; Granovetter 1973). The network of the MNE is considered as nodes with links to external (inter-firm) and internal (intra-firm) actors, and with types of formal and informal structure. Increasingly, it is also being applied to subsidiary-level research (Birkinshal and Hood, 1998b; Gupta and Govindarajan, 2000). The network concept provides a parallel understanding of the management and governance of networks in terms of how subsidiaries evolve, and how they exchange information and develop innovation activities with other actors.

2.3.2 Innovation in the MNE Networks

International business literature has long recognised the association between technology and MNEs. A growing number of studies have focused directly on the innovation processes of MNEs, because MNEs are regarded as being distinctive from other firms for their roles in international technology transfer or diffusion (Cantwell, 2001). One conventional innovation development in the MNE is that certain innovation capabilities are retained at the HQ, because the HQ needs to protect its core competences and to achieve economies of specialisation and scale in R&D. The other traditional innovation is that subsidiaries of MNEs facilitate their own resources and capabilities to create innovations that respond to the needs of the local environment (Bartlett and Ghoshal, 1990).

Recently, attention has shifted towards MNEs as centres for international technology creation and innovation (Chesnais, 1988). With an increasing internal (intra-firm) and external (inter-firm) integration of national affiliations, MNEs have established international networks for integrating cross-border technological developments (Cantwell, 1999; Zander and Sölvell, 2000). As a result, new collaborative innovation with different national units to create innovative products and processes has evolved. This network approach to innovation in MNEs is initially from international production and international R&D facilities. It represents a departure from local market-oriented investments towards internationally integrated strategies (Hedlund, 1986; Bartlett and Ghoshal, 1989), which is more focused on combining its internal capabilities within the MNE network. The integrated internal network of R&D and production within the MNE indicate that innovation is viewed as a hierarchical process in association with the HQ, which plays a central role (Bartlett and Ghoshal, 1986). In particular, innovation development is considered a top-down, deliberate managerial process, where the exploration of innovation created by heuristics, skill development, and fundamentally new insights take place at the HQ level, while the exploitation of these capabilities take place at the subsidiary level (Nohria and Ghoshal, 1997).

The growing number of strategic alliances between MNE competitors and a greater variety of local network associate MNEs with their suppliers, customers and other relevant participants has long suggested the importance of external linkages in the development of new technology and the rate of innovation of the MNE (Cantwell, 2001; Frost, 2001). The early literature on the local network was derived from internationalisation of R&D, focusing on modified and new products introduced to the local market. In particular, it was interested in the local R&D functions and the changing requirements for the management of international R&D in the MNE network (Håkanson, 1990; Pearce, 1989; Pearce and Singh, 1992). The MNE used its host-country links to exploit economies of scale and location advantages, and to realise potential scope advantages by applying innovations and know-how generated in one subsidiary elsewhere in the MNE (Bartlett and Ghoshal, 1986). This type of innovative subsidiary is one important contributor to the learning process that characterises innovation and leads to the creation of new technology in the sense of new production systems (Cantwell, 2001).

The issue of innovation in the MNE network has shifted to examine why existing MNEs source technology-creation resources and capabilities internationally through an internal network of geographically dispersed affiliates. This has led to a greater interest in the competence-based perspective of the firm in the analysis of the MNE (Cantwell, 1991; Cantwell and Piscitello, 2000), and in the role of inter-firm alliances in the capability generation of partner MNEs (Chesnais, 1988; Hagedoorn and Narula, 1996). A growing understanding of the importance of effectively managing innovation activities within the MNE network has shed light on the significant role of the subsidiary in relation to its internal and external network linkages to leverage the MNE's resources and capabilities.

2.3.3 Innovation in Subsidiaries

A number of contributions have illustrated the increasing importance of research and development activity outside the country of origin, suggesting that foreign subsidiaries play increasingly important roles in the generation of new technology in the MNE network (Cantwell, 1989; Dunning, 1994; Papanastassiou and Pearce, 1994; Pearce, 1989). Technological development is specifically a key resource for economic growth and competitive advantage, which has been theoretically and empirically verified in the MNE and its subsidiaries (Asakawa, 2001; Bartlett and Ghoshal, 1990; Chesnais, 1986; De Meyer, 1992; Dosi *et al.*, 1988; Mansfield, 1968; Pearce, 1994). Earlier MNE studies suggest that the approach to technology in the dispersed parts of the MNE network is mostly limited to the application of centrally generated technology through the production of products originally created in the parent company's innovation process. According to Hymer (1976), MNEs engaging in overseas production might have some form of proprietary advantage to compensate for the natural disadvantage of competing with existing firms in the host country. Dunning (1985) also stated that the parent company possesses the privilege of income generating assets and transaction advantages. As a result, the MNE controls the asset of, and capability for, multinational coordination. This increasingly draws attention to the way subsidiaries evolve innovative activities and undertake important research and development work, and become active participants in the formulation and implementation of the strategy of MNEs (Bartlett and Ghoshal, 1986; Gupta and Govindarajan, 1994; Hedlund, 1986).

The recent evolution of the MNE is seen as greatly expanding the scope of local operations in terms of technological and market heterogeneity. It gradually gives the subsidiary a greater role in the innovation of new products for the MNE. In addition, some overseas R&D centres contribute to the enhancement of core technologies for sustaining MNE competitiveness. Ghoshal and Bartlett (1988) examined a number of aspects regarding autonomy, local resources, normative integration and interunit communication, which were positively associated with the creation of innovations but negatively connected to adaptation and diffusion in subsidiaries. Birkinshaw (1997) suggested that certain subsidiaries were given the responsibility for innovating or pursuing initiatives, while others were given implementation roles. Bikinshaw (2000) further investigated the subsidiary initiative, finding that innovation activities taken in subsidiaries had significant impacts on the strategy and structure of the MNE. Papanastassiou and Pearce (1999) suggested that creative subsidiaries with product mandates might be the best way of effectively monitoring local technological and market knowledge on behalf of the MNE. Anderson and Forsgren (2000) also found subsidiaries to be strongly embedded, in a technological sense, in their external networks. Altogether, this is seen to be not only important to subsidiaries, but also influential for MNEs' product and production strategies. By taking part, subsidiaries may enhance their stocks of knowledge regarding the possibilities and future prospects of innovative products and/or processes through the utilisation of external network linkages such as customers or suppliers. These types of knowledge, in turn, can provide valuable advantages for the subsidiary to influence the strategic behavior of the MNE. Many recent studies expanding on this perspective have focused on the geographic origins of the technological knowledge sources: 1) internal MNE (home country), and 2) external environment (host country), by exploring and/or exploiting these resources and capabilities in terms of the process of subsidiary technological innovation and subsidiary competence-creation (Almeida and Phene, 2004; Cantwell and Mudambi, 2005; Frost, 2001; Manolopoulos *et al.*, 2005). A central issue in this regard is that the development of subsidiary technological capability depends on the internal technological richness of the MNE, subsidiary in-house capability and external (location) technological knowledge systems and location specific advantages.

In short, earlier research has tended to assume that the central HQ acts as the initiator of innovative activity and repository of technological capability within the MNE. We now know, however, that the subsidiary can, and does, act as a source of capability and can take the initiative in process and/or product innovation. Subsidiaries that are innovative or take the initiative derive their technological capability from the two technological sources - internal and external MNE network linkages. As a result, we argue that a subsidiary explores and/or exploits internal and external MNE network linkages as its technology sources during the process of subsidiary technological innovation.

2.3.3.1 Technological Innovation Evolved by Subsidiaries

The study of subsidiary technological innovation has become an important aspect of subsidiary evolution. The central issue in this regard is the extent to which subsidiaries are simultaneously embedded in two knowledge contexts - internal MNE and external environment (i.e. host country), which have impacts on the subsidiary development of knowledge and capabilities (Anderson and Forsgren, 2000; Almeida and Phene, 2004; Cantwell and Mudambi, 2005; Frost, 2001; Manolopoulos *et al.*, 2005).

Papanastassiou and Pearce (1999) argued that most innovative subsidiaries are likely to operate in ways that retain strong interdependencies with the mainstream of the HQ's technology, and that are likely to broaden their range of technological sources through in-house scopes and the implementation of collaborations with other sources of the host-country scientific communities. Andersson *et al.* (2001)

also argued that the closer a subsidiary's external business relationships with suppliers and customers, the easier it would be to assimilate new knowledge from outside, and the more it would be able to innovate and advance its performance in the local market. In addition, subsidiaries' involvements with the technological capabilities of their MNE networks were clearly decisively related to the sources of technological knowledge and expertise they facilitated (Papanastassiou and Pearce, 1999). Moreover, Almeda and Phene (2004) and Frost (2001) used patent data separately to study the influence of internal and external knowledge sources on subsidiary innovation, and confirmed that subsidiary technological innovation depends on internal MNE knowledge and external/local knowledge systems, including innovative firms and research institutions. Nonetheless, using patent data as a measure of the output of the innovation process has some well-known drawbacks: 1) little is known about what subsidiaries or the HQ do with their patents; 2) not all inventions are patented, or patentable; 3) it is difficult to ascertain the share of patents that is actually translated into commercially viable products and so on (e.g. Kogut and Chang, 1991; Patel and Vega, 1999). Manoploulos *et al.* (2005) empirically tested the relationship between sources of technology acquired and/or generated internally and/or externally. More specifically, they identified seven types of technological innovation sources: 1) Technology of established products; 2) New product group technology; 3) In-house R&D; 4) Other sources of R&D in the MNE; 5) Collaborative R&D with other local firms; 6) Collaborative R&D with local scientific institutions; 7) Informal development of engineering and production personnel.

To sum up, subsidiaries gradually evolve from those that leverage home country capabilities in local markets to those that build new expertise with host country inputs and facilitate the exploitation of these innovations throughout MNEs (Malnight, 1995). The roles that subsidiaries play often are the result of dynamic interplays with many factors, including the HQ mandate, internal subsidiary decision-making and host country characteristics (e.g. Birkinshaw and Hood, 1998b). Thus, we argue that the developments of subsidiary technological capabilities are based on multi-faceted interaction with their internal and external network linkages which can leverage MNEs' competences and 'tap into' the development of location specific advantages.

2.3.3.2 Technological Innovation Processes in Subsidiaries

To reflect on the complexity surrounding the issue of processes of technological innovation, in this section, we adopt Pavitt's (2005) elaboration to discuss this particular issue at the subsidiary level. Innovation processes differ in many respects according to the size of a firm, the corporate strategy and previous experience of innovation. It involves the exploration and exploitation of opportunities for new or improved products, processes or services, based either on an advance in technical know-how, or a change in market demand, or a combination of the two. In particular, the process of innovation inevitably involves the process of learning through either experimentation or improved understanding (Pavitt, 2005). The process of MNE technological innovation has been generated widely in association with: 1) the global strategy pursued by the MNE parent company (Hout *et al.*, 1982); 2) the establishment and development of international sustainable competitive advantage (Franks, 1989); 3) the improved internal networking capabilities of the MNE (De Meyer, 1993); 4) the ability of the subsidiary to add value through in-house facilities (White and Poynter, 1984) the subsidiary's growing capacity to create and diffuse its own innovations throughout the parent network (Ghoshal and Bartlett, 1988); and 6) the necessity for the subsidiary to become more responsive to the needs of its own customers and local markets (Erickson, 1990). Increasingly, empirical evidence suggests that the process of technological innovation has focused on the subsidiary level and in the direction of more subsidiary initiatives of technological innovations that are valuable to the MNE network (Birkinshaw and Hood, 1998b; Birkinshaw, 2000; Frost, 2001).

The developments of technological innovation in the MNE are begun largely at the HQ, and are transferred infrequently and with various lags, to foreign subsidiaries (Behrman and Fischer, 1980). Subsidiaries start to adjust products received from the HQ, and adapt them to the specific needs of the local market

(Gupta and Govindarajan, 1991; Hedlund and Rolander, 1990). Bartlett and Ghoshal (1989) argue that the subsidiary with exceptional capability can play a crucial role in creating a product in cooperation with local customers. They also assert that subsidiaries do possess unique technological capabilities in MNEs, and that such capabilities are frequently the result of subsidiary innovations or initiatives (Bartlett and Ghoshal, 1989; Ghoshal and Bartlett, 1988). Many investigators have recently turned to the development of subsidiary technological innovation. Egelhoff *et al.* (1998) used technology as a path to evaluate subsidiary development by exploring subsidiary initiatives with the original/extensional development and exploitation of some unique/existing technical capability. They found that subsidiaries had engaged in a variety of technology-based initiatives. Papanastassiou and Pearce (1997) were also interested in measuring the technological sources utilised by subsidiaries. Their research showed that the creative subsidiary built up a certain degree of technological capacity within its own operations, i.e. a R&D laboratory or an engineering unit, but tended also to establish collaborative arrangements with other elements in the host-country's science and technology base. They further investigated subsidiaries with R&D sectors in the UK and found that the crucially creative R&D activity (radically changed products) was retained in parent companies (Papanastassiou and Pearce, 1998). Pearce (1999) analysed which individualised technological activity at the subsidiary level could increase value-added based scope around its own technology and, in turn, contribute to the overall evolution of the MNE. Frost (2001) turned to elaborate where the technical ideas that underpin and inform subsidiaries' innovations were likely to originate. His results highlighted the linking of distinctive technical capabilities of foreign subsidiaries to local sources of knowledge and locational technological advantage. At the same time, the home country played an improtant role as source of knowledge for innovating subsidiaries. The study of centres of excellence emerging in subsidiaries has become an important aspect of product and process innovations. In particular, a set of subsidiary capabilities have been explicitly recognised by the MNE as leveraging and disseminating subsidiary specific-advantages to the MNE network (Andersson and Forsgren, 2000; Frost *et al.*, 2002).

Despite the fact that most studies have recognised that subsidiaries can be specialised in the development of technological innovation in products and processes, they do not provide a precise definition of what types and/or levels of technological innovation are constituted; rather, they focus on R&D or manufacturing units and limit their measurements of technological sources, capability linkages and product developments. In particular, several studies have neglected to consider the type of (i.e. new and/or improved) technological innovations and/or the different degree of technological innovations (i.e. radical/advance, incremental/applied, basic). Arguably, a subsidiary can develop its distinctive technological capabilities through the process of technological innovation in different levels and/or types of products/processes by exploiting and/or exploring the MNE internal and external (local) technological resources and/or capabilities.

2.3.3.3 Definition and Framework of Technological Capability (TC)

2.3.3.3.1 Concepts of TC

As discussed above, the subsidiary can be a principal actor in technological innovation within the MNE network. Different subsidiaries have different firm-specific advantages. As a consequence, a subsidiary capability in the form of MNE activities is the focus of this study, while understanding the interactions of the subsidiary with its internal- and external- MNE networks is an additional aim. Given that technological innovation output indicators tend to be confined to the input side of the technological innovation process - mainly to R&D, in this study, we attempt to extend the TC indicators to non-R&D innovation, placing particular focus upon subsidiary value-added activities, for instance, marketing and production innovation.

The term TC is used here to refer to the ability to make effective use of technological knowledge in an effort to assimilate, use, adapt, and change existing technologies. It also enables one to create new technologies and to develop new products and processes in response to a changing economic environment.[7]

[7] A similar definition of technological capability has been used by Bell and Pavitt (1992, 1997), Ernst *et al.* (1998),

Technology is applied here to refer to the practical application of knowledge and skills to the establishment, operation, improvement, and expansion of facilities for transformation, and to the designing and improving of outputs (Kim, 1997). The important feature of TC accumulation seen clearly in the existing literature is firm-specific advantage, as specified by Teece *et al.* (1990). International business literature has emphasised how internationalisation also changes the structure and nature of TCs within MNEs (Zander, 1999). More specifically, foreign subsidiaries initially respond to local market needs, and the associated establishments of foreign manufacturing require an in-depth understanding of product specifications and manufacturing techniques. Over time, some of the more important subsidiaries thus become more accomplished in terms of TCs, and may develop the capacity to introduce new products and technology without support from the home units (Forsgren, 1989). As the pursuit of local business opportunities is partly built on the transfer of knowledge and technology from the home country; subsidiaries increasingly embed with local customers, suppliers and with other partners such as research institutions, universities and governments (Andersson and Forsgren, 1996; Forsgren and Johanson, 1992). Thus, it is clear that TC at subsidiary level is not a single action, but a long-term process consisting of multi-level/unit interactions. In particular, subsidiary TC is achieved through the MNE group's (internal-) and the host country's (external-) technological linkages. Consequently, the subsidiary can retain core-competence from the parent company and develop its capability depending on its embeddedness in the local or global network.

2.3.3.3.2 Framework of TC

TC taxonomy is applied in understanding each subsidiary's capabilities in the form of functional value-added activities. The focal subsidiary's links with its internal and external network are also analysed in this study. Adopting TC taxonomies from UNCTAD in a study of some East and South East Asian countries (Ernst *et al.*, 1998), the taxonomy categories TC fall into six types of function, with knowledge and skills positioned as the core elements that

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Fransman (1998) and Kim (1997).

subsidiaries undertake in order to acquire, assimilate, facilitate, change and create technologies, as summarised in Table 2.2.

Table 2.2 The Taxonomy of Technological Capability

Types of Functions	Definitions
Investment capability	The ability to undertake the functions of identification, preparation, design, setting up and commissioning of new industrial projects, or the expansion and/or modernisation of existing ones
Production capability	The ability to operate plants, where shop floor experiences and learning by doing have an important role. This capability entails production management, production engineering, repair and maintenance of physical capital.
Minor technical change capability	The ability to adapt engineering and organisational features, reverse engineering and analytical design, and system engineering.
Marketing capability	The ability to deal with demand patterns, marketing trends, user needs and skills so as to collect marketing intelligence.
Linkage capability	The possession of organisational competence to transfer technologies at three levels: within a firm, among firms, and between firms and their scientific and technological infrastructure (network).
Major technical change capability	The ability to create technologies which are new in principle, design new features of products and processes, (including initiative new product or process), and the ability to deploy scientific knowledge in developing patentable ideas.

Source: Ernst *et al.*, 1998

Ernst *et al*'s taxonomy is an extended and updated version of Bell and Pavitt's work.[8] They consider the technological capability including those of other taxonomies, such as Westphal *et al.* (1985) and Lall (1992); specifically, marketing capability is distinguished from production capability so as to understand its commercialised technology. They also discriminate between minor and major technical change capabilities in order to identify which type of technical change leads to new innovation. It is also noteworthy that in this taxonomy, the linkage capability is considered in association with the technology transfer internal (intra) and external (inter) to firms.

[8] Bell and Pavitt (1992; 1993) are mainly concerned with technical change as the focus of TC leading to production capacity.

In short, applying this more detailed classification of TC by Ernst *et al.* (1998), it is easier to identify the overall subsidiary technological capability and its technology sources. However, Ernst *et al.*'s (1998) taxonomy neglects to consider 'technological learning', which depicts the dynamic process of acquiring technological capability from internal and external linkages. For this reason, the present study will also include learning capability in the TC taxonomy.

2.3.3.3.3 Learning Capability

In technologically intensive fields, where there are large gains from innovation and steep losses from obsolescence, competition is best regarded as a learning race. The ability to learn about new opportunities requires participation in them, thus a wide range of inter-/intra-organisational linkages are critical to knowledge diffusion, learning, and technological development (Powell, 1998). Learning capability here is used to denote the dynamic process of acquiring technological capability and the capacity to assimilate knowledge, whereas problem-solving skills represent the capacity to create new knowledge (Kim, 1997, 1998). In particular, we argue that the locus of subsidiary technological capability can be found in internal and external linkages of learning. Learning is a complex process involving many different types of activities, and does not refer simply to a machine's or a piece of equipment's knowledge, skills and experience; rather, it refers also to the conscious, systematic and frequent effort made by the actors concerned. According to Fransman (1986), learning requires an expenditure of effort, therefore it is a costly activity. Moreover, learning does not accrue automatically as a function of output, investment or time, and the gain from learning cannot be presumed. Nelson and Winter (1982) have identified the cumulativeness and tacitness of knowledge as crucial characteristics in learning. The accumulation of technology is a continuous, long-term process which relies on feedback flows of learning/information from within the industry and from users (Baark, 1991). These learning activities are dynamic phenomena. They involve myriad improvements and changes (Boisot, 1995). Powell (1998) investigates the relational capability, and how and when organisations are able to combine their existing competencies with the abilities of others. A research study was conducted by Bresman (2000) into how pharmaceutical firms integrate their external knowledge to evolve their product development. The findings indicated that there may be a need to combine different types of learning mechanisms for effective learning (Teece *et al.*, 1992; Bell and Casiolator, 1993; Cooper, 1995).

A firm can use various learning mechanisms (Leonard-Barton, 1995; Nevis *et al.*, 1995) to gain technological knowledge. The learning categories (shown in Table 2.3) introduced by Bell (1984), with the focus on the specific core elements of learning including accumulation of skill, information and knowledge, will be employed to indicate what learning mechanisms are utilised by subsidiaries to acquire or disseminate different types and/or levels of technological capability.

Table 2.3 The Categories of Learning Capability

Elements	Definitions	Authors
Learning by doing	This includes incremental improvements made before and after technology is implemented and used. This form of learning refers to all learning-by-operating, using, changing, trying and adapting. This kind of learning is also found in studies of learning mechanisms presented in studies where problem identification and solution finding can be done through practical tests and checking.	Arrow, 1962; Lapid,1994; Von Hippel and Tyre, 1995
Learning by prior experience	This way of learning helps firms to acquire knowledge and experience through their personnel before they start working for the firm and increase firm's absorptive capacity for subsequent learning.	Bell, 1984
Learning by training	This refers to various training and supporting activities and the hiring of experts from outside to solve problems in firms to share their experience with the firms' personnel. It includes in-house and/or off-site training activities.	Bell, 1984
Learning by searching consultants	The role of local consultancy is crucial to the successful transfer of turnkey projects from an external source for internal incorporation by the firm.	Robert,1973
Learning by collaboration	This is a function of access to knowledge and possession of capabilities for utilising and building on such knowledge embedded in the exercise of routines. Moreover, learning by connections can be significant for the acquisition of technological capability.	Lall and Wignaraja, 1994; Powell, 1998

Overall, the proposed learning categories have a function (value-added) based focus and include product-process learning focus, documentation mode, skill development focus and formal-informal learning purposes, which will be operationally used to identify subsidiary capability. Arguably, a subsidiary develops its technological capability through internal and external linkages to learn about different types and levels of technological innovation that are critical to its developments of TC.

2.4 Concluding Remarks: Research Propositions and Conceptual Framework

In the preceding sections, a number of issues around MNE management and technological innovation have been extensively reviewed. This section begins by providing a summary of the key issues raised in each part of the literature review in order to identify theoretical gaps. It puts forward specific propositions relating to the relationship of the contextual factors to the development of subsidiary capability.

The review has illustrated the range of MNE management, moving from the HQ down to the subsidiary, exploring the research area of international management strategy and the specific subtopic of the HQ-subsidiary relationships, subsidiary strategic roles and developments. As subsidiaries develop their own unique resources and/or capabilities embedded in the homogenous internal MNE and heterogenous host country environment, the extent of influence of these situations on subsidiary technological development are reflected not only in the subsidiary's scope of responsibilities, but also in the value-creation activities. This raises the question as to the circumstances under which subsidiaries exploit and/or explore internal and external technological resources to enhance or strengthen their capabilities.

Broadly speaking, this study draws upon the literature on the subsidiary evolution (Birkinshaw and Hood, 1998b), although we confine the study to the development of subsidiary capability, and do not contemplate the issue of capability depletion. The study, however, goes beyond the issue of subsidiary evolution, adopting the differentiated network approach, by investigating the internal and external technology sources explored and exploited by subsidiaries during the process of development of TC. At the same time, the concept of autonomy is employed to indicate the relationship between the HQ-subsidiary in terms of the development of subsidiary capability. In addition, the communication system mechanism is adopted to understand how a subsidiary develops, shares and leverages knowledge via internal and external network linkages during the process of technological capability development.

2.4.1 Research Propositions

The object of this section is to identify some important theoretical gaps to guide the formulation of central propositions. Each proposition directs attention to a particular gap and/or issue that will be examined within the scope of the study to provide the research with appropriate direction, and also to assist the researcher with regard to acquiring relevant data. Accordingly, the purpose of the propositions is not to establish formal statistically tested or testable hypotheses for this study.

In the past, the field of MNE management viewed the HQ as a provider of innovation and technological transfer that were subsequently distributed to subsidiaries (Vernon, 1966). However, Hedlund (1994) proposed a different model of innovation in the MNE. Those scholars in support of his model regarded technological expertise and innovation of specific products and services as being significantly disseminated among different countries (Vernon, 1979). MNEs therefore began to employ local resources to create innovative products and processes (Ghoshal and Bartlett, 1988), instead of relying on the HQ for innovation. This changing process highlights the fact that innovation in the MNE is no longer simply the responsibility of the HQ. In fact, with regard to a local environment, a subsidiary has greater autonomy to build up its capability for contributing to the innovation of the MNE. In more recent studies of MNEs, the HQ is not just an innovator, but a technology vehicle for absorbing local knowledge and facilitating the MNE's worldwide capabilities (Tallman and Fladmoe-Lindquist, 2002). However, the successful monitoring and development of local technological resources lead MNEs to encourage localisation of technology development. In this context, subsidiaries seek network linkages with research-active host institutions in order to take advantage of local ideas and products. At the same time, they continuously develop and share resources and knowledge with internal MNE affiliated-units. This leads to the first research proposition:

> ***Proposition 1: Subsidiaries explore and/or exploit links with other organisations in their internal (the HQ, sister-units) and external (local or regional/global) networks during the process of subsidiary technological innovation to develop 'in-house' technological capabilities.***

In this context, the MNE is a differentiated network organisation with lateral communication systems to and from subsidiaries. In addition, it disseminates and leverages different degrees of technology created in different subsidiaries within the MNE network. This technological development implies intensive technological knowledge-leveraging on the part of the MNE network (Mansfield *et al.*, 1979; Pearce, 1989; Florida, 1997), in association with more complex decision-making processes and strategic directions in the interest of the HQ or the subsidiary. This particularly highlights that the HQ cannot effectively make all decisions because it does not possess extensive knowledge of subsidiaries and must, consequently, rely on the subsidiaries (Binkinshaw and Hood, 1998a). This raises a question with regard to the extent to which each subsidiary in the MNE's internal network can have decision-making autonomy in terms of technological innovation to develop its specific in-house capability. Indeed, subsidiaries are simultaneously embedded in the internal MNE network and external environments of regional/global and/or host country (Almeida and Phene, 2004). Some subsidiaries can act as 'competence-creators' within such networks, by absorbing local knowledge and exploiting the MNEs' worldwide capabilities (Cantwell and Mudambi, 2005). This can be hindered when they behave completely autonomously and strive for their own initiatives (Manolopoulos *et al.*, 2005). At the same time, if subsidiaries own more radical competences, this may stimulate them to initiate the development of distinctive capabilities, leading to empire-building (Birkinshaw and Ridderstråle, 1999). This debate leads to the following research propositions:

Proposition 2: Different degrees of subsidiary autonomy influence the nature of the internal MNE network, and the extent of influence of internal and external network linkages on the development of subsidiary technological capability.

Proposition 2a: Different types/dimensions of subsidiary decision-making will have different impacts on subsidiary autonomy.

Proposition 2b: Different technological sources will influence subsidiary autonomy.

Proposition 3: Different intensity of communication systems across internal and external network linkages will be associated with different degrees of subsidiary autonomy, and will leverage different types/levels of technological development.

The above-mentioned MNE studies suggest that the two contemporary positions of technology-development in the dispersed parts of the MNE network are mostly limited to the application of centrally generated technology through the production of products originally created through the parent company innovation process. Alternatively, subsidiaries have evolved innovative activities and undertaken important research and development work, becoming active participants in the formulation and implementation of the strategy of the MNE (Bartlett and Ghoshal, 1986; Gupta and Govindarajan, 1994; Hedlund, 1986). The recent evolution of the MNE is seen as greatly expanding the scope of local operations in terms of technology and market heterogeneity, permitting subsidiaries to become increasingly involved in the innovation of new products/processes for the MNE and/or overseas R&D centres. This, in turn, leads the subsidiaries to contribute to the enhancement of core technologies to sustain the MNE's competitiveness (e.g. Birkinshaw and Hood, 1997; Birkinshaw, 2000; Cantwell and Mudambi, 2005). We now know, however, that the subsidiary can explore and/or exploit internal and external technology sources utilised by the subsidiary during the process of technological innovation. As a result, we argue that a subsidiary with the 'specific advantage' of technological capability will gradually influence the technological scope and/or technological decision-making of the MNE over time.

> ***Proposition 4: Subsidiaries with different types of technological capability from the HQ will gradually influence the MNE's technological scope or technological decision-making.***

Furthermore, subsidiaries gradually evolve from those that leverage home country capabilities in local markets to those that build new expertise with host country inputs and facilitate the exploitation of these innovations throughout MNEs (Malnight, 1995). The roles that subsidiaries often play are the result of the dynamic interplay amongst the HQ mandate, internal subsidiary decision-making and host country characteristics. Thus, we argue that the technological capability of the subsidiary has multi-faceted dimensions of interactions with internal and external network linkages, which can be discerned in their various forms of functional activities (Rugman and Verbeke, 2001). As a result of this, the subsidiary may exploit core-competence from the HQ and explore its capability, depending on its local or regional network.

> ***Proposition 5: Internal MNE and external environment origins of technological sources will give rise to proprietary in-house capabilities in subsidiaries. These will be embedded in the forms of functional activities and interactions with its internal and external linkages, and amount to distinctive 'subsidiary-specific advantage'.***

2.4.2 Conceptual Framework of Subsidiary Capability

Building on the earlier examination of other studies, this research aims to explore the relationship between subsidiary capability and autonomy and the mediating effects of communication systems, by linking internal and external networks through which the subsidiary accesses and leverages particular technological capabilities, and through which the parent company, HQ, exercises its control. The central research questions of this study discuss:

- ***How, and under what conditions, a subsidiary develops its technological capability through internal and external network linkages.***

- ***What relationships determine the degree of subsidiary autonomy and why.***
- ***The nature of the relationship between the development of subsidiary technological capability, subsidiary autonomy and communication systems.***

It has been widely acknowledged that subsidiaries have unique in-house capabilities that are embedded in two contexts: 1) the internal technology source including the HQ and affiliated-units, such as the R&D centre; 2) the external technology source comprised of local, regional/global entities, such as local universities (e.g. Almeida and Phene, 2004; Frost, 2001). This conceptual framework is depicted below in Figure 2.5. The study of subsidiary technological innovation/initiative has become an important aspect of subsidiary evolution. A subsidiary that can pursue its own interests to initiate technological innovation subsequently develops its specific capability (e.g. Almeida and Phene, 2004; Birkinshaw *et al.*, 1998; Birkinshaw, 1999, 2000; Frost, 2001). Subsidiary capability is one of the most complex of the MNE's organisational processes, involving the intensive technological knowledge leveraging of the MNE networks, in association with more complex decision-making processes and coordination systems (i.e. communication) being initiated in the interest of the HQ, the subsidiary and/or local environment. The objective of this research is to examine the internal and external network linkages as technology sources explored and/or exploited by subsidiaries during the process of development of subsidiary capability.

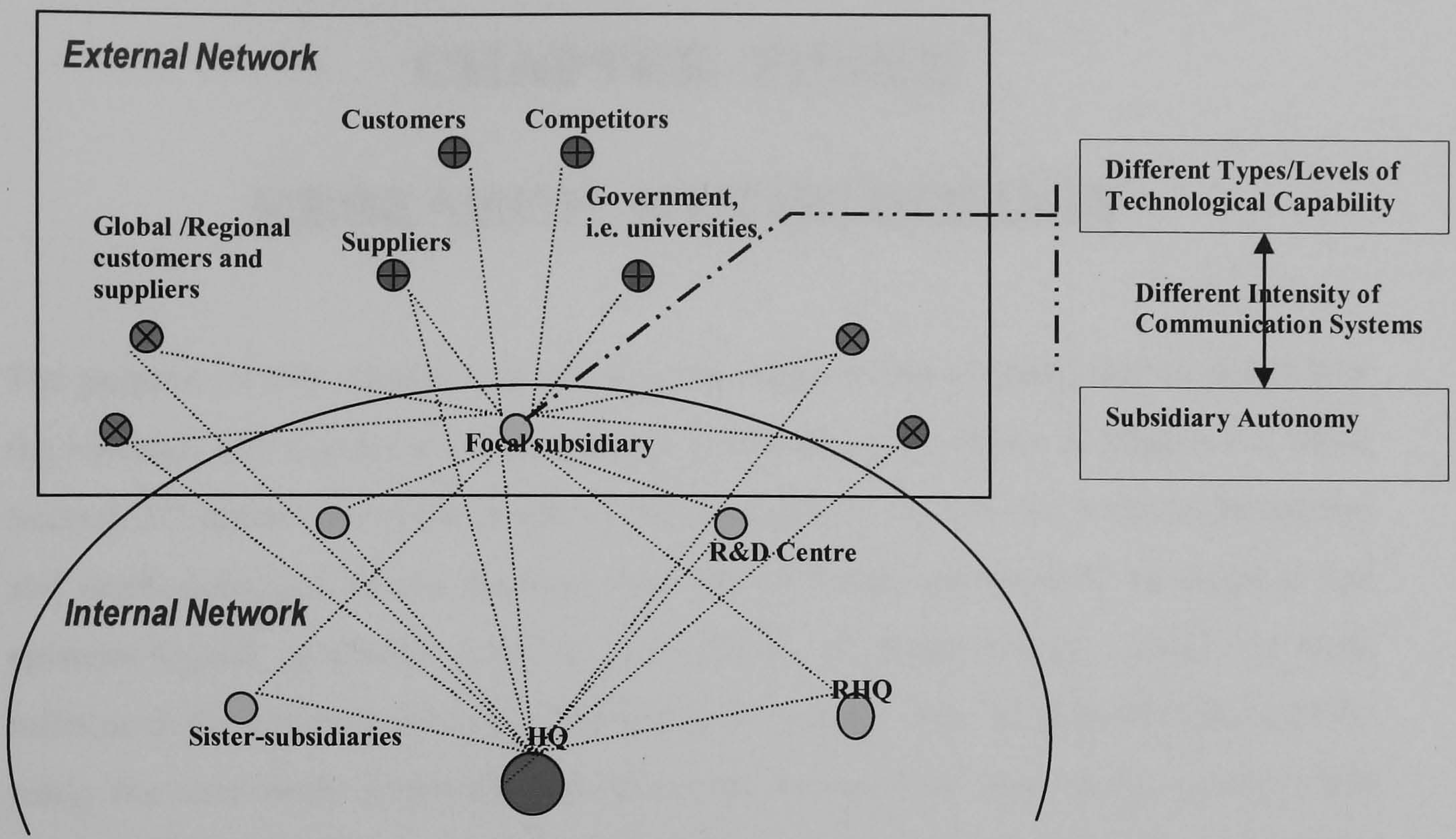

Figure 2.5 Conceptual Framework of the Development of Subsidiary Capability

CHAPTER THREE

RESEARCH METHODOLOGY

The purpose of this chapter is to present the scope of the research and to detail how the research was conducted. This chapter is organised as shown in Figure 3.1. First, Section 3.2 departs from the scope of this research to explain the main philosophical and methodological issues, showing how the different intermediate ontological and epistemological positions lead to the choice of methodology, which in turn, influences the research strategy. The research strategy then explains the reasons for using the case study approach, and discusses issues about case study quality. Case study design is explained, including the importance of context, the unit of analysis, and a selection of the multiple case studies, as well as the criteria and process. Next, the data collection process is described, including: gaining and maintaining access; preparing for the data collection; (conducting a pilot case study); developing a case study protocol; and the main methods used for collecting the evidence. The last section of data analysis describes processes and practices for managing data, transforming data, displaying data, data verification and drawing conclusions.

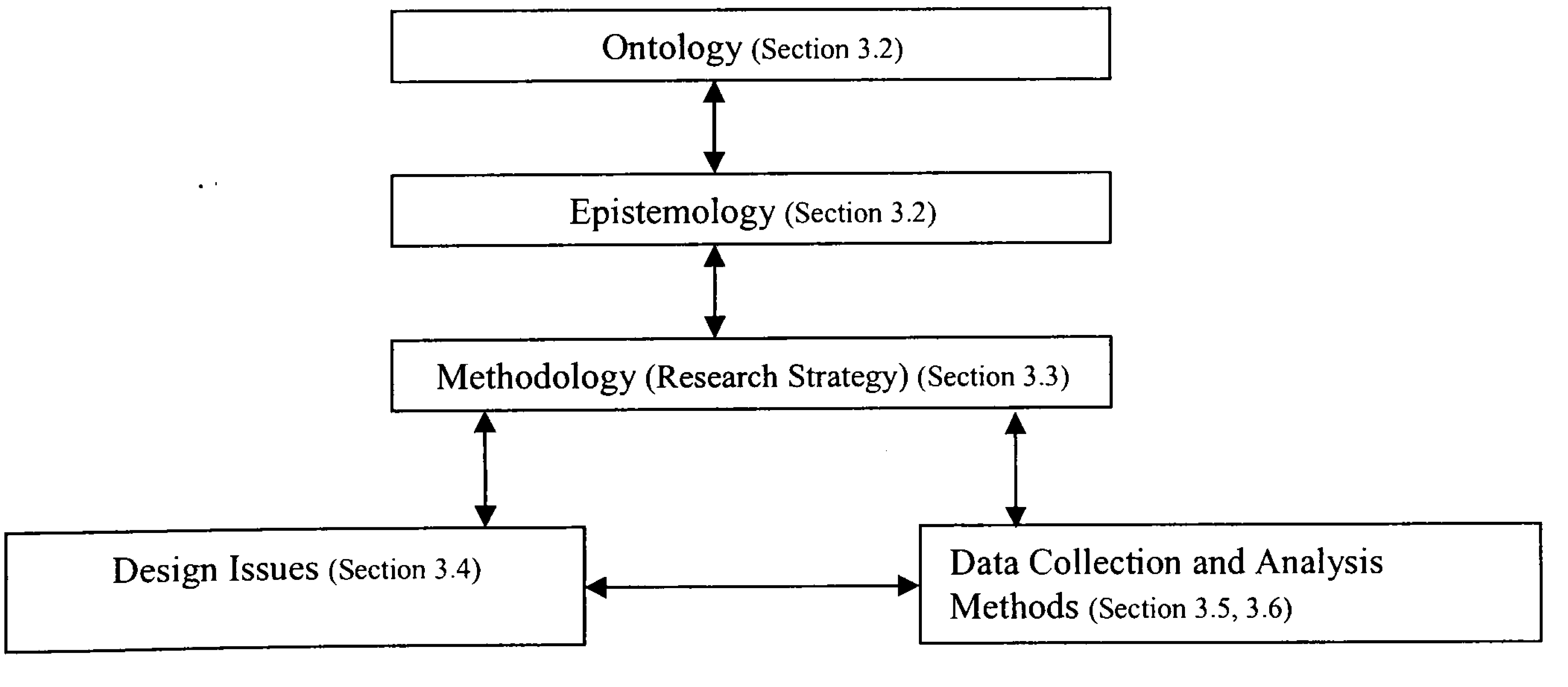

Figure 3.1 Thematic Framework of the Research Methodology

3.1 The Scope of the Research

The focus of the present study is on how a subsidiary develops its technological capability in association with internal and external networks. The development of the subsidiary (technological) capability involves complex decision-making processes and collaboration linkages being initiated in the interests of the HQ, the subsidiary and/or external/local environment, which are being investigated from the perspective of subsidiary autonomy. Furthermore, not only is the subsidiary capability studied in the forms of operational activities and interconnections with internal and external linkages, but also examined in the context of the initiative of technological innovation based on local, centre and global/regional innovation stimuli. With such a focus in mind, we apply the conceptualisation of the MNE as a differentiated MNE, proposed by Nohria and Ghoshal (1997), underlining the internal and external network perspective which is composed of distributed resources and communication systems linked through different members. The positioning of this study is its focus on the foreign-owned subsidiary as the focal unit of analysis, and the approach taken is to view a subsidiary in terms of its autonomy to decide technological innovative actions in accordance with strategic missions/interests of the MNE as a whole. By contrast, a subsidiary may not always act in compliance (product specialist) with the HQ, rather, it may facilitate its local or global/regional linkage to develop its technological innovation. Figure 3.2 provides an overview of how subsidiary capability and subsidiary autonomy are studied.

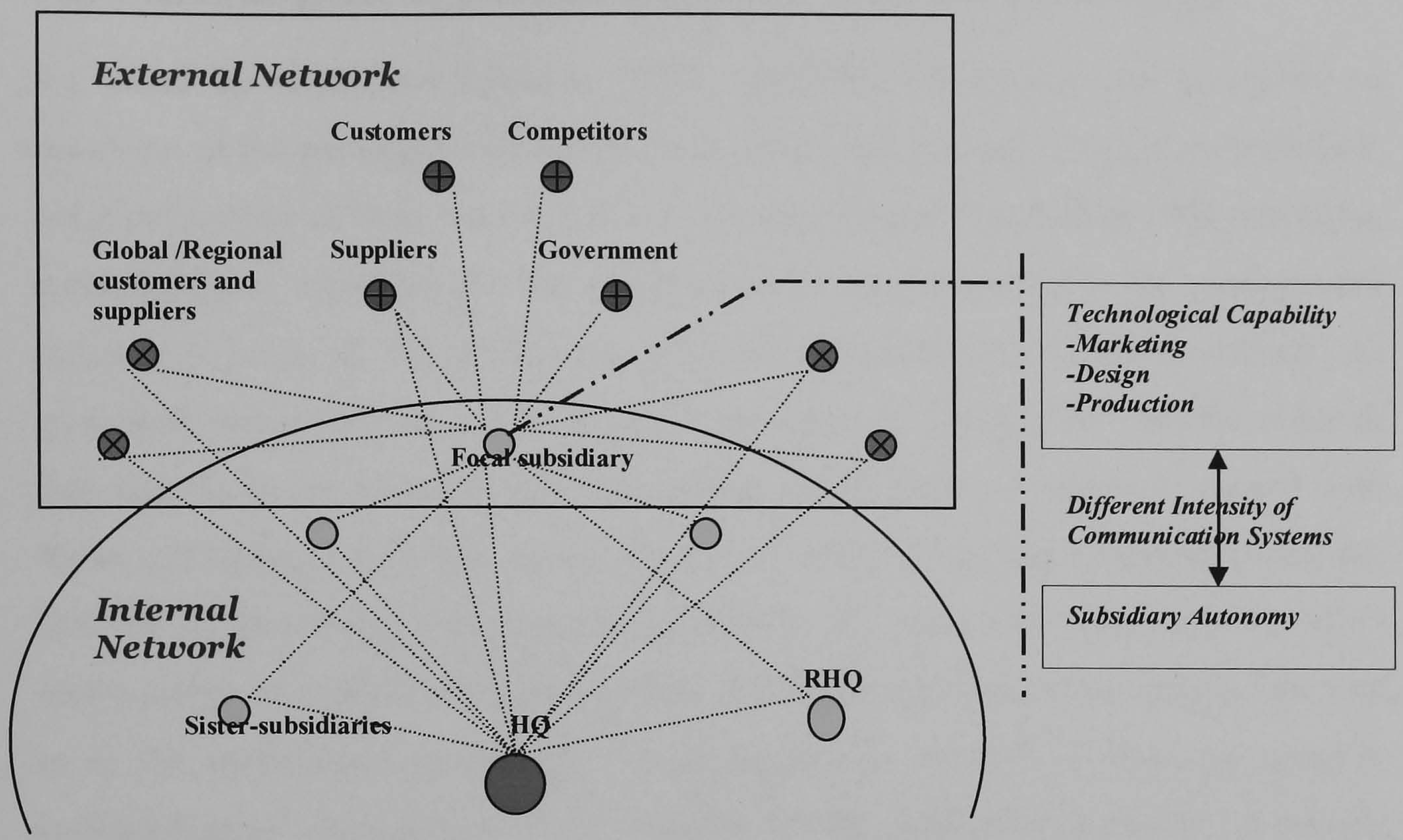

Figure 3.2 Empirical Framework of the Subsidiary Autonomy and Capability

3.2 Philosophical Justification of the Methodology

As stated by Guba and Lincoln (1994), questions of method are secondary to questions of the paradigm which guide the researcher, not only in choice of method, but also in terms of their ontological and epistemological foundations. The prevailing methodological approach for the social sciences, and particularly for management research, is based on objectivism, positivism and quantitative statistical methods. As qualitative researchers are more driven by the nature of the problem than the method, they tend to be interested in ontological and epistemological issues, in accord with Miles and Huberman (1994); it makes sense to state ontological assumptions and the theories of knowledge and method that inform the researcher. This section views methodology as embedded in ontological and epistemological assumptions,[1] as well as in the motivations and values of the researcher. In other words, the specific methodological approach used in relation to the research questions is closely connected to the researcher's preference for interpretivist or functionalist explanations, which in turn, is influenced by the researcher's assumption about the objective or subjective nature of human reality. In the following sections, the main philosophical assumptions which underlie analysis of the possible stances that can be taken within the field in terms of three sets of assumptions concerning *ontology*, *epistemology* and *methodology* are justified.

The fundamental ontological inquiry is whether reality is of an objective nature and external to the individual or the product of individual cognition and mind (Babbie, 1992). It shifts from a time- and human-free objective reality towards a more context-bound intersubjective reality (Burrell and Morgan, 1979; Kvale, 1996; Morgan and Smircich, 1980), in which the social world is to be understood from the point of view of the individuals who are directly involved in the events that are investigated.

[1] The assumption of ontology entails the nature of the social world and what can be known about it; epistemology refers to the nature of knowledge and how it can be acquired.

In this research, in *ontological* terms, a 'subtle realism' approach, in accordance with Hammersley (1992), is employed. We perceive the social world as existing independently of individual subjective understanding, being accessible to the research only via the respondent's interpretations, which then are further interpreted by the researcher. The concept of truth from such a perspective is more problematic and arbitrary than it is for pure objectivists. This is because rather than regarding the empirical world as a universally causal mechanism waiting to be uncovered, the social world, which may still contain some regularity, is subjected to an ongoing construction process conducted by reflexive actors (Andersen and Skaates, 2004). This is in line with 'transcendental realism' advocated by Miles and Huberman (1994), in which social phenomena exist not only in the mind, but also in the objective world, in which a number of repeatable regularities and sequences link phenomena. This stance allows us to employ their standards in rigorous analytical procedures for the social sciences in general. We therefore assume that knowledge is a social and historical product and that facts come to us laden with theory (Miles and Huberman, 1994). We focus on the complexity of MNE network management as the situation unfolds; in particular, we attempt to understand the relationship between subsidiary autonomy and technological innovative developments by interpreting the meaning people assign to this activity/action, and the development they undertake as a result of this meaning. We understand the critical importance of respondents' own interpretations of the relevant research issues, and accept that their different vantage points produce different types of understanding. The diversity of perspectives thus adds richness to our understanding of the various ways in which that reality has been experienced.

Epistemology is concerned with the theoretical understanding of the method or grounds of knowledge used in a particular field. Although the boundaries between the epistemological paradigms are becoming increasingly blurred, in particular in IB research, which is multi-paradigmatic by nature (Toyne and Nigh, 1998), the positivist and interpretive paradigms represent poles in an ongoing debate regarding what constitutes warrantable knowledge (Henwood and Pidgeon, 1999). Even with the interpretivist paradigm, there may be several answers to what can be known (e.g. Guba and Lincoln, 1994). Our acknowledgement of interpretivism is reflected in practices considering the importance of understanding people's perspectives in the context of the conditions and circumstances (e.g. MNE organisation) of their everyday concepts and meanings. The researcher therefore seeks to obtain extensive description and as much detailed information as possible in order to grasp their perspectives or engagements with the research issues, and then to reconstruct these meanings (Blaikie, 1993). We also recognise the importance of the researcher's interpretations, with the proviso that such interpretations remain clearly delineated from those of the respondents. In evolving our interpretations, we keep as closely as possible to respondents' accounts, but acknowledge that deeper insights can be obtained by synthesising, interlocking and comparing the accounts of a number of respondents or cases (e.g. Eisenhardt, 1989; Ghauri, 2004; Yin, 2003a). We also consider other forms of inference (e.g. cluster and ranking characteristics/concepts) and theoretical thinking to position our interpretation in the MNE context. The process of interpretation is illustrated in Section 3.6.

The purpose of the *Methodology* section is to demonstrate the grasp of the theory of method and to lay out general methodological considerations consistent with the research problems, ontological and epistemological positions and underlying theories. The knowledge of methodology is then applied by the researcher. Furthermore, in accordance with Zalan and Lewis' (2004) claim that the field of IB study has paid dearly for its obsession with rigour in the choice of methodology, leading to statistically significant but largely useless results, the choice of methodology is determined not only by ontological and epistemological stance, but also by the objective of the study, the nature of the research problem and the theoretical frameworks of the study. These are the primary concerns, which are in line with the ontological and epistemological stance. The objective of the study is to investigate subsidiary management, and the methodology used by related researchers to assess the relationship between HQ-subsidiary and/or subsidiary development (e.g. Bartlett and Ghoshal, 1986, 1989; Papanastassiou and Pearce, 1994) is very often purely quantitative. Qualitative methods are an appropriate option in this research. More specifically, these methods are suited for finding causal relationships, looking directly at states and events, and showing how these lead to specific outcomes (Miles and Huberman, 1994). Qualitative methods, particularly the case study approach, offer a unique advantage to observe, describe and explain dynamic cooperation of the subsidiary inside and/or outside the MNE. In general, whenever a holistic, dynamic and contextual explanation of the phenomenon is required, qualitative methods are the most appropriate methodological choice (e.g. Pettigrew, 1990, 1992). The chosen methodology in this study is consistent with underlying theoretical frameworks, and some researchers even engage in highly inductive research from an atheoretical position (Eisenhardt, 1997). Bartlett and Ghoshal (1989) suggest that while the theory of the transnational has been built inductively, it has had eminent theoretical antecedents, such as the global integration-local responsiveness framework (Prahalad and Doz, 1987) and the strategy-structure literature, discussed in this research (see Chapter 2).

In sum, the diverse ontological and epistemological perspectives within the qualitative studies indicate that 'subjective' and 'objective' approaches should not necessarily be seen as mutual exclusive (e.g. Willmott, 1993). On a practical level, it seems hard to find researchers encamped in one fixed position in the philosophical stance, such as 'relativism' or 'postpositivism'. Specifically, while a number of postpositivists use naturalistic and phenomenological approaches, others dispute the validity and importance of subjective meanings. We are therefore more concerned with ensuring a suitable fit between the research methods used and the research questions. We consider the quality and rigour in the research process to be determined more by choosing the correct research methods for the researcher than by limiting ourselves to combining only those research methods which are viewed as philosophically consistent (Snapė and Spencer, 2003).

3.3 Research Strategy: Searching for an Appropriate Approach

Generally, the choice of a suitable research strategy essentially considers: a) the type of research question posed, b) the extent of control a researcher has over actual behavioural events, and c) the degree of focus on contemporary as opposed to historical events (Yin, 2003a: 5). The research questions of this study mainly focus on 'why' and 'how' questions being answered, with 'what' questions being a justifiable rationale for conducting an exploratory study with the goal of developing pertinent hypotheses or propositions for further understanding of the relationship between subsidiary autonomy and subsidiary capability. Moreover, this research seeks to investigate the phenomena of subsidiary autonomy and subsidiary technological capability in the MNE context over business co-operation and/or coordination events. In general, this research centrally incorporates 'how' and 'why' questions, and involves a focus on contemporary phenomena within subsidiary management activities. In light of this, the researcher made the decision to adopt the case study method as the approach to be used in this explanatory study, which is also complemented by an exploratory and descriptive study.

Case studies can also provide qualitative and quantitative evidence to demonstrate how a subsidiary cooperates and develops its technological capability with its internal and external MNE networks. A case study is a useful method when the area of research is relatively less known. Eisenhardt (1989: 548-9) also argues that the case study is:

> *Particularly well-suited to new research areas or research areas for which existing theory seems inadequate. This type of work is highly complementary to incremental theory-building from normal science research. The former is useful in early stages of research on a topic or when a fresh perspective is needed, while the latter is useful in later stages of knowledge development.*

Theories of the organisation and management of MNEs do not present an uncontested view of how subsidiaries in MNE networks are operated or managed. The clearest example is perhaps the ongoing debate regarding whether a subsidiary's management and strategic behaviour are controlled by the HQ and/or whether it has autonomy to initiate its own strategy and operation. Furthermore, case studies have been combined with a variety of different epistemological positions, from positivist to phenomenological (Ghauri, 2004), in accordance with the stance and rationale of this research.

In short, '*the case study method is particularly well-suited to international business research...*' (Ghauri, 2004), which has the potential to deepen our understanding of the research phenomenon (i.e. subsidiary capability management) through a review of existing (historical) material and records plus interviews and interactions with respondents. The case study also provides the contextuality for the MNE study on understanding the links between industry-level relationships and firm (the subsidiary and/or the HQ) decision-making (Ghauri and Holstius, 1996). The rationale for employing a case study is justified by the research questions, objectives and the research setting in the complexity of the MNE organisation and management.[2]

3.3.1 The Case Study Approach

Case studies involve investigations of one or several social systems, e.g. MNE organisations. The empirical research in a case is characterised by intense study of the object in focus, and from several different aspects. Given the many characteristics to choose from, case studies can use multiple sources of data collection, i.e. archives, interviews, questionnaires, and observations. The main feature is therefore the depth and foci of the research object, whether it is a subsidiary or many subsidiaries. It is necessary to have sufficient information to characterise and explain the unique features of the case study, as one can work with either single or multiple cases, and numerous levels of analysis.

[2] Stake (1994) adopts a similar approach to defining case studies. He considers them not to be "a methodological choice but a choice of object to be studied." Furthermore, the object must be a "functioning specific', not a generality.

In determining the appropriate use of the case study, a degree of confusion surrounds the distinctions among qualitative data, inductive logic and case study research. A number of approaches to case-study research are evident in the literature, for example, Glaser and Stauss (1967) detail a comparative method for developing grounded theory; Yin (1994, 2003a) advocates the case study approach; Miles and Huberman (1994) propose several techniques to analyse qualitative data. However, there is a lack of clarity about the process of actually generating/testing theory from cases, especially regarding the central inductive process and the role of literature (Eisenhardt, 1989). Accordingly, Eisenhardt's study (1989) provides a clear process of building theory from case study research, by means of presenting a methodological framework for using multiple case study in order to test theories or build theories. Although we claim that Eisenhardt's process is applicable to this research approach, we agree with Eisenhardt (1989) and Yeung (1995) that the operationalisation into a particular architecture should remain a flexible process allowing for a tailor-made design.

Table 3.1 Process of Case Study Research

Step	Activity	Reason
Getting Started	●Definition of research questions ●Possible a priori constructs	●Focuses efforts ●Provides better grounding of construct measures
Selecting Cases	●Neither theory nor hypotheses ●Specified population ●Theoretical, not random, sampling	●Retains theoretical flexibility ●Constrains extraneous variation and sharpens external validity ●Focuses efforts on theoretically useful cases- i.e. those that replicate or extend theory by filling conceptual categories
Crafting Instruments and Protocols	●Multiple data collection methods ●Qualitative and quantitative data combined ●Multiple investigators	●Strengthens grounding of theory by triangulation of evidence ●Synergistic view of evidence ●Fosters divergent perspectives and strengthens grounding
Entering the Field	●Overlap data collection and analysis including field notes ●Flexible and opportunistic data collection methods	●Speeds analyses and reveals helpful adjustments to data collection ●Allows investigators to take advantage of emergent themes and unique case features
Analysing Data	●Within-case analysis ●Cross-case pattern search using divergent techniques	●Gains familiarity with data and preliminary theory generation ●Forces investigators to look beyond initial impressions and see evidence through multiple lenses
Shaping Hypotheses	●Iterative tabulation of evidence for each construct ●Replication, not sampling, logic across cases ●Search evidence for 'why' behind relationships	●Sharpens construct definition, validity, and measurability ●Confirms, extends, and sharpens theory ●Builds internal validity
Enfolding Literature	●Comparison with conflicting literature ●Comparison with similar literature	●Builds internal validity, raises theoretical levels, and sharpens construct definitions ●Sharpens generalisability, improves construct definition, and raises theoretical level
Reaching Closure	●Theoretical saturation when possible	●Ends process when marginal improvement becomes small

Sources: Eisenhardt (1989)

Table 3.1 tabulates the case study process proposed by Eisenhardt (1989). This research process initially requires at least broad research questions, a means of selecting cases in specified or purposeful research samples and the use of specification of constructs to shape the protocols. In this framework, even the constructs developed from an extensive literature review search and overlap of data analysis with data collection give the research a start in analysis while, at the same time, allowing the researcher to take advantage of flexible data collection (Eisenhardt, 1989). The first step of analysis is within-case analysis, which typically involves detailed case study write-ups for each case. '*These write-ups are often simply pure descriptions, but they are central to the generation of insight..., in addition, it gives investigators a rich familiarity with each case, which, in turn, accelerates cross-case comparison*' (Eisenhardt, 1989: 540). After cross-case comparison, a researcher is able to go beyond initial impressions through the use of structured and diverse lenses on the data, in turn; the researcher is able to compare data with theory/literature and to develop new hypothesis, before closing with the formulation of new theories.

Although there is some debate about Eisenhardt's form of case research, such as Dyer and Wilkins' (1991) critique of Eisenhardt's approach, which focuses on theory generation including the attributes of hypothesis-testing research, at the same time, they also endorse the comparative method in developing theory, agreeing with Eisenhardt's view. Applying Eisenhard's process provides a clear guideline for a novice researcher, who can be guided to structure elements of the case study and to ensure that study consistency is accomplished. Nonetheless, in this study, extensive use is made of the case study strategy and techniques suggested by Yin (1994, 2003a) and Miles and Huberman (1994). More specifically, Yin (2003a) provides well-appreciated guidance to the case study researcher in terms of illustrating the logic of the case study design in association with the data collection and the conclusion to the initial questions of the study. Regardless of the type of case study used, the common complaints about case studies are that their outcomes are difficult to generalise and findings difficult to validate (Yin, 2003a). These issues are examined below to ensure the quality of the case studies.

3.3.2 Triangulation

Triangulation puts focus on the integration of multiple data sources in a multi-method design, one of the defining features of the case study. It refers to the collection of data through different methods, or even different kinds of data on the same phenomenon. The advantage of triangulation is that it can produce a more complete, holistic and contextual portrait of the object under study. In the case study approach, triangulation is particularly important, as the investigator needs to check and validate the information being received from various sources, and to examine it from different angles (Ghauri and Gronhaug, 2002). A number of authors, such as Denzin (1989), Patton (2002) and Yin (2003a), suggest four types of triangulation in making evaluations of triangulation: (a) methodological or methods triangulation: comparison of data generated by different methods; (b) data or source triangulation: comparison of data from multi-sources, e.g. interviews, documentation; (c) investigator or multiple analysis triangulation: use of different interviewers to compare and check data collection and interpretation; (d) theory triangulation: examination of data from different theoretical perspectives.

In practice, we employ various procedures to increase our understanding and explanation. More specifically, triangulation during data collection is performed by interviewing various respondents on the same topic and questions; and by interviewing the same respondent on a particular topic (e.g. technological innovative capability) more than once, as well as by the combination of primary and secondary data source (multiple sources) triangulation. As analytical triangulation, it is conducted by using dissimilar (cross-case) analytical methods, and by applying variations within the same (within-case) analytical technique. With theory triangulation, we enfold the findings with the juxtaposition of different theoretical perspectives to deepen insights, which help us to clarify meaning by identifying different perspectives on the phenomenon (Denzin, 1989; Flick, 1992).

Nonetheless, all types of triangulation have limitations in what they can contribute to the full 'confirmation' of a finding from multi-case studies. Hammersley (1992) argues that "*we can never know with certainty that an account is true because we have no independent and completely reliable access to 'reality'.... He then suggests ground for assessing 'adequacy' including credibility, centrality and relevance, all of which would seem vital in judging the integrity of research evidence.*" Other methods that can be used to assess 'adequacy' are elaborated in the following sections.

3.3.3 Generalisations

With regard to using multiple cases, the mode of generalisation is 'analytic generalisation' (Yin, 2003a), in which a previously developed theory is used as a template with which to compare the empirical findings of the case study. As Yin (2003a) suggests, if two or more cases are shown to support the same theory, replication (e.g. theoretical replication) may be claimed. The empirical findings may be considered more potent if two or more cases support the same theory but do not support the opposing theory. Eisenhardt (1989) indicates that generalisability from multiple-case studies can be enhanced by using comparison of the emergent concepts, theory, or hypotheses with existing literature. In short, the use of theory, in conducting a multi-case study, is not only a support in defining the appropriate research design and data collection, but also becomes the main vehicle for generalising the findings of the case study (Yin, 2003a).

Furthermore, when conducting multiple-case, the findings are generalised from one case to the next on the basis of a match by means of conceptual or theoretical grounds for the underlying theory or for the research setting/context (e.g. subsidiary capability), not on representative grounds and not to a large universe (Miles and Huberman, 1994).

3.3.4 Validity and Reliability

The concepts of validity and reliability are developed in the natural sciences. Because of this, and due also to the very different epistemological idea of qualitative research, there are real concerns about whether the same concepts have any value in determining the quality of qualitative evidence. A number of authors argue that measures of validity and reliability are wholly inappropriate for qualitative study, and cause considerable confusion when applied (e.g. Hughes and Sharrock, 1997; Marshall and Rossman, 1999; Lincoln and Guba, 1985). However, as validity, meaning 'well grounded', and reliability, meaning 'sustainable', are related to qualitative research, they are helpful in defining the strength of the findings. Moreover, as a research design is supposed to represent a logical set of statements, a researcher also can judge the quality of any design according to certain logical measures, including trustworthiness, credibility, confirmability and data dependability (Yin, 2003a). It is for this reason that we discuss how validity and reliability can be interpreted and understood in the conducting of the multiple-case studies.

A clear distinction is often made between four types of measures that are linked to the different phases of research: construct validity, internal validity, external validity and reliability (e.g. Kidder and Judd, 1986; Yin, 2003a), which are summarised in Table 3.2. In practice, the way in which the investigator deals with these issues varies according to the different phases of research. More specifically, the multi-source methods and established chain of evidence have been used in this study, as discussed Section 3.5. With regard to internal validity, the case-study used adopts Eisenhardt's approach, in which the search for evidence of 'why' behind findings/relationships, and comparison with similar and conflicting literature, can enhance internal validity. This study uses multiple-case studies, elaborated in Section 3.4.3.2, which can help to strengthen external validity. Moreover, reliability is considered in this study by developing protocol and a database, which are discussed in the following sections.

Overall, construct validity and reliability become the major concern during the data collection process; internal validity is the key issue during the data analysis stage; and external validity is crucial to the research design.

Table 3.2 Case Study Tactics for Four Design Measures

Measures	**Case Study Tactic**	**Phase of research in which tactic occurs**
Construct Validity	● Use multiple sources of evidence	Data Collection
	● Establish chain of evidence	Data Collection
	● Have a key informant review case draft	Composition
Internal Validity	● Pattern-matching ● Explanation-building ● Address opposing explanations	Data Analysis
External Validity	● Use replication logic in multiple-case studies	Research Design
Reliability	● Use case study protocol ● Develop case study database	Data Collection

Source: Yin (2003a, p.34)

3.4 Designing Case Studies

Following on from how the philosophical stance and the research orientation influence the case-study design, a good case-study design is one which has a clearly defined purpose, in which there is a coherence between the research questions and approaches proposed, which generates valid and reliable data (Lewis, 2003). Selecting research settings and populations involve identifying those which by virtue of their relationship with the research questions and research propositions, are able to provide the most relevant, comprehensive and rich information. These decisions follow from the particular research aims, questions and even research propositions, but should be consistent with existing literature and/or understanding of the research context. This section explores three key aspects of case-study design. The first theme is the importance of context. We attempt to identify the MNE context as being considerably more complex than we originally perceived; in particular, we attempt to show that subsidiary action and its local interpretation are always embedded within the social world of the subsidiary to influence the MNE's strategies and/or actions. The second theme is the unit of analysis, the fundamental component in defining the research boundary in a complex context. More specifically, we demonstrate that the appropriate unit of analysis both pertains to the literature, and leads us to clarify the research questions and research propositions. The third theme is the selection of cases, a process critical for sound understanding of the research phenomena. A number of issues regarding criteria and procedures of the case selections and the use of multiple-case studies are elaborated.

3.4.1 The Importance of Context

"With its own unique history, the case is a complex entity operating within a number of contexts, such as physical, economic and so on. The case is singular, but it has subsections, groups, occasions, a concatenation of domains, many so complex that at

best, they can only be sampled. Holistic case study calls for the examination of these complexities" (Stake, 2000). One of the most enduring ideas of the MNE organisational perspective is that the MNE is increasingly confronting an environment that requires simultaneous emphasis on local responsiveness and global integration. As a consequence, the MNE has gravitated towards a (differentiated) network conceptualisation (i.e. Birkinshaw, 2000; Forsgren and Johanson, 1992; Nohria and Ghoshal, 1997). Network approaches portray the subsidiary as a value-adding actor with links to internal and external members, showing how the subsidiary evolves with external actors, and how the subsidiary coordinates with internal actors in the MNE. Accordingly, the interplay of multiple and interlinked levels (i.e. HQ-subsidiary or subsidiary-local customers) are included across the international business environment, national business systems, and industry sectors of the contexts, within which MNEs are embedded. Therefore, understanding context is likely to be an important aspect of the case studies.

Contextualism (e.g. Payne, 1982; Pettigrew, 1990) recognises that organisations are embedded in an environment that conditions their actions and performance, with the managers acting and reacting in association with the environment. In the meantime, managers exert strategic choices and may not follow the environmental directives. The important recognition is that the MNE organisation is embedded in interconnected levels of context, which is across the global level, home-country level and host-country level. These multiple levels of context demonstrate how the MNE structure and behaviour are shaped.[3] However, the multiple levels of context are challenging tasks for both data collection and analysis, in which they pose the difficulty of integrating data from diverse perspectives.

In essence, each MNE is a network organisation; consequently, each of the national operating subsidiaries of the MNE, in turn, interacts with other members which are

[3] Some of the writing on MNE context management has discussed both structural and behavioural elements that can be seen as complementary, rather than competing, management approaches (e.g. Bartlett and Ghoshal, 1989; Prahalad and Doz, 1981).

internal and/or external of the MNE. The different national context may have different influences on these operating subsidiaries. Moreover, this study particularly examines the subsidiary's specific capabilities or competences, which are fundamentally context-specific and typically build upon the host country's national innovation system (Rugman and Verbeke, 2001). For this reason, we concentrate on Taiwan-based multinational subsidiaries in the Electronics industry; specifically, on the semiconductor sector (see Chapter 4). This allows us to eliminate context-specific variation when examining the divergent determinant of subsidiary capabilities or competences (Cantwell and Mudambi, 2005), as well as provide a deeper and richer portrayal of the interaction between internal and external subsidiary linkages to develop subsidiary-specific technological capabilities.

3.4.2 The Unit of Analysis

No issue is more important than defining the unit of analysis. Without a tentative definition, the researcher does not know how to limit the boundaries of the study. Because case studies permit a researcher to collect data from many perspectives and for time periods of undetermined duration, a researcher must clearly define the unit of analysis at the outset of the study (Yin, 2003b). The primary unit of analysis of this study is in line with Birkinshaw's (1997, 2000) studies, which focus on the foreign wholly-owned subsidiary, where the subsidiary is defined as a value-adding activity outside the MNE home country. The research posited here is concerned with subsidiary activities and/or responsibilities, and the way in which the subsidiary relates to other members internal and external to the MNE, in particular, how the subsidiary evolves its technological capability.

One challenging characteristic involves the context of the subsidiary. Considering the internal level of context, the HQ managers and other corporate actors have power or influence at either the process or the individual (manager)-level that transpires in the subsidiary (Bartlett and Ghoshal, 1989, 1995; Parhalad and Doz, 1981). Thus, this study proposes that the different degree of autonomous characteristics/categories can impact on the internal/corporate level. Understanding the subsidiary internal link with its HQ and/or other corporate actors is part of the context. In terms of the subsidiary's external level of context, the literature on MNEs emphasises that a subsidiary deals with responsiveness to the local environmental demands and conformity to the parent company norms (Bartlett and Ghoshal, 1989; Prahalad and Doz, 1987). This study thereby examines the nature and strength of the linkage between the subsidiary and its local environment context (namely high-tech industry infrastructure in Taiwan). In particular, it examines how the subsidiary evolves its technological capability in relation to external/local or internal links.

Given the levels of the analysis context, the literature relevant to international business (e.g. the MNE perspective) has signified an important role in the subsidiary study. In essence, the subsidiary with internal and external links is an embedded unit of analysis that illuminates relationships between subsidiary autonomy and subsidiary technological capability. Clearly, this research identifies the definition of the main and embedded unit of analysis, as well as the definition of the levels of the context surrounding the subsidiary. It pertains to the existing international business and innovation management literature which supports further comparisons between the findings of this study and previous studies, and helps to explain the generalisability of the findings of the case study to similar cases and contexts focusing on the same unit of analysis - the subsidiary (Yin, 2003a).

3.4.3 Selecting Cases

An important question in case-study research is how to select cases. The concept of population is crucial, as it sets the boundaries for selection and controls for external variation. Moreover, it helps the research in defining limits for generalising the findings (Eisenhardt, 1989). Selecting research settings and populations involve identifying those which, by virtue of their relationship with the research questions, are able to provide the most relevant, comprehensive and rich information. This decision flows from what the research questions are, and reflects in existing literature or understanding of the research context. Nonetheless, the important step is to assess the accessible population, the population to which we can have access (Cooper, 1984). Out of this accessible population we select multiple-cases (subsidiaries) for study. This selection is based on criteria that are consistent with the research aims and questions that influence the number and choice of subsidiaries to be studied. The chosen subsidiaries are in accordance with our theoretical framework and the variables we are studying. However, important considerations in the selection process are not only differences, but also similarities, with all the cases (subsidiaries) sharing a number of features that made them comparable. In the following sections, we discuss criteria and procedures of the case selection, before moving on to elaborate on the selection of the multiple cases.

3.4.3.1 Criteria and Procedures

Initially, the case selection accorded with Pettigrew's (1988) study, which specifies the chosen population to reduce extraneous variation and clarifies the domain of the findings as large corporations operating in specific types of environment. Due to the focus of the present study on the context of MNEs, this research is aimed at understanding the specific advantages of subsidiaries in terms of their value-added activities with the MNE networks and how a subsidiary develops technological capabilities. This study therefore defines the case selection from a population of large MNEs based in the electronics industry in Taiwan, allowing the researcher to control environmental and industrial variations and effects. There are compelling reasons for selecting the electronics industry in Taiwan. Three major reasons are: (a) Taiwan has been ranked as one of the top five countries in terms of global competitiveness in the world economic forum from 2002 to 2005, as shown in Appendix A; in particular, Taiwan's leadership in technological activities (e.g. patent activity) has been ranked among the top five countries. This provides powerful evidence of Taiwan's technological progress and activities as being technology innovation-intensive development. (b) The Taiwan government has invested heavily in high-technology, particularly in the electronics industry, which has certainly furthered its national competitive advantages. In addition to this, while the Taiwan government has made efforts to develop this industry, a large number of electronic MNEs have participated in the development. Although this industry has been evolved from being government-driven to being fully private enterprise-driven, some MNEs have still continued to operate their business activities in Taiwan to supply to the local market and/or to the global market (detailed in Chapter 4). (c) Given that the researcher is Taiwanese, aware of geographic accessibility and country specific-competencies, this is significant in relation to accessibility issues.

The appropriate study population has been defined on the basis of the above-mentioned considerations. The next phase is to examine the appropriate sample frame and the number of subsidiaries needed for selection. The case selection is based on a theoretical framework, the purpose of which is the development and testing of theoretical constructs. Three constructs are recognised from the MNE literature (e.g. Nohria and Ghoshal, 1997; Birkinshaw, 1997) and reflected in the research questions and objectives: (1) the subsidiary is fully foreign-owned; (2) the subsidiary has undertaken at least one specific value-added activity for the MNE; (3) the subsidiary is involved in at least one respect in the technological innovation activities relating to marketing, design and/or production. On the basis of the criteria, the company list of foreign direct investment in Taiwan is used as a sample fame to select the purposive subsidiaries.

It is essential to point out clearly the selection procedures through theoretical criteria and then operational criteria: (a) the electronics industry (b) US, European, Japanese foreign wholly-owned firms due to the amount of investments and the number of firms in Taiwan. The investigator deliberately selected both typical and atypical subsidiaries in order to strengthen the emergent theory and produce contrasting results. The listed-companies had been screened to satisfy criteria, although some of them did not fit in terms of theoretical and/or operational criteria, for example, not being involved in technological innovation activities or not being a foreign wholly-owned subsidiary; or others were not willing to participate in this project. Six subsidiaries in total agreed to take part in the study, although one later withdrew. The gaining and maintaining of access is discussed in detail in Section 3.5.1.

3.4.3.2 Multiple-Case Studies: Comparison Cases

Eisenhardt (1989: 549) argues for the use of more than a single case and suggests that "*while there is no ideal number of cases, a number between 4 and 10 cases usually works well. With fewer than 4 cases, it is often difficult to generate theory with much complexity and its empirical grounding is likely to be unconvincing....*" Andersen and Skaates (2004), and Werner (2002) also advocate that the multiple-case designs remain the most important research method within the current 'niche' of qualitative international business research. The ultimate aim of multiple-case designs is the construction of explanatory middle-range theory[4] (Frederickson, 1983; Pauwels and Matthyssens, 2004).

In multiple (comparative) case designs, we study the same questions in all multinational subsidiaries and compare them with each other to draw conclusions. The main purpose of conducting multiple-case studies is to compare and replicate the phenomena (e.g. subsidiary-autonomous actions, subsidiary decision-making autonomy) in a systematic way, to explore different dimensions or variables of our research issues. In this design, we regard each case as a particular purpose in the research. By looking at a range of similar and contrasting cases, we recognise a single-case finding, grounding it by specifying what, how and why it carries on as it does. Therefore, this study is strengthened by the precision, the validity and the stability of the findings (Miles and Huberman, 1994), in accordance with Yin's (2003a) proposed 'replication strategy'. More specifically, we generalise from one case to the next on the basis of a match to the underlying theory or perspective (e.g.

[4] In middle-range theory-building, the researcher disaggregates complex contexts and circumstances into more discrete, carefully defined chunks and then reintegrates these parts with an explicit analysis of their context (Peterson, 1998).

the MNE literature), not to a larger universe. The choice of multiple-cases is made on conceptual/theoretical grounds instead of representative grounds (Miles and Huberman, 1994). Consequently, the major benefit of using multiple-case designs is that multiple over single case designs contribute to replicate the findings allowing for comparison, which in turn, permit greater position for theoretical generalisability.[5]

[5] This study puts the emphasis on the characteristics of the subsidiary phenomenon in the MNE context, in accordance with Glaser and Strauss (1967), Gummeson (1991) and Pettigrew (1990), who suggest that the objective of social research is to explore phenomena in their contexts.

3.5 Conducting Case Studies

This section provides a series of explanations of the conducting of data and evidence collection. The first section describes the procedures for gaining and maintaining access. The preparation for doing the data collection, including the pilot case study and the development of the case-study protocol, are discussed in the following section. The last section provides an explanation of the collecting of the evidence-multi-sources used to gather evidence/data. Due to the overlap of data collection with data analysis, very initial data-analysis data documenting is also indicated.

3.5.1 Gaining and Maintaining Access

According to the criteria and procedures for selecting cases, the listed-cases had been initially screened from the list of wholly-owned foreign firms in Taiwan. The screening process began with a review of numerous documents, reports and company literature, e.g. annual reports, published information on the electronics industry by Gartner, registered information released by international Sematech. Some of the candidate firms were telephoned or emailed in order to gain further information and knowledge about their products and activities. However, quite a few of the candidate firms were not suitable for selection, for example, they were not involved in technological innovation activities and/or were not foreign wholly-owned subsidiaries; and/or were transferring the subsidiary from Taiwan to China, and so on.

Unsuitable candidate firms/MNEs were screened out of the process. 20 suitable candidate MNEs were then approached through the supervisor's recommendation/reference through email or in writing. Making studies accessible to these candidate MNEs, we initially emailed directors in the RHQs or directors in the subsidiaries with the attachments in the appropriate language (English or Traditional Chinese) about the research brief introduction (see Appendix B.) and research summary, including the research questions, scope, practical research design and benefits for the researched MNEs. As a follow-up, telephone calls were made either in English or Mandarin to the informants or to the key contactors[6] regarding the research purpose and objectives of the research with each suitable subsidiary. Soon after the follow-up, 6 subsidiaries agreed to take part in the study, namely 2 US subsidiaries, 1 European subsidiary and 3 Japanese subsidiaries. One US subsidiary initially expressed interest in participating, but withdrew their interest over time due to new personnel announcements being made. Another US subsidiary withdrew from the research project due to changed strategic developments in its business environment, after documentation related to the company's background and the specific projects had been collected and one interview conducted.

There were 4 participating subsidiaries while the researcher conducted the data collection in Taiwan. In order to reach theoretical saturation, the researcher attempted to contact two European MNEs and two US MNEs in Taiwan by writing e-mails to the president in the RHQs and/or subsidiaries. Eventually, one positive response from the president of a European subsidiary was received in a very short time. A series of interviews were arranged soon after, gaining access into the subsidiary (ST). Five subsidiaries from different MNEs in total (2 European subsidiaries and 3 Japanese subsidiaries) took part in the research project. The US subsidiaries were absent from the selected cases, due to their core-strategic business being re-deployed and re-allocated into Greater China (e.g. Mainland China, Hong Kong, Macao and Taiwan). The portfolio of the selected subsidiaries is detailed in Table 3.3, the subsidiaries remaining anonymous due to ethical/confidential agreements.

[6] The key contactors are introduced by alumni or friends in order to gain access to the subsidiaries.

Table 3.3 The Portfolio of the Sampled Subsidiaries

MNE (Subsidiary)	Home Country	Revenue of the Parent Company *	Key Operating Activity	Ages of Subsidiary	Employees	% of Revenue earned by Subsidiary
PH	Europe	5,720	IC design, packaging & testing manufacturing	38	600***	4-5%
RS	Japan	8,849	IC-products marketing & system solution design	2**	100	3%
ST	Europe	8,760	IC-products marketing & system solution design	9	150	0.5%
MT	Japan	3,563	IC products manufacturing	6	50	2%
HT	Japan	8,756	IC products marketing & manufacturing	14	100	2.5%

* The revenue is estimated in millions of U.S. Dollars at the year of 2004.

** This corporation is a joint-venture between two top ten world-wide electronic product groups/divisions of Japanese MNEs .

*** Employees, including manufacturing manpower, total 2200 people.

3.5.2 Preparing for Data Collection

Before collecting the evidence, it was essential to acquaint myself with the electronic industry as well as each subsidiary. This desk research involved a review of historic and current reports, internet based information and other publicly available information such as newspapers, magazines and a number of industrial reports. This helped me to accumulate prior knowledge about the industry and firms in preparation for the in-depth interview. This preparation to some extent shaped the case study protocol development and the conduct of the pilot case study.

3.5.2.1 Pilot Case Study

Yin (2003a: 79) proposes that *the pilot case study will help you [a researcher] to refine your [his/her] data collection plans with respect to both the content of the data and the procedures to be followed....The pilot case study is more formative, assisting you [a researcher] to develop relevant lines of questions [and] possibly even providing some conceptual clarification for the research design as well.* Due to the complexity of the research phenomena, I decided to conduct the pilot case study in order to gain a clear picture from many different angles or different phenomena before seriously identifying the theoretical sample criteria (see Section 3.4.3.1) and carrying out the data collection (as detailed in Section 3.5.3). The pilot case study was conducted in one European subsidiary in Taiwan in Spring 2003, the most complicated case, as suggested in the MNE literature (e.g. Nohria and Ghoshal, 1997). The case was also the most accessible and geographically convenient.

There are many advantages in doing a pilot case: (a) it provides an effective approach to appraising the case study protocol; (b) it helps us examine whether the interview questions match the research aims and objectives; (c) it provides a way to identify and define the research phenomena where these were previously unclear or unknown to the researcher; (d) it helps us redefine certain concepts (e.g. technological innovation) that were misinterpreted by the respondents; (e) it provides an opportunity for the researcher to develop hands-on experience for the remaining case studies. In particular, the pilot case enables the researcher to develop and improve her formulation of interview questions, interview techniques and questioning sequence, skills which would not be developed without practical experience. More importantly, one of many benefits of the pilot case study is that it helps to identify the multiple-dimensions of subsidiary autonomy concepts and the characteristics of technological innovation capability in order to refine operational measures. In addition, one important result of the pilot study is the development of the conceptual framework and the theoretical sample criteria; another importance is logistical and replication developments on gathering specific technological capabilities at the subsidiary level. These developments make it extremely useful for data to be collected and for the full study to proceed.

3.5.2.2 Development of the Case-Study Protocol

The protocol is more than an instrument and contains three elements, as Yin (2003a) suggests: (a) it includes the procedures and general rules to be followed in using the protocol; (b) it is directed at an entirely different party; (c) it is essential while the researcher is conducting a multiple-case study. In accordance with Yin (2003a: 67), the protocol is a major way of increasing the reliability of case study research and guides the investigator in carrying out the data collection. A well-designed protocol provides flexible direction to field-work process and essential documentation of a central aspect of the research. As Burgess (1984) asserts, a protocol gives documentation of subjects to investigate, serving as an interview agenda, guide, or *aide-mémoire*. The protocol helps to ensure that relevant issues are covered systematically with some uniformity, and to enhance the consistency, while still allowing flexibility to pursue the detail of data collection.

Table 3.4 provides an illustration of the protocol being used for this study project, which contains a number of main points: (a) an overview of the research; (b) research questions; (c) interview questions; (d) field procedures. However, in essence, the protocol aims to remain brief and flexible, allowing the researcher to exercise her judgement about how to use and approach each section during the process of collecting evidence.

Table 3.4 The Protocol for Conducting the Case Study (see Appendix C-E)

A. Brief introduction with the research focus to, and ethical consideration of, the case study
    (Designed as a cover-letter)
B. Research Summary
    B1: Research topic
    B2: Research objectives and questions
    B3: Research scope
    B4: Research design
    B5: Benefits to participated MNEs
C. Checklist for Interview (Only used by the researcher)
    C1: Characteristics of the subsidiary
    C2: Subsidiary autonomy, including communication systems
    C3: Technological innovative capability
    C4: External relationship with suppliers or customers or competitors
    C5: Host country issues
D. Interview Questions (Deliver to the participators)
E. Data Collection Procedures
    E1: Names of the subsidiary to be visited
    E2: Data collection plan, including contact persons and the calendar period for the site visits, the amount of time to be interviewed

3.5.3 Collecting the Evidence

One of the main strengths of multi-case studies is that they allow us to use multiple sources of data and evidence. In this study, we primarily gather evidence/data from the different sources: documentation, archival records and interviews, which are discussed in the following sections. Data/evidence documenting is also described in the section below.

3.5.3.1 In-depth Interview

One of the most important sources of case study is the interview (Yin, 2003a). In-depth interviews provide an opportunity for detailed investigation of each person's personal perspective, for in-depth understanding of the personal context or complex issues within which the research phenomenon is located, and for very detailed subject coverage. Generally, the interviews appear to be guided conversations rather than structured queries, in other words, the actual stream of questions in the case study interview is likely to be fluid rather than rigid (Rubin and Rubin, 1995).

In conducting the case studies, data was gathered by interviewing two groups of people who were directly and indirectly involved in the subsidiary capability development: (a) project managers taking part in one of the technological innovation activities, such as, marketing, design and production; (b) top and middle managers: e.g. finance & accounting, human resources, marketing, R&D, marketing, manufacturing, etc. on the subsidiary level. The number of interviews carried out is shown in Table 3.5 below.

Table 3.5: The Number of Interviews

MNEs	Home County	Position of Interviewee	No of Interviews
PH	Europe	General Manager, Head of Departments Project Managers, Senior Engineers	13
RS	Japan	Vice President, Head of Departments Senior Engineers	13
ST	Europe	President, Product Division Director Head of Departments, Senior Engineers	10
MT	Japan	General Manager, Head of Departments Senior Engineers	10
HT	Japan	General Manager, Vice General Manager Operational Manager, Head of Departments Senior Managers	9
Total			55

In this study, the main aim is to consider co-operation between subsidiaries and their parent companies and the way in which subsidiaries develop technological innovation capabilities. In particular, why and what relationships determine the degree of subsidiary autonomy, and how a subsidiary develops its technological innovation capability through internal and external linkages. To gain insight into this development, I adapt an in-depth interview technique and focus on subsidiary cooperation with the internal and external partners in terms of technological innovation development. I choose to interview managers inside the subsidiaries, because this study has emphasised more actively the development of technological capability across internal and external linkages. It would, of course, have been appropriate to interview people outside the subsidiary, but for practical reasons, limits have had to be placed; in view of the purpose of our study, it seemed acceptable to forego interviews with 'outsiders'. Nevertheless, the findings of this study are also relevant to external network issues, since they reflect the perception of problematic areas from an actor participating in the relationship.

Furthermore, I use the case study protocol as a guide and usually conversational questions are followed up by more detailed remarks. A digital recorder was used during the interviews. Semi-structured and open-ended questions were used for all respondents (managers). Additionally, the issue of communication systems was combined with the scale of frequency; some managers, in the positions of project and administrative managers, were asked for two interviews to enquire into the two issues of subsidiary autonomy and technological capability. By discussing their answers, I also gave the respondents a chance to consider and correct their responses (Yin, 2003a). Each of the interviews averagely lasted two hours. The interviews were conducted over along the period of December 2003 to April 2004 in Taiwan.

3.5.3.2 Documentation & Archival Records

By using documents, we gain access to a large variety of data: formal documents, such as annual reports, academic articles and books, newspaper clips, and internal business plans, project proposals, publicity materials, etc. For these case studies, the most important use of internal company documents is to corroborate and augment evidence from the other sources that assist in verification of the information gained in the interview, and provide specific details to corroborate information, if the documentary evidence is contradictory (Yin, 2003a: 87). Specifically, it is applied when situations or events cannot be investigated by direct observation or questioning (Hammersley and Atkinson, 1995). However, it is often noted that documentary data has its weaknesses and should therefore be treated with caution, due to its potential selectivity of the facts provided (Stake, 1995).

Archival records are used to corroborate and augment evidence from other sources, and to collect information at the industry level as well as the five subsidiaries. In particular, the quantified data about the different types of technological capability are collected from the subsidiaries, which are used in conjunction with documented sources of information.

As regard both documents and archival records, great care has been taken in checking pieces of evidence against each other, the researcher remaining mindful of the fact that most of the reviewed information has been written with a specific purpose in mind. Moreover, both sources of information help preparation of interviews and assist in illuminating deeper meanings in order to verify and validate collected evidence.

3.5.3.3 Data Documenting

All of the interviews were recorded and stored in an electronic digital recorder and uploaded onto a computer database in conjunction with interview (field) notes taken during the interviewing process.

Prior to descriptive analysis and coding (elaborated in Section 3.6), two features of data documenting were conveyed. Firstly, the interviews were transcribed into traditional Chinese by the researcher. It appeared to be most sensible to conduct the actual analysis in the original language (Vaara and Tienari, 2004), and then to translate the findings into English by the researcher and a few native speakers with relevant knowledge. This guaranteed the correctness of the translation, avoiding potential linguistic biases and ensuring that the essence of the meaning and the spirit of the interview were not lost. Secondly, the substantive content of the interviewee's account were detailed by the researcher and were given meaning shortly after the interview was conducted to prevent confusion. Soon afterwards, each database was documented by each subsidiary, including transcribed interviews, interview notes, relevant information and original digital records. The secondary data, such as public information, reports from research institutions or magazine articles, were also organised as a database. The data was cross-referenced from the start of the research on an ongoing basis.

3.6 Analysing Case Studies

As Eisenhardt (1989) writes, "analysing data is the heart of building theory from case studies, but it is both the most difficult and the least codified part of the process." In doing case study research, 'authenticity' rather than reliability is the main issue (Ghauri, 2004). The aim is not just 'authentic' understanding of the people's experience; data has to be interpreted against the background of the context in which they are produced (Hammersley and Atkinson, 1983). How does the researcher ensure and demonstrate that this study has produced an authentic interpretation rather than a misguided one? This brings to the fore the importance of making sure that data collection and analysis take place in parallel during the case study research. Following Miles and Huberman's (1994) suggestion that interweaving data collection and data analysis right from the first case/interview is the best policy in doing case study, in the present study, the researcher started to analyse the cases immediately after the interviews to compare notes, transcripts and documents. Clearly, this parallel procedure has its risks. Once the researcher has analysed the data and given it an initial interpretation, the researcher may find it difficult to change her/his view of the data. Given the risk of being blocked by first impressions, the researcher endeavoured to avoid drawing rigid conclusions too early in the research process. The purpose of this section is to explain how the data was analysed, clustered/categorised, displayed and interpreted within and across case studies. The data analysis process is outlined in Table 3.6.

Table 3.6 Data Analysis Process

Analysis Process	Analysis Activity	Reasons	Key References
Managing Data	Identifying initial themes or concepts Assigning meaning	Gains familiarity, Generating themes and Concepts	Miles and Huberman (1994) Ritchie and Lewis (2003)
Transforming Data	Coding Patten-matching Within-case analysis, Searching for cross-case analysis and comparison	Optimise the identified themes and concepts Verifying the emergent relationships between categories	Eisenhardt (1989) Miles and Huberman (1994) Yin (2003a)
Displaying Data	Case Descriptions Tabulating of evidence for each construct and displaying in matrices	Allow the unique patterns of each case to emerge and sharpens construct definition, validity	Eisenhardt (1989) Miles and Huberman (1994) Yin (2003a)
Drawing Conclusion and Verification	Enfolding conflicting and similar literature Explanation-building verification	Building internal validity, Building a general explanation order to answer how and why questions	Eisenhardt (1989) Miles and Huberman (1994) Yin (2003a) Glaser and Strauss (1967)

3.6.1 Managing Data

In the initial data management phase, the researcher is faced with a mass of unwieldy, tangled data, so the first task is to make the data more manageable in order to identify themes and/or concepts. The influences of research questions, conceptual framework and/or proposition, proposed in Chapter 2, therefore have given priorities to the relevant analytic process (Miles and Huberman, 1994; Yin, 2003a). More specifically, the propositions help to focus attention on certain data, and to ignore other data which are not related to our set of research questions. They lead us to begin by sorting and reducing data through all of the field notes, transcripts and documents. Moreover, they guide us to identify initial themes and concepts, i.e. subsidiary autonomy, in the margins, or even attach pieces of paper with staples or paper clips that contained my notions about what I labelled, sorted and compared with the different parts of the data. More importantly, these themes and concepts are kept as close as possible to the respondents' own language and understandings. This initial process of data management can be further developed for data transformation and data display with within-case and across-case analysis.

3.6.2 Transforming Data

Data transforming involves in the data process of selecting, focusing, simplifying and abstracting the data that has been undertaken continuously throughout the life of our case study research. As data collection proceeds, further episodes of data transforming used for coding, making clusters, writing summaries and teasing out categories and dimensions until the final conclusions are completed. Data transformation is not something separate from analysis; it is part of analysis (Miles and Huberman, 1994). In particular, there are various data transforming techniques involved in carrying out two key aspects of analysis a) within-case analysis and b) searching for cross-case patterns in this study.

3.6.2.1 Within-Case Analysis

Having generated and applied a set of themes and concepts in managing the data phase, some specific dimensions of subsidiary autonomy between strategic and operational decisions in relation to value-added activities, and three specialist technological capabilities from subsidiary value-added activities and some other relevant themes (i.e. communication systems, subsidiary networks) are derived, as presented in Chapter 5. The researcher makes use of the synthesised data, identifying key dimensions and mapping the range and diversity of each phenomenon. As a result, it makes complicated data understandable after assigning data to themes and concepts to portray meaning. In particular, classifying and categorising the data helps the researcher to interpret it, to search for common or conflicting constructs and concepts in the data and to look for constructs and concepts related to our research propositions and research questions (Ghauri, 2004; Ritchie and Lewis, 2003). Once a much clearer view of the actual empirical evidence began to emerge, the researcher started to write an initial report on each individual case.

3.6.2.2 Cross-Case Analysis

Coupled with within-case analysis is the cross-case search for 'patterns' (Eisenhardt, 1989). Cross-case comparisons are done by forming clusters or categories, particularly on the three themes, namely subsidiary autonomy, subsidiary technological capabilities and communication system, the categories and dimensions of which are suggested by the research problems and existing literature. In doing case comparisons, the researcher looks for within-case similarities combined with inter-case differences. The comparison process involves inspecting cases and attempting to put them into clusters that share similar patterns of configurations; later, the juxtaposition of seemingly similar cases is carried out by the researcher searching for differences, and, in the same way, by the researcher searching for similarity in apparently different cases (Eisenhardt, 1989). This process leads to the development of matrices, permitting systematic comparisons between the similarities and differences across-cases. Accordingly, the researcher compares dimensions, categories, relationships and effects. For example, one of the matrix techniques adopted is referred to by Miles and Huberman (1994: 137). This type of matrix focuses on effects whereby the cause of the effects are being compared and contrasted by converting the data into primitive quantities. More specifically, each subsidiary is ranked as relatively 'high', 'moderate', 'low' or 'negligible' (if a subsidiary does not have this activity or action) in relation to each concept (i.e. marketing-related technological capability) or dimension (i.e. financial decisions), together with specific quoted examples (Miles and Huberman, 1994); these are internally valid, relative constructs rather than absolute measures, as presented in Chapter 6.

Another step undertaken in this cross-case analytical process of answering our research question is to verify our propositions (Ghauri, 2004). The researcher verifies the propositions by using 'pattern matching' (Campbell, 1975; Yin, 2003a), where a search is made for a systematic or unsystematic pattern in order to accept or reject the research propositions. This systematic analysis enhances the researcher's confidence in building explanations in findings and in drawing general conclusions. This is presented in Chapter 7.

3.6.3 Displaying Data

The next major flow of analysis process is data display. Generically, a display is an organised, compressed assembly of information that allows conclusions to be drawn (Mile and Huberman, 1994). Presenting data with displays helps the researcher and readers to understand what is happening, and even assists the researcher in deciding whether to take further actions with regard to data analysis. In this study, the data displays are broken down into two phases: within-case study and cross-case study.

3.6.3.1 Within-Case Analysis

The within-case analysis phase, presented in Chapter 5, typically involves detailed case study write-ups for each individual case. The early write-up is constructed of each case description (Eisenhardt, 1989; Pettigrew, 1988), and the more or less generic themes (e.g. subsidiary internal and external networks or communication systems), concepts (e.g. marketing capability or design capability) and dimensions (e.g. decision-making) are used. Each case description is used alongside tabular displays and information graphs (Leonard-Barton, 1988), which permit the analysis of the unique patterns of each case to emerge before moving on to in-depth analysis and exploration of the interrelationship between different factors (Eisenhardt, 1989; Mile and Huberman, 1994; Yin, 2003a).

3.6.3.2 Cross-Case Analysis

The reasons for carrying out cross-case analysis in this study are that it helps the investigator to look beyond initial impressions and to see evidence through multiple lenses (Eisenhardt, 1989). In addition, it can deepen understanding and explanation of the case studies being built through examination of similarities and differences across cases in order to enhance generalisability (Glaser and Strauss, 1970; Mile and Huberman, 1994). Accordingly, we look for themes (i.e. subsidiary autonomy) and dimensions/variables (i.e. product-development decision-making), and attempt to put them into groups or clusters so as to convert the evidence into primitive quantities, together with tabular, quantitative measures/data and brief quoted examples (Eisenhardt, 1989 and Miles and Huberman, 1994). To develop a good case comparison in multiple cases, we also test our propositions by cross-checking for commonality and integrating the evidence to verify our conceptual framework, as displayed in Chapter 6.

3.6.4 Drawing Conclusions and Verification

Yin (2003a) suggests that no matter what analytic tool or strategy has been used, a researcher must ensure that the analysis is of the highest quality. Mile and Huberman (1994) propose that conclusion drawing is also verified as the analyst proceeds. Therefore, adopting Eisenhardt's (1989) approach-constantly compared data and theory to examine which theory closely fits the data from the within-case and cross-cases analysis, themes, concepts and relationships between dimensions begin to emerge. This verification process is similar to that in hypothesis-testing method. The key difference is that each hypothesis is studied for each case, not for the aggregate cases; moreover, this process is more researcher judgemental than objective. In the meantime, we write up each case description, which provides extensive interviews and other documentation (i.e. internal case reports), showing the sources of the findings. To maintain a flowing narrative reading, some of the data are presented in the form of word tables and/or quantitative tabulations.

The following verified process is a comparison of the emergent constructs, concepts, dimensions and/or relationships, and propositions across cases with the extant literature (Eisenhardt, 1989; Yin, 2003a). This involves going to and fro amongst the evidence, emergent explanations and existing literature in search of what similarities, contradictions and the reasons for such. In essence, the evidence across cases is investigated in a number of different ways to further understanding of what is causing or influencing phenomena to occur. Therefore, this multiple-cases study dissects and arrays the evidence from three constructs - subsidiary autonomy, technological capability and communication systems to their related concepts, dimensions and relationships (see Chapter 6) in the form of diagrams and ranking and work tables. Generalisation about the determinations of subsidiary autonomy and the relationship between subsidiary autonomy and technological capability are then derived by using a replication logic/strategy (Eisenhardt, 1989; Yin, 2003a).

3.7 Concluding Remarks

In this chapter, we have outlined the research methodology in an effort to link our philosophical stance, research scope and research frameworks to the empirical study undertaken. We started the section with the scope of the research by providing an empirical framework of multinational subsidiary network relationships in terms of three constructs - subsidiary capability, subsidiary autonomy and communication system. The following justifications of the philosophical stance further explained that the methodology was to demonstrate the grasp of the theory of method and to lay out general methodological considerations consistent with the research questions, ontological and epistemological positions and underlying theories. Since we consider the nature of the research questions and focus on a contemporary phenomenon within the subsidiary management, the case study approach has been applied in this study. The case study provides a great variety of possibilities to understand the research phenomena, as well as the use of qualitative and quantitative evidences. In determining the appropriate use of the case study, a degree of confusion surrounds the distinctions among qualitative data being evident in the literature; the case-study approach advocated by Eisenhardt (1989), Miles and Huberman (1994), and Yin (2003a) have greatly influenced the case design, data collection and data analysis of this research.

In designing case studies, the issue of setting is shaped not only by a host of contextual factors, but also by the nature of the MNE networks. With this network thinking, each of the national operating subsidiaries interacts with other actors internally and/or externally to the MNE. Based on the context of the host country and the MNE, the primary unit of analysis of this study is defined as the foreign wholly-owned subsidiary, which possesses a value-adding activity in the host country. The issue of selecting case criteria and procedures has been well developed in this part, demonstrating that 5 multinational subsidiaries and the electronics industrial sector in Taiwan have been chosen for theoretical and practical, not statistical reasons.

Before collecting the evidence, we gained access to managers involved in operational and technological innovation activities. The case-study protocol had been employed through 55 in-depth interviews. All of interviews were recorded and transcribed soon after the interview. We also utilised data from a large variety of documents and archival records.

While the data was being collected, we started analysing the cases, in turn, and moved on to search for pattern-matching across cases, and further to make cross-comparisons. Simultaneously, we scanned additional theoretical fields of concepts, which helped us interpret the empirical data. Furthermore, we developed the frameworks by enfolding the evidence in the literature and engaging in continuous interaction of the evidence and our general ideas. A number of steps were also taken to ensure an authentic interpretation and to enhance the quality of this research.

CHAPTER FOUR

COUNTRY and INDUSTRIAL CONTEXTS

The dynamics of leading-edge industries are of primary importance in understanding national trajectories of industrialisation and corresponding spatial development. With reference to the national role and the increasing importance of globalisation of production and innovation in respect to technological changes in the environment, it is generally agreed that we have entered into a new more complex form of internationalisation—globalisation. Internationalisation involves functional integration between internationally dispersed economic activities (Chesnais, 1992; Dicken, 2003). In this process, the operation of MNEs is the most important force creating international changes in the nature and location of economic activity, as well as a new international division of labour. The strategies and operations of MNEs, and the resulting map of international production, operation and investment are much influenced by technological change. The effects of technology on the changing patterns in this regard have important implications for the acquisition of valuable resources from the environment and/or selective development of the environment for knowledge (Andersson *et al.*, 2001; Sölvell and Zander, 1995). The MNE started its R&D functions abroad mainly for the adaptation of products developed in the home country to local tastes or customer needs, and the adaptation of processes to local resource availabilities and production facilities. With the increasing competitive advantage in innovation of the host/local country, some subsidiary R&Ds have created new technology in association with specific competent counterparts from the host/local country (Cantwell and Mudambi, 2005; Pearce, 1999; Zander, 1999). In this chapter, we explore this transformation toward internationally integrated strategies within MNEs as well as the impact of 'local/national' issues. In addition, we reflect on the extent to which country and industry effects are influenced by the research in this regard. In particular, Taiwan is remarkable for technology innovation-intensive development and its flexible networking in the electronics industry, which may illustrate the influence of idiosyncratic elements of the host-country economy, such as local research or institutional infrastructure, technology development and/or skilled workforce.

In this chapter, we demonstrate the implications for Taiwan's electronics sector of recurrent global restructuring of the industry. The indispensable role of the nation is examined as an agent of both industrial restructuring and of production location. It also shows that the trajectory of development of electronics in Taiwan is a function of global forces as refracted through the prism of a national strategy. This elaboration departs from the specific assemblage of characteristics of individual nations - particularly in Taiwan, and of local counterparts. Likewise, Taiwan's research institutions will not only influence the way in which globalising processes are experienced, but also will influence the nature of those processes themselves.

This section of the study is structured as follows. Section 4.1 explores the trajectory of Taiwan's technological innovation developments. The main aim is to set out the technological innovation pathways of major Taiwan institutions, the central theme being that the globalisation of economic activity arises from the dynamic interplay between the strategies of Taiwanese governments and the character, direction and nature of technological change. In Section 4.2, we explore the electronics industry in Taiwan, in essence, to illustrate the electronics industry following the global shift from developed country to AP, and identify where semiconductor production fits into the global electronics production network. The evolution of Taiwan's electronics production chains is also discussed. In Section 4.3, we highlight the way in which interaction between the national/local (namely Taiwanese) infrastructure and industry and the MNE creates complex structures and/or strategies in which there are present elements of both concentration and dispersal. Also explored is the view that more intensely innovative subsidiaries become more interesting vehicles for technology creation or exploitation with local linkages.

4.1 Taiwan's Technology Development: the National System Pathway

Since the early 1960s, labour-intensive assembly of electronics production has been increasingly dispersed to the periphery of the world system, to locations in EA and South America (Davis and Hatano, 1985; Henderson and Scott, 1987; Henderson, 1989; Scott, 1987; Scott and Angel, 1988). These developments, in turn, have exposed the indigenous industrialists of the peripheral countries to the high-tech industry of developed countries. It is with such a background that Taiwan's electronics industry has developed, starting with simple export-oriented industrial development. Over the course of the 1980s and 1990s, development moved Taiwan's industries in the direction of 'knowledge-intensive' activities (Mathews and Cho, 2000).

Assembly lines in the electronics industry mushroomed in Taiwan from the early 1960s. They were attracted by the following factors: (i) three export processing zones (EPZ) built with the advice and assistance of the United States Agency for International Development (USAID); (ii) the financial incentives associated with national export-oriented industrialisation policies - tax holidays, exemption from import duties, and unlimited repatriation of profits; and above all, (iii) cheap and non-unionised labour (Scott, 1979: 360).

The intensive competition in the electronics field between the USA and Japan was the determinant of Taiwan's own incipient industry. The larger American electronics companies initially established assembly plants in Taiwan between 1966 and 1970. These investments were strongly encouraged by the US government, which sought to replace USAID to Taiwan with multinational capital and expertise (Gold, 1986, 1988). By 1984, the electronics industry accounted for over half of American investments in Taiwan, and represented over 40% of total foreign capital in Taiwan (Cheng, 1986: 94). Most of the investments went to wholly-owned subsidiaries, with initial capital supplied by the parent firms (Gold, 1986). In the case of Japan, market shrinkage stemming from American competition and soaring wages at home stimulated Japan's electronics manufacturers to expand the scale of existing subsidiaries abroad and to establish new production facilities in Taiwan. By 1984, Japanese investments represented 30% of foreign capital in Taiwan, the greater part being in the electronics sector (Cheng, 1986: 94). Most Japanese investments in Taiwan were joint ventures with local entrepreneurs. The Japanese partner was often required to import equipment and components from the parent company in Japan (Simon, 1988). The products were, in part, exported back to Japan if further processing were needed (Gold, 1988); however, most went to America.

In the early 1970s, the substantial rise in wages made Taiwan less attractive, and Taiwan's assembly plants gradually lost their competitive advantage to other Southeast Asian countries such as the Philippines and Malaysia (Scott, 1987). It became increasingly difficult for Taiwan to retain foreign-owned chip assembly lines. In addition, sub-contracting work from core countries was now under threat, and the lack of functional integration within Taiwan's electronics firms caused them to be exposed to competitive, and often unstable, markets. The dire situation in the electronics sector exerted political pressures, compelling the state to take on a major interventionist role in its restructuring. The only means of Taiwan's industry breaking the accumulative impasse was to upgrade its electronics niches in the global labour division through technological innovation (Simon, 1992). The immediate reason therefore, for the Taiwan government's intervention in the electronics industry was to assist it in catching up with advanced producers in Europe, the USA and Japan.

Initially, it was the Taiwan government that took on the central role of technological improvement of the industry. A number of strategic agencies were established from the early 1970s, the aim of which was the promoting of research and development in the electronics sector. They included the Committee for Promotion of the Information Industry, and the National Science Council (NSC). In addition, the state created various research centres, notably the ITRI, as well as public-private joint venture organisations. Prominent amongst the latter were the Computer Industry Development Centre and Industrial Technology Transfer Corporation. These non-profit public agencies facilitated cheap transfers of national-funded R & D outputs to a technology-starved private sector. The development in this regard was coordinated at three levels: upstream, midstream, and downstream (Li, 1988: 245-6). First, the upstream projects served to mobilise research talent to meet the manpower needs of research centres and the private sector. They usually involved large-scale R&D undertaken by the NSC and the Ministry of Economic Affairs (MOEA), in conjunction with various academic institutes. Second, the midstream projects concerned the development and demonstration of technologies and products to establish the basis for the downstream electronics. They were (and are) carried out with the aid of the MOEA, the Electronics Research and Services Organisation (ERSO) of ITRI, and the Institute of Information Industries. Third, under the support and guidance of the Industrial Development Bureau (IDB) and the MOEA, the downstream sectors served the function of developing new products and new markets for manufacturers. In addition, the IDB encouraged enterprise R&D for product development by making use of the Measures for Encouraging Product Development by Private Industry. A considerable number of new products were developed as a result of these coordinated efforts (Li, 1988: 246).

In the early 1980s, government efforts to boost industry upgrading and increase national competitive advantages had driven Taiwan industries towards knowledge and technically intensive activities. This resulted in the successful development of the electronics/semiconductors industry in the Hsinchu Science-Based Industrial Park (HSIP). The HSIP set out to create its core high-technology capabilities within the government power. To facilitate these institutional creations in association with ITRI and its specialised divisions, such as the Electronic Research Service Organisation, proved a source of 'migratory knowledge' for the electronics and computer industries: top researchers and engineers were continuously encouraged to move out into the private sector and to establish innovative start-up companies (Ernst, 2000a). In particular, the government employed public sector financing and publicly-funded but privately-operated demonstration ventures, such as United Microelectronic Corporation (UMC) and TSMC, which were quickly privatised and listed on the Taiwan Stock Exchange. TSMC was also listed on the New York Stock Exchange. TSMC was formed by the public sector in the form of a joint venture with a Dutch multinational company in order to acquire the semiconductor technological capability. It was evident that ITRI and its laboratories had acted as a prime vehicle for the leveraging of advanced technologies from abroad and for their rapid diffusion of dissemination to Taiwan's firms (Hobday, 1995; Mathews and Cho, 2000). In addition, it worked as closely as possible with the private sector and was engaged with industry associations in the formation of various R&D collaborative projects.

With the enactment of the Statute for Upgrading Industries in 1991, the government launched the "Measures for the Accelerating of Investment and upgrading of the Manufacturing Industry" and the " Training Programme for Industrial Technical Personnel", and actively planned and developed industrial parks in Hsinchu, Taichung and Taina, basic industrial zones in Changpin and Yunlin. In addition, the Hoping Cement Zone in Hualien adjusted the industrial structure and lay a foundation for the upgrading of industries. The "Measures for Boosting Economic Development" were promulgated in 1993 to implement the "Strategies and Measures for Development of Ten Emerging Industries", and to actively promote the development of the emerging industries. In 1995, an industrial promotion task-force was designated for three key industries: information technology, precision machinery, and the biotechnology and pharmaceuticals industries. They were established in association with a support system of the design service industry and common technical, human resource, promotion and environmental agencies, in order to achieve the goals of promoting industrial restructuring and increasing industrial added-value (Industrial Development Bureau, 2003).

Taiwan's industrial community has built a solid foundation through more than fifty years of endeavour, and is now an important player in the global economy. Since its accession to the WTO on 1 January 2002, Taiwan has encountered challenges from a more liberalised and competitive domestic market, as well as Mainland China's magnetic effect. The government thus launched the "Challenge 2008-National Development Plan" to actively increase industrial value and develop core industries including digital content, semiconductors, image displays and biotechnology. In the results of the 2003 Global Competitiveness Index rankings, Taiwan's rose to 5th place in the overall rankings and received a boost from higher scores in the quality of public institutions. The most evident improvements included more favourable perceptions of the independence of the judiciary, less favouritism in the decisions of government officials, better control of corruption, and greater public trust of politicians. Taiwan's leadership in technology (ranked No.3) also received a further boost from increased patent activity. These rankings attest to Taiwan's tremendous national technological system pathways.

In addition, while national development focused upon the electronics industry, it suffered from the lack of sophisticated workforce and education facilities with advanced R&D capabilities. Therefore, higher education was reorganised to meet local labour requirements in the upgrading of electronics manufacturing. Under the Programme for Strengthening the Education, Training, and Recruitment of High-Level Science and Technology Personnel, promulgated in 1982, most of these American-trained engineers have been lured home (Li, 1988). By the early 1990s, one in every four candidates for doctorates in electrical engineering at American universities was from Taiwan. In 2004, Taiwan had approximately 150 recognised institutions of higher education, both public and private. Taiwan's universities turn out 20,000 graduates with Master's or Ph.D. degree level qualifications. The regeneration of electronics manpower thus, has created a high-quality human resource and a professional workforce. Table 4.1 shows that the quality of Taiwan's human resources in terms of productivity, skill levels, and innovative ability has won worldwide recognition.

Table 4.1 Global Rankings by International Organisations

Items Ranked	**Taiwan**
Growth Competitiveness	3
Labour Performance	3
Innovative Ability	2
Technical Skills	2

Source: WEF, Global Competitiveness Report 2002-2003

4.2 Industrial Context: Global Production Network in Electronics

The electronics industry started in the late 1940s with transistors and the development of the mainframe computer. The US relied on global production networks for manufacturing services, and for almost two decades, the US was the world leader in the electronics industry. In the 1980s, however, Japan caught up with respect to DRAM, becoming the world's leading producer, later followed by the so-called Asia Tigers - Korea, Taiwan, Singapore and Hong Kong.

Defining the electronics industry is problematic.[1] Understanding of the competitive dynamics of the electronics industry is not only an issue for sector specialists, but also for the electronics industry, and is of critical importance for the enhancing of productivity, competitiveness and long-term growth (Ernst, 2000b). Due to the development of the mainframe computer and the invention of the transistor, there is a rapid diffusion of basic technologies, creating a pool of independent specialised suppliers, and likewise, semiconductor firms, that aggressively pursue international market share expansion and technology development. This highlights a symbiotic relationship between computers and semiconductors (Ernst, 2000b). Figure 4.1 demonstrates the electronics production chain, indicating the precise place of semiconductors production in the electronics production chain.

[1] Ernst's research (2000b) has shown that products in the electronics industry are inadequate to define when specialised suppliers, such as semiconductors, exist; when there is complex market segmentation and abrupt change in demand patterns, when there is intense and unpredictable technical change and when financial institutions accelerate the pace of industrial restructuring and increase uncertainty.

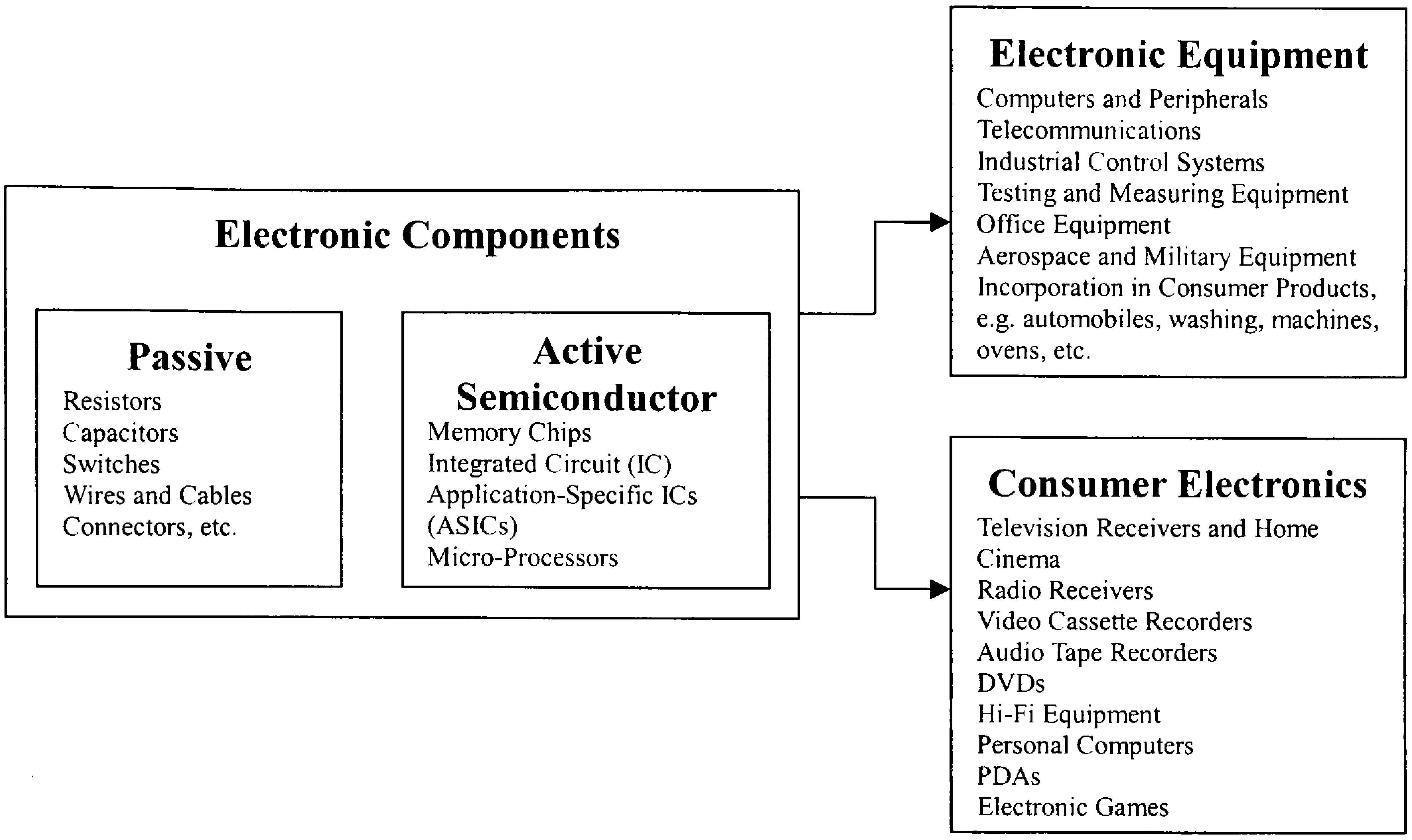

Figure 4.1 The Electronics Production Chain
Source: Dicken (2003: 400)

The analysis of Asian Tigers' development in electronics, began with the idea of 'flying geese' (Akamatsu, 1956) and with Japan at the forefront. As Japanese wages increased and the yen appreciated, production facilities and technology flowed outward from Japan to the more successful East Asian newly industrialised countries, such as Korea, Taiwan and Singapore (e.g. Ernst, 1997; Hobday, 1995; Mathews and Cho, 2000). This technology movement starts with the design of ICs, performed with sophisticated computer-aided design tools, resulting in the production of circuit diagrams in multiple 'layers'. The flow then moves through the production of specialised intermediates, such as silicon wafers and masks, used to 'etch' the pattern of the circuits on the silicon through a series of highly complex steps know as photolithography. This results in a finished wafer, on which are found the ICs, built up through various layers of metal and semiconductor materials in silicon. It then proceeds through the testing of the circuits, the cutting or sawing of the wafer to secure the individual chips, and their packaging onto plastic or resin substrates to form the familiar 'chips' with their multiple leads for insertion into circuit boards (Mathews and Cho, 2000). The value chain of the semiconductor sector is presented in Figure 4.2.

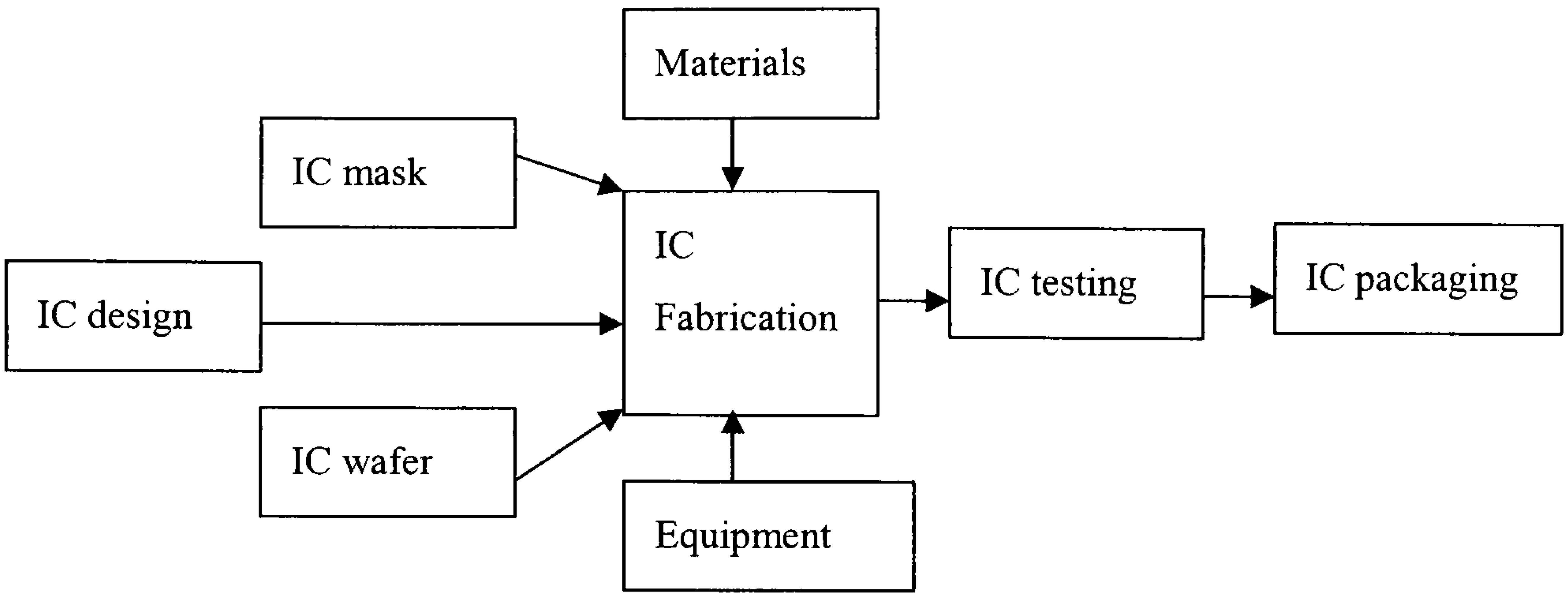

Figure 4.2 The Value Chain of the Semiconductor Sector
Source: Mathews and Cho (2000: 39)

Semiconductor production is a highly capital-intensive sector which tends to be dominated by very large MNEs. However, it is a sector in which some parts of the production chain can be geographically separated from the other stages in the sequence (Dicken, 2003). More specifically, the potential for mass production varies greatly between the standard device and the custom device. Production of standard devices demands large-scale mass production; manufacture of custom chips demands much smaller runs. The development of semi-customised and application-specific IC devices has extended the use of mass production techniques into new areas. In 2002, Taiwan's products, such as Foundry, IC Packaging, Optical Disk Driver, LCD monitor were ranked top in the world, and IC design and DRAM ranked among the top three in the world (ITRS, 2004).

4.2.1 Formation of Electronics Production Chains in Taiwan

There is broad consensus that integration into global production networks (GPNs) has been a powerful source of industrial upgrade, fostered through export-led growth, for EA countries such as Taiwan. EA's catching-up in the electronics industry, particularly in the semiconductor sector during the late 20th century, provides a fascinating example of this: an early integration into GPNs has provided Asian producers with access to the industry's main growth markets, helping to compensate for the initially small size of the domestic market, particularly in Taiwan (Ernst, 2000b).

The preferred competitive strategy of the Taiwan electronics industry has been to increase functional integration in manufacturing through extensive use of tiered production chains. Initially, it was involved in direct contract manufacturing relations with US and European manufacturers by investing the world's first EPZ for semiconductors in 1965. This marked the start of Taiwan's involvement in the back end of the semiconductor industry, encompassing testing, packaging and assembling. In the early 1970s, the ITRI launched into electronics and semiconductors, the technology leverage being dependent on their own efforts in association with the government initiative. Afterwards, Taiwan had few established large firms in electronics, and they were unable to run the risks with regard to major technological upgrading. Thus, the public sector of ERSO, a subordinate organisation to ITRI, signed an agreement for the technology transfer of Complementary Mental Oxide on Silicon (CMOS) technology with US electronics firm RCA in Taiwan. This agreement was to promote active R&D to improve and advance the IC design technology through public agencies and funding. In the 1980s, a Science and Technology Congress managed to generate all-important political support for the push to lift Taiwan's technological competence, and in paticular, to continue with the relatively expensive promotion of the IC technology development. The ITRI, especially ERSO, in association with the assitance of other government agencies, served as a central R&D support for new private firms, being the organisation from which many of the new Taiwanese semiconductor companies such as TSMC, UMC and Winbond were spun off. Furthermore, with regard to the creation of high-technology infrastructure in the form of HSIP and related infrastructure services developed in ERSO/ITRI, such as Taiwan Mask, clustering was fostered to create the requisite infrastructure needed for a world-class IC technology, such as LSI and very large scale integration (VLSI). The business was flourishing in terms of design and fabrication of the semiconductor devices logic chips, input-output devices, and customised circuits for the global supply chain management of their OEM customers. In the late 1980s to the 1990s, Taiwanese firms like Winbond, UMC, TSMC and Mactronix had developed a capacity to provide a package of services across a wide range of value chain activities, which has sustained Taiwan's position and rapidly deepened their roots of sustainability as preferred OEM suppliers. However, Taiwan policy-makers advocated setting up a much larger and more diversified electronics industry, including DRAM, active matix LCD, computer, etc., in order to involve more value-adding links in the global production chain. Table 4.1 summarises the developmental stages of the Taiwanese semiconductor industry.

Table 4.1 Stage in the Development of Taiwan's Semiconductor Industry

Pre-1976 *Preparation*	1976-1979 *Seeding*	1980-1988 *Technology Absorption and Propagation*	1989-1998 *Sustainability*
Labour-Intensive Semiconductor back-end operation and testing	Licensing of IC fabrication technology and its adoption by public sector R&D institute	Technology absorption and enterprise diffusion	Entry of firms to cover all phases of semiconductor manufacturing and full product range, including DRAMs
Dominated by foreign MNEs	Electronics Industry Development Programme	Establishment of secure infrastructure in the form of the Hsinchu Science-based Industry Park	From VLSI to ULSI technology
Establishment of ITRI and ERSO		ERSO acquires skills covering all phases of semiconductor manufacturing moving from LSI to VLSI technology	Submicron stage of public-sector-led R&D
		Spin-off of private companies and entry of private sector	Cooperative R&D system of innovation established

Source: Mathews and Cho (2000: 162)

4.3 Concluding Remarks: Interconnected Contexts

There has been an important debate in innovation literature about the extent to which there has been a globalisation in the production and commercialisation of knowledge (Cantwell, 1995; Dunning, 1977; Dunning and Wymbs, 1999; Patel, 1995; Pavitt, 1984). On the one hand, contributors to that debate argue that countries are very specialised in terms of what kinds of technologies their firms encompass. The MNEs of the world tend to own advanced technology and generate a high percentage of their worldwide patents in their home countries, and these are quite consistent with the overall profiles of export specialisation of the home country's economy. This is because even MNEs are embedded in wider institutional contexts and systems of externalities, which enable them to generate new, commercialisable knowledge (systems of innovation) that are highly specific to particular industries, countries and regions (Rugman and Verbeke, 2001; Cantwell and Mudambi, 2005).

The internationalisation of production and the penetration of new geographical markets tend no longer to be pursued solely through new direct investment, the establishment of international networks as formal or informal alliances having become key (Moulaert and Swyngedouw 1992: 47). The major players in the electronics industry of the core countries have thus been under tremendous pressure to pursue a competitive strategy of vertical integration on a worldwide scale (Ernst, 1985, 1987). Moreover, with increasingly global production and accumulation, multinational electronics have simultaneously become more embedded in localities and regions (Morris, 1992; Cooke *et al.*, 1992). This shift in the accumulation/competitive strategies of global electronics has enabled the nationalist state in Taiwan to take advantage of the international corporations in the restructuring of its domestic industry. The state, MNEs and local electronics corporations have combined to create tripartite alliances, some formal and others less so. With Taiwan increasingly isolated from the international community since the early 1970s, "....the importance of these links extends into the political arena, providing the island with international legitimation through its participation in a transnational system where economic and technology relation with MNEs act as a proxy for formal diplomatic relationships" (Simon, 1992: 101). With the purpose of keeping the crisis in the electronics industry at bay, and to bolster Taiwan's international standing, the state has constantly courted foreign investment, and directly intervened in the various strategic alliances by injecting money into electronics development. It has also exerted pressure on the MNEs to forge as many linkages as possible with local firms, through the purchase of inputs locally and via subcontracting relationships (Amsden, 1991).

To promote its strategic alliance strategy, the Taiwan government set up special agencies throughout the core countries (Li, 1988). As a result, a number of MNEs were attracted to the island from the 1970s onwards. Taiwan partner organisations took a share of the long-term investment risks, while the state ensured adequate supplies of intermediate goods, cheap skilled labour, and an attractive grant regime (e.g. Saghafi and Davidson, 1989; Simon and Schive, 1986; Simon, 1988). Multinational electronics firms were thereby able to minimise investment risk and start-up costs, an irresistible lure in the context of intensified competition globally. Both production, and to a degree accumulation, were shifted to a Far East locus (Clifford, 1992). The multinationals supplied the technologies which were urgently needed for developing new products. This helped Taiwan's electronics industry to survive restructuring crises, and to launch assaults on fiercely competitive global markets.

The preferred competitive strategy of the Taiwan electronics sector has been to increase functional integration in manufacturing through extensive use of tiered production chains. The first link is essentially dominated by the large MNEs, which have been responsible for the development of technical innovations and new products, making use of both domestic strategic alliances between the state and large local firms, and the international triple alliances mentioned earlier. For example, MNEs in semiconductors produce the basic electronic components and introduce the required technologies through their triple alliances (Saghafi and Davidson, 1989). Manufacturing of products is then subcontracted to the related alliance, and operating across a wide range of electronics manufacturing, these firms enter state led arrangements with one another. The aim of such arrangements is to raise levels of innovation in order to confront international markets relatively early in the life-cycle of the individual product (Levy, 1988).

The hierarchical system of electronics production represents a clear strategy for reducing production costs and enhancing organisational flexibility of production within a turbulent market. The nature of the labour process within the hierarchical framework also illustrates new management practices in electronics. These are designed to pursue greater labour flexibility and control at a time when labour bargaining power has been heightened due to growing shortages. Consolidating the hierarchical production chain becomes a primary means of surviving in global markets, which are increasingly competitive and uncertain over time. As a result, the organisational structures of electronics manufacturing have deepened, substantially strengthening the capacity to control the production process.

In short, Taiwan's national system pathways are idiosyncratic and shaped by institutional and systemic elements, particularly government technology policies, business government interaction in technological innovation, the functioning of business networks, and the role of the non-profit infrastructure, including universities and research institutions, etc. (Dosi *et al.*, 1990; Nelson, 1993). Therefore, the dispersion of the country knowledge base across borders may be limited because of the low absorptive capability of potential recipients located abroad (Rugman and Verbeke, 2001), unless multinational subsidiaries located within the national border have direct access to the accumulated specialised resources and positive externalities of the national system. These subsidiaries, in turn, will benefit from the country-specific, technological and organisational capabilities and their linkages with both local and global opportunities (Campbell and Verbeke, 2000; Rugman and Verbeke, 2001).

4.3.1 Implications for the Taiwan-Based MNE Subsidiaries

As the MNE pursues sustained competitiveness from which they facilitate a constant drive for new products, improved production processes and/or better organisational management, national industries need to evolve in a similar and complementary way around higher-value-added sources of comparative advantage (Papanastassiou and Pearce, 1999). The nationally distinctive features of the system are characterised by path dependencies in their knowledge development trajectories which are idiosyncratic and shaped by institutional and systemic elements, such as business government interactions in the innovation field and the role of the local infrastructure. In addition, they are reflected in the particularly sectoral patterns of strength or technological capability that are present in private firms in each country (Dosi *et al.*, 1990; Nelson, 1993; Patel and Pavitt, 1994; Rugman and Verbeke, 2001). An MNE integration of geographically dispersed and locally specialised activities tends to strengthen and not to dismantle nationally distinctive patterns of development or national systems of innovation (Cantwell, 1995). Thus, the creation of technological capability for the MNE is, in part, tacit and context-specific, becoming localised and embedded in social organisations (Nelson and Winter, 1982). This organisational distinctiveness has a location-specific as well as a firm-specific dimension. In other words, advanced national knowledge development systems may act as a 'pull' on MNEs to perform locally firm-specific advantage creating activities (Rugman and Verbeke, 2001). Given the fact that Taiwan has a high proportion of skilled workforce (shown in Table 4.1), had national expenditure on R&D as a percentage of GDP[2] at 2.3% in 2002, and that the number of registered US utility patents amounted to 5,298 in 2002 (UPTO, 2003), Taiwan provides innovative infrastructure for MNEs' subsidiaries, such as regional HQs or R&D centres.

In light of the fact that changes in technological know-how and consumer taste are unprecedented, managing the innovative process has become more crucial in MNEs. Innovation strategies in MNEs require more diversity with the important implications for the role of subsidiaries in recognising the potential for competence-creating and/or -exploiting. The subsidiary is increasingly being viewed as a technology-vehicle for developing innovative activities in collaboration with internal and external linkages. Some studies support the idea that

[2] The gross domestic product in 2002 was US$281.9 billion.

a subsidiary can contribute more creatively to technology generation within such a network. Better is the local infrastructure in the site location, which increases its potential skill base and local linkages with other innovative firms and research institutions. They also vehemently promote the influence of location on subsidiary mandates, as well as on the determination of R&D in subsidiary competence-creating and/or subsidiary competence-exploiting (Cantwell and Mudambi, 2005; Pearce, 1999). For competence-creating subsidiaries in comparison with competence-exploiting subsidiaries, the presence of local skills, educational resources and research infrastructure is critical. In this respect, the adequacy of local infrastructure, the educational system and the science-technology linkages clearly influence the functional scope of the subsidiary mandate and the subsidiary role within the MNE network (Cantwell and Molero, 2003; Cantwell and Mudambi, 2005).

Nevertheless, irrespective of subsidiaries' nationality and/or strategic roles, all subsidiaries are positively influenced by various internal technology sources (Kogut, 2000; Manolopoulos *et al.*, 2005; Nohria and Ghoshal, 1997); some MNEs have been able to establish closer cross-border connections through the emergence of internationally integrated corporate networks for dispersed technological development (Cantwell and Piscitello, 2000; Zander and Sölvell, 2000). In particular, the diversifications of MNEs acquire (new) technological knowledge through dispersed subsidiaries. The ability of the subsidiaries to fulfil their role relies, in turn, on their embeddedness in local networks with other firms and other institutions and/or universities (Cantwell and Molero, 2003). How and why the subsidiary develops its local/external linkage to build up the specific technological capability will be investigated later in this research.

CHAPTER FIVE

WITHIN-CASE ANALYSIS

In this chapter we focus our attention on describing and analysing the five Taiwan-based multinational subsidiaries, PH, RS, ST, MT and HT.[1] In particular, we describe and interpret how the five subsidiaries have evolved their capabilities through internal and external network linkages.

Each case begins with a generic introduction to the parent company and business segments or divisions in order to provide a whole picture of the MNE. Before considering the capabilities of each subsidiary, it is necessary to describe in more detail the subsidiary's background, role and development, which serve as the starting point for each case. The empirical framework employed in this study as set out in the third chapter is used to consider each of the subsidiary network relationships and to highlight issues related to the influence of subsidiary capabilities. Considering affirming our central research questions, the following generic sections are aimed at acquainting the reader with subsidiary decision-making autonomy, subsidiary technological capability and subsidiary communication systems.

The chapter is arranged as follows: 5.1 case study 1: PH, 5.2 case study 2: RS, 5.3 case study 3: ST, 5.4 case study 4: MT and 5.5 case study 5 HT, respectively. This chapter will lay the foundations for making cross-comparisons of the qualitative empirical data in the following chapter which serve to complement the quantitative evidence acquired from the respondents of the in-depth cases.

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[1] The actual names of the companies, their subsidiary units and other related operations are not disclosed in order to preserve confidentiality of privileged information.

5.1 Case Study 1: PH

The foundations for what was to become one of the world's biggest electronics MNEs were laid in Eindhoven, the Netherlands, in 1891, to manufacture incandescent lamps and other electrical products. In early 1998, the HQ was moved to Amsterdam.

In 2002, the MNE narrowed the scope of its operations, grouping its activities into 5 product divisions (PDs): consumer electronics, medical systems, domestic appliances and personal care, lighting, and semiconductors. Each PD was headed by its own Chairman but shared a general management system under the HQ. At the end of 2004, the MNE had approximately 140 production sites in 32 countries, and sales and service outlets in approximately 150 countries, with sales of US$36.6 billion and revenues of US$12.3 billion worldwide, distributed as follows: Europe (43.98%), North America (24.57%), Asia Pacific (26.46%) and another (4.99%) in Latin America and Africa (Annual Report, 2004).

The PH MNE employed approximately 161,586 people at the end of 2004, the largest headcount being in lighting (with 44,000 employees) and semiconductors PDs and allocating in the Asian Pacific region.

Semiconductors PD

The semiconductor PD was a leading supplier of silicon system solutions for mobile communications, consumer electronics, digital displays, contactless payment and connectivity, and in-car entertainment and networking. It was not active in the memory, microprocessors (MPU) or optoelectronics parts of the semiconductor industry, which were outsourced to other MNEs.

In the preliminary ranking by Gartner Dataquest, it ranked as one of the top ten worldwide vendors, with US$6,400 million sales and US$5,720 million revenue in 2004, employing more than 35,100 people, 6,000 of whom were engineers or software engineers. It comprised 6 system labs, 20 manufacturing sites and sales organisations in 60 countries around the world (Annual Report, 2004 and Company Website).

5.1.1 Subsidiary Background

The PH subsidiary had been in Taiwan since 1966 as a major manufacturing and operation centre for some of its production lines, including semiconductors, electronic components and monitors. It was one of the largest foreign companies, foreign investors and foreign employers in Taiwan. It had been a leading player in Taiwan's foreign business community and had evolved with the Taiwan electronics industry.

In 1999, the PH subsidiary had six production centres, its operations including the global HQ and Competence Centre of Monitors, the Asia Pacific Office of Semiconductors, the Asia Pacific (AP) Office of Components and the Regional R&D Centre (Basic Research) with 11,561 employees. Since 2003, it has had one national organisation (NO) and Kaohsiung Semiconductor operational centre.[2] The president in Taiwan PH stated:

> *We have earned great competence awareness and recognition from the PH global family to establish several PD* HQs in Taiwan.[3]

The operations concentrated on management, development of products, product management and global commercialisation, thereby transforming the manufacturing centre into a competence centre.

> *This was a reflection of the changing environment of Taiwan's electronic business. Most of the more low-end production has migrated places with lower wages and lower production costs, namely mainland China in most cases.'*

The PH subsidiary now has 3,500 employees in total, with around 2,400 employees in the semiconductor operations. In 2004, revenues amounted to US $300 million.

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[2] It consists of an applied R&D centre, five manufacturing operations, logistics and some supportive functions.

[3] The PDs' HQs in Taiwan include Business Creative Unit-Multimedia Displays, Regional Sales Organisation of Semiconductors, Business Unit-Display Solutions and Optical Storage (Source: http://www.chinapost.com.tw/archive/).

5.1.2 Subsidiary Role and Development

The subsidiary business development roles changed along with the evolution of Taiwan's industrial environment. During the 1960s, Taiwan was focused on a labour-intensive economy, and the PH subsidiary chose to be an offshore assembly centre. It brought in all the components, manufactured in Taiwan and then shipped the products abroad. In the 1970s, Taiwan became capital and technology intensive, and the subsidiary turned into an international production centre. The PH subsidiary started to invest more in Taiwan, using local components and machinery, producing components locally, and migrating more R&D and competence into Taiwan. In the 1980s, Taiwan had transformed into an information and knowledge intensive economy, and the role of the PH subsidiary had changed into an AP Office for Semiconductors, and the Global Business Centre of Monitors and a (Applied) R&D Centre of Semiconductors in association with the production centre. In 2003, the PH subsidiary re-focused on value-added activities such as design, sales, and product development, departing from its former role as an assembly and production centre.

5.1.3 Subsidiary Network Relationships

Focusing principally on the Taiwan PH subsidiary which consisted of the NO and semiconductors operational centre, but the discussion also extends to exploration of the coordination and cooperation between businesses in different PDs. The PH network relationships, shown in Figure 5.1, started with the internal network from the perspective of the subsidiary, moving on to the relationship between the subsidiary, the PDs and the HQ, and then the subsidiary to its sister-subsidiaries; and finally exploring the external network, elaborating on the local link with the subsidiary, and the global link with the subsidiary.

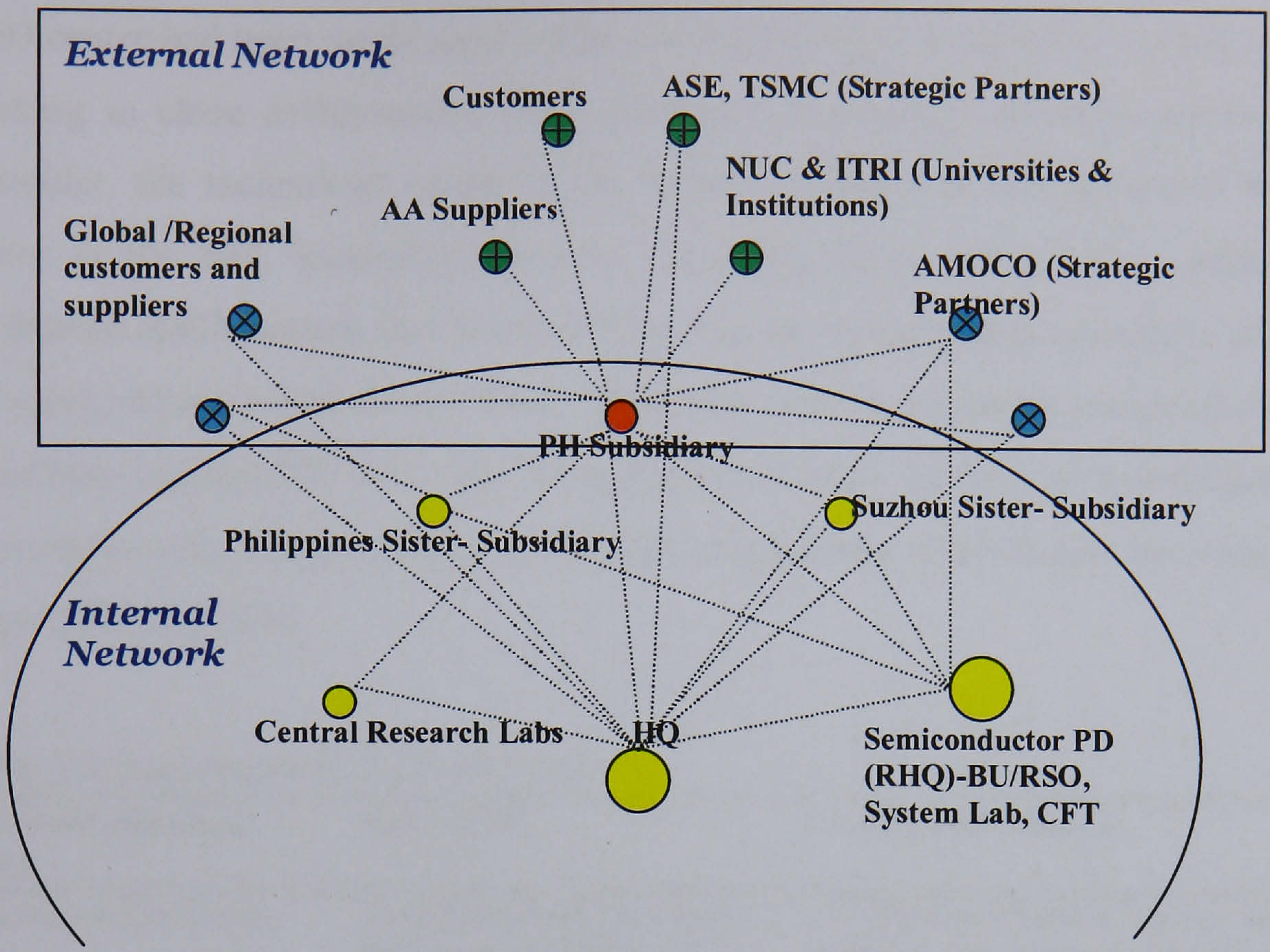

Figure 5.1 Internal and External Linkages of PH Subsidiary

5.1.3.1 Internal Network

Figure 5.1 shows the simplest representation of the network linkages of the PH subsidiary. The subsidiary consisted of its national organisation (NO) and wholly-owned semiconductor operations. The subsidiary activities involved developing and manufacturing of semiconductor packaging and testing, as well as the marketing of a diverse range of products for the PDs (See Table 5.1). The main responsibilities of the NO were for plant operations and marketing and sales, as well as acting as a supporting organisation in collaboration with the various PDs.

With regard to the semiconductor operations, the subsidiary took charge of the development and manufacture of middle- and high-end engineering and production towards complex, specific and customised semiconductor packaging & testing products, particularly for communications, and consumer multimedia, automotives and home appliances. Soon after PH manufactured high quality of semiconductors products, 90% of the products were supplied to Regional Sales Offices (RSOs) which were allocated within the semiconductors PD. The RSO of AP was allocated in Taiwan and the others were distributed around the different regions. An applied

R&D centre had been established within the semiconductor operations since 1988, working in close collaboration with worldwide technology clusters/centres,[4] in particular, the technology centre in the semiconductor PD and advanced R&D centre in the HQ, located in Europe. The continuous collaboration with the worldwide R&D centres had enhanced the overall technological capability of the PH semiconductor operational centre, especially in terms of design and production. It had been mandated to assist the Philippines and Suzhou plants (sister-subsidiaries) to use low- and middle-end production and engineering technologies between the years 1997 and 2002.

Table 5.1 Businesses of PH Subsidiary

Product Division (PD)	Businesses	Principal Products
Consumer Electronics	Connected Displays, Home Entertainment Hubs and Networks, Mobile Infotainment	TV products, Video Products, Audio Systems, Separates and Portables; LCD and CRT Computer Monitors; Mobile Phones and Cordless Digital Phones and Accessories.
Domestic Appliances and Personal Care	Home Management and Consumers' Wellness	Shaving and Beauty, Oral Healthcare, Food and Beverage Appliances, and Home Environment Care.
Semiconductors	Communications, Automotives, Computing, Consumer Multimedia, Industrial and Home Appliances	Nexperia-a 'System-on-a-Chip', Enhanced Data for GSM Evolution (EDGE), Radio Frequency Identification (RFID) and Near Field Communication (NFC)
Medical Systems	Medical Imaging Modalities, Patient Monitoring Systems	X-Ray, Ultrasound, Magnetic Resonance, Computed Tomography, Nuclear Medicine, Positron Emission Tomography, Radiation Therapy Planning, Patient Monitoring, Resuscitation Products and Healthcare Information Management.

[4] The total research and development activities are allocated between the Technology Cluster, which invests in competencies and technologies relevant to the entire MNE and the PDs. Within the Technology Cluster or Centres, approximately 2,100 staff are employed in the Central Research Unit, and 1,600 in advanced development and in the development of equipment. In the PDs, which focus on product development and development of production methods, approximately 15,600 people are active in the R&D segment (Annual Report, 2004).

Lighting	Lamps, Luminaries, Lighting Electronics, Automotive and Special Lighting	Incandescent and Halogen Lamps, Compact and Normal Fluorescent Lamps, Automotive Lamps, High-Intensity Gas-Discharge and Special Lamps, LED-Based Lighting, QL Induction Lamps, Fixtures, Ballasts and Lighting Electronics.

Source: Annual Report, 2004

5.1.3.2 External Network

The PH subsidiary had a very interesting history of connections and local external links (Please refer to Figure 5.1). In the mid-1980s, the PH parent company made joint investments with Taiwan Semiconductor Manufacturing Company (TSMC), the world's largest made-to-order chipmaker, making the company the largest single shareholder of TSMC with a 19% stake. The reasons for the PH MNE holding an interest in TSMC were to secure a strategic supply of wafers, to share and exchange technology and manufacturing knowledge, and to share the risk of capital expenditures (Annual Report, 2004). The PH subsidiary was involved in two joint ventures in Taiwan. It controlled 51% of a new digital storage company, which was formed under a partnership with BenQ Corporation to make optical storage products. It also had a 48% stake in Arcadyan Technology Corporation, and set up as part of a partnership with Accton Technology Corporation to manufacture wireless products (Company Website and Annual Report, 2004). As the CEO of the PH subsidiary stated:

> *'We are exploring opportunities for local strategic partnerships because the parent company prefers to increase procurement and outsource activities in Taiwan.'*

The other Taiwanese company (ASE) working in the advanced semiconductor engineering field provided an interesting example of sharing and exchanging packaging & testing technologies, and was at this time an international partner of the PH semiconductors PD. On the whole, those strategic partners were the key determinants of their specialisation in manufacturing technology and knowledge involvement in the PH subsidiary, and were now leveraging the local links from the PH subsidiary in Taiwan to the PH MNE networks.

One of the Japanese suppliers (AA) was set up in Taiwan to supply the IC and discrete components (e.g. lead-frame) to the semiconductor operations. A close collaboration with the semiconductor PD remained for supplying components.

Moreover, the PH subsidiary collaborated with local universities to carry out basic chemical and material technical and human resources developments. As well as cooperating with the Industrial Technology Research Institute (ITRI), they commenced generating technological knowledge for promoting sustainable development in high-technology.

With the global link (shown in Figure 5.1), their main mandates were to supply components (e.g. wafer or chip), materials (e.g. chemical materials) and equipment (e.g. wire bonding), to the PH semiconductor operational centre. It was noticeable that the semiconductors PD played a key role in the process of managing the procurement and supply chain. The role of the semiconductors PD, the business units (BUs) in particular, was mainly to negotiate prices, forge bonds of trust and maintain close relations.

5.1.4 Subsidiary Decision-Making Autonomy

Since 2002, the governance model and the process implemented have become consolidated in the hands of the five PDs, most of whose CEOs have become members of the Group Management committee. The HQ has turned into a "strategic controller", the principal function of which is to set the corporate strategy, approve the PDs' strategies and control their performance. The primary businesses are managed through the PDs, for instance, the semiconductor PD consults with the semiconductors operational centre and assigns high quality managers locally and regionally, adhering to local operating procedures, as agreed by the subsidiary and implemented by the NO within Taiwan.

The generic management system is shared across all PDs, such as the semiconductor PD, including strategic planning memoranda, financial management, human resource management, marketing management and technology management.

More specifically, with regard to the semiconductors business activities, the R&D and manufacturing are dictated by the PD, rather than the HQ, although the HQ might make occasional suggestions (See Figure 5.1). Given the fact that the semiconductor PD guides a generic management system, the PH semiconductor operational centre still retains autonomy for making decisions in business processes.

5.1.4.1 Financial Decisions

In general, the semiconductor PD allocated capital investment to the semiconductors operational centre, although the semiconductors operational centre would propose new investment ideas to the PD. For example, during the 1970s, the general manager of the semiconductors operation proposed an automatic manufacturing wire-bonding system to the HQ,[5] and has made a number of significant proposals since then. Other financial decisions, such as working capital/expenditure, were made by the subsidiary and were allocated by the PD.

5.1.4.2 Purchasing Decisions

Most procurement decisions, for example, those relating to sources and prices were made in the PD and the NO to carry out the procurement activity. More specifically, the NO sought local (Taiwan) strategic partnerships by increasing procurement activity in the year 2004. In fact, the PH MNE procured around US $4.5 billion worth of products in Taiwan, as announced by the NO in Taiwan (Source: http://www.taipeitimes.com/News/). Given the fact that the purchasing decision was mainly the domain of the PD, the semiconductor operational centre was to provide the demand for equipment and materials.

5.1.4.3 HR Decisions

In accordance with the HQ's HR strategy, the HR practice was carried out by the NO, reflecting national differences. The more autonomous recruitment and training developments were evolved in the semiconductor operational centre. One respondent stated that the semiconductor operational centre was looking to recruit

[5] The business management system during the1970s was controlled by the HQ, instead of the PD.

an additional 200 engineers in 2004 to complement its expanded production and IC testing facilities. A careful recruitment and selection procedure, followed by intensive and continuous vocational training with the emphasis on teamwork, was implemented. Furthermore, the semiconductors operational centre retained its autonomy in terms of decision-making in personnel promotion as well as expatriated senior engineers to the sister-subsidiaries. Notably, the president of the PH subsidiary in Taiwan was a Taiwanese appointment.

5.1.4.4 Marketing Activity Decisions

The PH had long been better at technology development than at marketing. By leveraging the PH brand-name globally, the semiconductors PD centralised the marketing strategy, including market development, key products focus, logistics management and customer management. The whole process of marketing strategy was developed across BUs, RSO and manufacturing operations, integrating marketing, hardware, IC and software development into one process, producing complete systems. In this respect, the PH subsidiary was integrated into marketing systems to meet the customers' needs with BUs and RSO.

5.1.4.5 Product-Development Decisions

As indicated above, the new marketing system implemented across the whole semiconductors PD, RSOs and international product marketing had a major impact on product development. Most importantly, it integrated marketing, sales, design and manufacturing into one process. The new system principally reflected the vital need for fast time to market and also made co-development with customers easier.

Decisions about product development were made in a forum consisting of marketing managers, managers of System Lab, Central Research Lab and innovation organisations in alignment with the PD strategy. With respect to product development, one director responded that the PH subsidiary had integrated into the MNE network as an international manufacturer; however, from time to time, it had made a number of suggestions with regard to package & test product developments and market knowledge to the PD.

5.1.4.6 Collaboration Decisions

Owing to the nature of the semiconductors business, and the strategy of the semiconductors PD association with the consumer, communication, automotive and computing businesses, the PH subsidiary appreciated that its operational centre should conform to corporation-side and industrial standards. Overall collaboration strategy was governed by the PD specifically to dictate that worldwide R&D, e.g. system lab or technical innovation, assisted the PH operational centre.

Furthermore, the PH subsidiary held a degree of autonomy for joint efforts in applied research and development with local partners. One respondent said that the PH subsidiary utilised ITRI and universities to conduct more applied semiconductor technical developments.

5.1.4.7 Subcontracting Decisions

With regard to subcontracting decisions, the country president of the PH subsidiary worked on behalf of the PDs and the Board of Management, and made a number of subcontracting and/or outsourcing decisions:

> *'Any party who holds the same values as us [the PH] and has supplementary [competences] from us can become our partner......we are seeking more partners because the parent company prefers to subcontract or outsource projects and many of the PH units worldwide have been replaced by strategic partners.'*

In contrast, the decision was tightly controlled by the PD due to the international network, and the semiconductor operational centre recognised this as a constraint on their activities, such as cost control. Nevertheless, its creativity was acknowledged, namely that it could opt for appropriate subcontractors to collaborate on the project.

5.1.4.8 Change in Operational Processes

With regard to changes in operational processes, managers in the PH subsidiary asserted that because of 'the PH Taiwan subsidiary's excellent advantages of know-how, experience, quality and people, it had earned great recognition [for its capabilities] from the HQ and the PD'. Over the years, the PH semiconductor operational centre had used a proactive stream of good operating results to bargain decision-making away from the PD. As an example, the subsidiary conducted innovative development of production processes to improve the wire-bonding system and the parent company accredited its performance and relocated its package & test R&D centre to the PH subsidiary. The subsequent development of the subsidiary had directed its attention to strong performance, and the parent company was valued accordingly. In tandem with this process, the parent company had gradually loosened its control over affiliated activities.

5.1.4.9 Technology Decisions

The increased emphasis on marketing led the semiconductors PD on a mission for connected consumer applications, which had a clear implication for technology management. In 2004, the PD reduced R&D costs to 1% of sales (US$6.4 billion), while continuing to invest in its technology partnerships, for example, with Freescale Semiconductor and STMicroelectronics, to drive state-of-the-art front- and back-end manufacturing capabilities in the latest technology processes and with the BMW, Bosch, DaimlerChrysler, General Motors, Motorola and Volkswagen of the FlexRay Consortium to develop the standard for automotive control applications (Company Web-site).

In fact, one senior director articulated that the PD formed the technology strategy in developing a close cooperation with partners and customers in the product development phase, as well as in forming an intensive collaboration with worldwide R&D organisations. The technology decisions in the PH subsidiary were in accordance with the PD strategy; in particular, innovative technology development[6] was ratified with the BUs through a strategic package development meeting. Nonetheless, the PH subsidiary had autonomy for choosing its subcontractors or external technology partners.

[6] In 2004, the annual expenditure on innovative technology development was US$0.6 million

5.1.5 Building Subsidiary Technological Capability

The PH semiconductors operational centre had long experience of IC packaging & testing, and worked with RSOs, IPM,[7] and BUs, as well as collaborating with worldwide R&D and innovation organisations. As an international semiconductors operational centre, it was responsible for producing customised and technological-intensive products, and it therefore enjoyed a close cooperation with different partners, including internal sister-units and/or external customers, suppliers, strategic partners. Table 5.2 illustrates the co-operation between different partners in the process of product development undertaken by the PH semiconductors operational centre. Such co-operation included different types of technological capability, linkages, and technology learning.

[7] IPM (international product marketing) is allocated in the semiconductors PD.

Table 5.2 Building PH Subsidiary Technological Capabilities

Type of TC / Phase	Theme	Main Processes	Internal and External Linkages	Outcome Assessments
Marketing Capability	Phase 1: *Survey*	Customer Needs and Wants	The PD e.g. IPM sets the product strategy with reference to the market/industrial information/trend.	Customer requirements/orders
	Phase 2: *Initiation*	• Preparation short-term products • Proposal for middle-term product developments • Precedence for long-term product developments	• Product development meeting-all range of products review with the RSOs, IPM and BUs. • Worldwide Technological Innovation/R&D organizations supports	• Strategic products development • Business/Product Roadmap
	Phase 3: *Definition*	• Feasibility study-technical and economical aspects • Drawing Framework/Working Sample • Short-term product (new) project management	• Annual product plan is reached in the product development meeting and the tasks are allocated to each site • Cross-levels/links learning new technology	• Industrial standard test • Scheduling time
Design Capability	Phase 4: *Design*	• Product Specifications • Design Review/Reference Sample • Procurement material, tool or pilot equipment	• Co-design/coordination with customers, suppliers, subcontractors…external and internal partners. • Cross links- technology collaboration • Exploit Existing Technology • Identify and replace existing/old technologies	• Time to market • Number of Patents • Advance Capability Index (ACI) • Turnover of Innovation
Production Capability	Phase 5: *Production*	• Pilot production • Production Management • Continuous improvement process	• Collaboration with internal and/or external links on material and equipment requirements • Production process coordinates with internal/external links	• Yield rate • Capacity Production Index (CPK) • Cost of ownership

5.1.5.1 Marketing Capability

According to the survey phase illustrated in Table 5.2, the co-operation was undertaken between the RSO in the PH subsidiary and International Product Management (IPM) throughout the process with the purpose of identifying market opportunities and satisfying the customer needs. The RSO in Taiwan was concentrating its efforts on new markets and old products in association with IPM, which was focusing on maintaining and further developing the product roadmap and creating new product opportunities, though clearly the RSO was responsible for identifying possible product gaps in the market as perceived by the customer base. Shortly afterwards, the RSO became involved in the hierarchical process of the central research labs with regard to assembly innovations for effective co-operation. They were also involved in some specific forums, the purpose of which was to ensure effective use of resources and to ensure that market information was efficiently shared. In essence, close cooperation with the central research labs and product divisional system labs was undertaken. An annual meeting (e.g. assembly engineering meeting, strategic package development meeting) produced a product plan, and a feasibility study was undertaken at each site. For instance, the PH semiconductors centre would take charge of high-end or technological-intensive package and test products. There was an initial degree of technology sharing and learning from different internal and external partners, such as internal semiconductor system labs or external material suppliers.

5.1.5.2 Design Capability

From 1988, the semiconductor PD started an applied R&D organisation within the semiconductors operational centre, which predominantly focused on the package & test product development and production method. It worked in close cooperation with the Central Research Labs,[8] System Labs and the Centre for Industrial Technology (CFT) (for the relationships of these units, please see Figure 5.2) to make technical ideas feasible for implementation in products, equipment and manufacturing processes. In this respect, one interviewee reported that the PH's applied R&D department (assembly innovation department) developed chip-scale-package and ball-grid arrays (BGAs) in close collaboration with CFT for the purpose of translating technical information into processes, equipment or manufacturable products by applying the invented technologies. Furthermore, it also carried out product integration projects through System Lab1 to improve embedded software in tandem with the central research lab to clarify the new product concepts.

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[8] The Central Research Labs draw upon a deep and broad technology foundation and seek to break down the barriers between technology and application domains in order to achieve the synergies that will lead to new product concepts and new business (Annual Report, 2004).

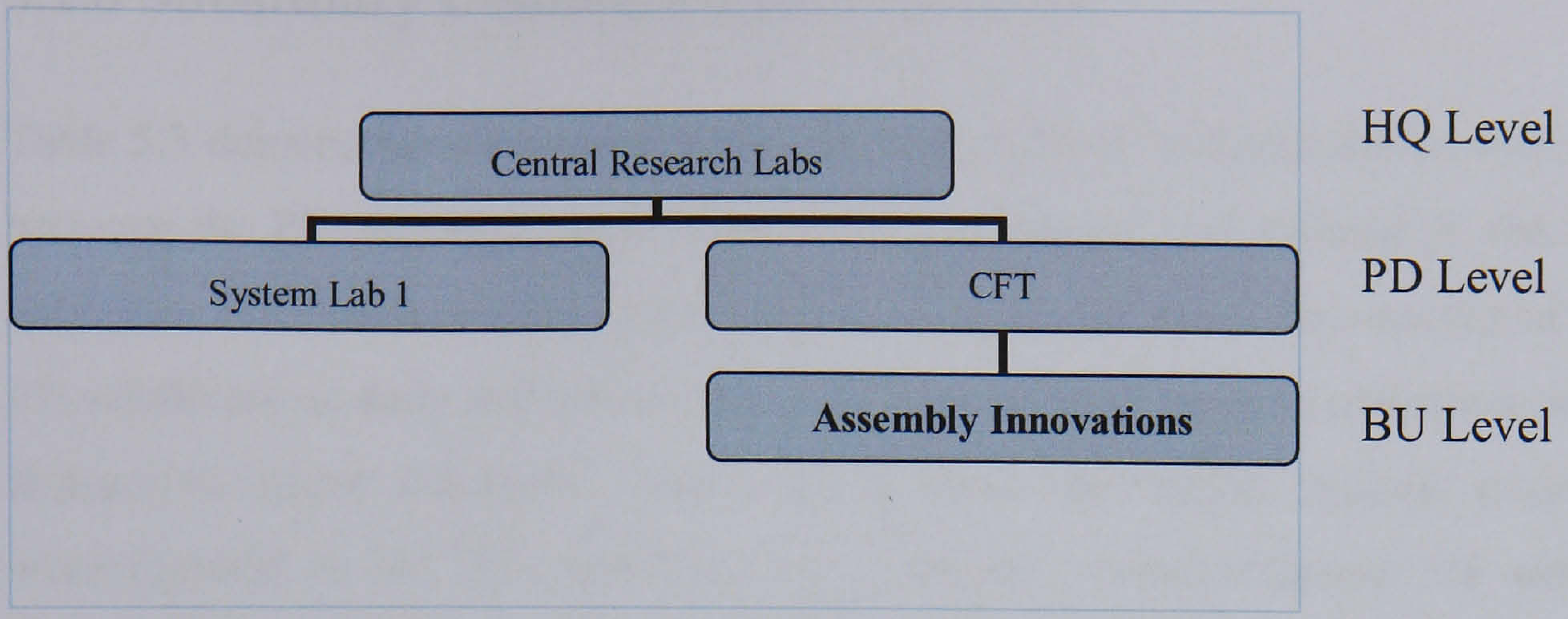

Figure 5.2 The Hierarchical R&D Organisations in PH Subsidiary

5.1.5.3 Production Capability

As assembly innovation identified a new product prototype and framework, new package & test production technology were migrated from the internal system lab 1 or CFT, and sometimes imported from external strategic partners such as Amkor. With reference to the production phase of the PH semiconductor package and test production, they were engaged in a series of processes from wafers→ wafers test → sawing → die bond → wire bond → molding → plating → marking → form → testing. They comprised internal and external partners, the function of whom was to fulfil the production process. One project manager stated that TSMC provided wafers that were delivered to the RSO for storing or distributing to the plants. Furthermore, the PH production plants outsourced plating jobs to one Japanese subsidiary in Taiwan. Overall, the processes of the package & test production entailed improved and/or new technical production technology and interconnected technology with respect to new wafer processes. For example, the dimension of wafer processing had been increased from 100mm to 200mm; in the near future it will be increased to 300mm. As a result, the package & test production technology will be changed.

> *'We have possessed a substantial in-house technology to fulfil a new manufacturing process together with worldwide networks.'* (Director of Assembly Innovation)

5.1.6 Subsidiary Communication Systems

Table 5.3 demonstrates a breakdown in the reciprocity of communication systems between the PH subsidiary and various partners internal and external to the PH networks. The business units, responsible for 20 manufacturing sites, contacted the PH subsidiary on daily and annual bases and used different types of communication features to submit functional reports and to share information. As new projects were dictated to the PH subsidiary, very frequent communications via email, telephone, conference call, and personal visits, between internal R&D organisations were to be expected, along with close cooperation with customers and suppliers and/or strategic partners. With the semiconductors PD or the HQ, annual meetings with heads of departments and the president of the NO were held. With respect to the local partners, communication was made when necessary.

Table 5.3 PH Subsidiary Communication Systems

Patterns of PH Subsidiary communications	Daily	Weekly	Monthly	Quarterly	Yearly
Internal Communication					
Sister subsidiaries	**Email/telephone/Fax**	----	----	----	----
Business units (across functions)	**Email/telephone/Fax**	**Intranet**	**Intranet/ Net Meeting**	**Face-to -Face meeting**	**Face-to-Face meeting**
Sister-R&D organisations	**Email**	**Conference Call**	**Personal Visiting**	**Face-to -Face meeting**	----
Other partners of the semiconductors PD/the HQ	----	----	----	----	**Face-to-Face meeting**
External Communication					
Local/Global customers & suppliers	**Email**	**telephone/ Fax**	**Personal Visiting**	----	----
Local/Global Strategic Partners	**Email**	**telephone/ Fax**	**Personal Visiting**	----	----
Local Universities & Research Institutions	----	----	**E-mail**	**Face-to -Face meeting**	**Conference**

5.2 Case Study 2: RS

RS was one of the top ten semiconductor companies in the world (Gartner Dataquest, 2005), a dedicated semiconductor product manufacturer providing leading edge solutions in order to improve the competitiveness of customers' end products. It was established on 1st April, 2003 as a joint venture between two Japanese Electric Corporations with headquarters in Tokyo, Japan. At the end of 2004, RS employed approximately 26,000 people in 18 organisations in Japan and 23 subsidiaries across Europe, North America and AP with sales of US$ 8,500 million and revenue of US$8,849 million.

Furthermore, it developed design and applied technologies and manufacturing subsidiaries around Europe and AP in order to integrate local needs into a global RS network. With the commencement of integrated operations, a number of AP subsidiaries, such as Taiwan, Singapore and China, evolved a full line-up of product marketing and applied design.

RS principally designed and manufactured highly integrated semiconductor system solutions. More specifically, it focused on four application fields: mobile, automotive, digital home electronics and network, where their ventured companies were both strong. It had further expanded its business in the areas of microcomputers, system-on-chips (SoCs), multi-purpose semiconductor devices for mobile, automotive and PC/AV markets, and also supplied flash memories, Smart Card ICs, mixed-signal products, SRAMs and more.

5.2.1 Subsidiary Background

The RS subsidiary started business activities in Taiwan on 1st July, 2003 and was integrated into both joint-ventured Japanese subsidiaries in Taiwan to form an operational organisation including marketing & sales and an engineering centre. With regard to the Taiwan subsidiary, operations consisted of development, design, sales and servicing of system LSI products such as microcomputers, logic, analog and discrete devices, flash memory and SRAM. The purpose of this integrated operation was to create the best synergy for engineering service driven by each regional or country market needs and customers' wants (Company Website).

The RS subsidiary employed 100 people and by 2004, had sales amounting to US $240 million.

5.2.2 Subsidiary Role and Development

When the RS subsidiary debuted in July 2003, the joint venture between the two Japanese electronics giants was already one of the largest microchip manufacturers and semiconductor vendors not only in Taiwan, but in the world. Building on the years of knowledge and experience of both companies in the semiconductor industry, the RS subsidiary delivered leading-edge technologies and products to its local and regional customers,[9] using the synergistic strength of the human and technological resources of the two companies.

In so doing, the RS subsidiary focused on four application fields: mobile phone, automotive, digital home electronics and network products organised into three business divisions (Table 5.4). In order to facilitate these three businesses, the RS subsidiary took local and regional needs into consideration by evolving a close collaboration with product development, design and production that spanned the globe.

Table 5.4 Businesses of RS subsidiary

Businesses	Principle Products
Micorcomputers and SoCs	Application Processors for Mobile Phones and Car Information Systems
Multi-purpose semiconductor device	RF (Radio Frequency) Device, MSIG for Digital Home Electronics and Network Products
Memory	Multi-Chip Packages (MCPs), DINOR-type Flash, AND-type Flash and Flash Cards, SRAMs.

Source: Annual Report, 2004

[9] This refers to customers who are in Great China, including Taiwan, Hong Kong and China,

5.2.3 Subsidiary Network Relationships

This section focuses on the network linkages of the RS subsidiary in Taiwan, as presented in Figure 5.3. The links begin with the internal network from the aspect of the RS subsidiary, then the RS subsidiary to the HQ and central R&D centre, and moves on to depict the links of the RS subsidiary to its sister-subsidiaries, before displaying the external network, simplifying the local and regional linkages with the RS subsidiary.

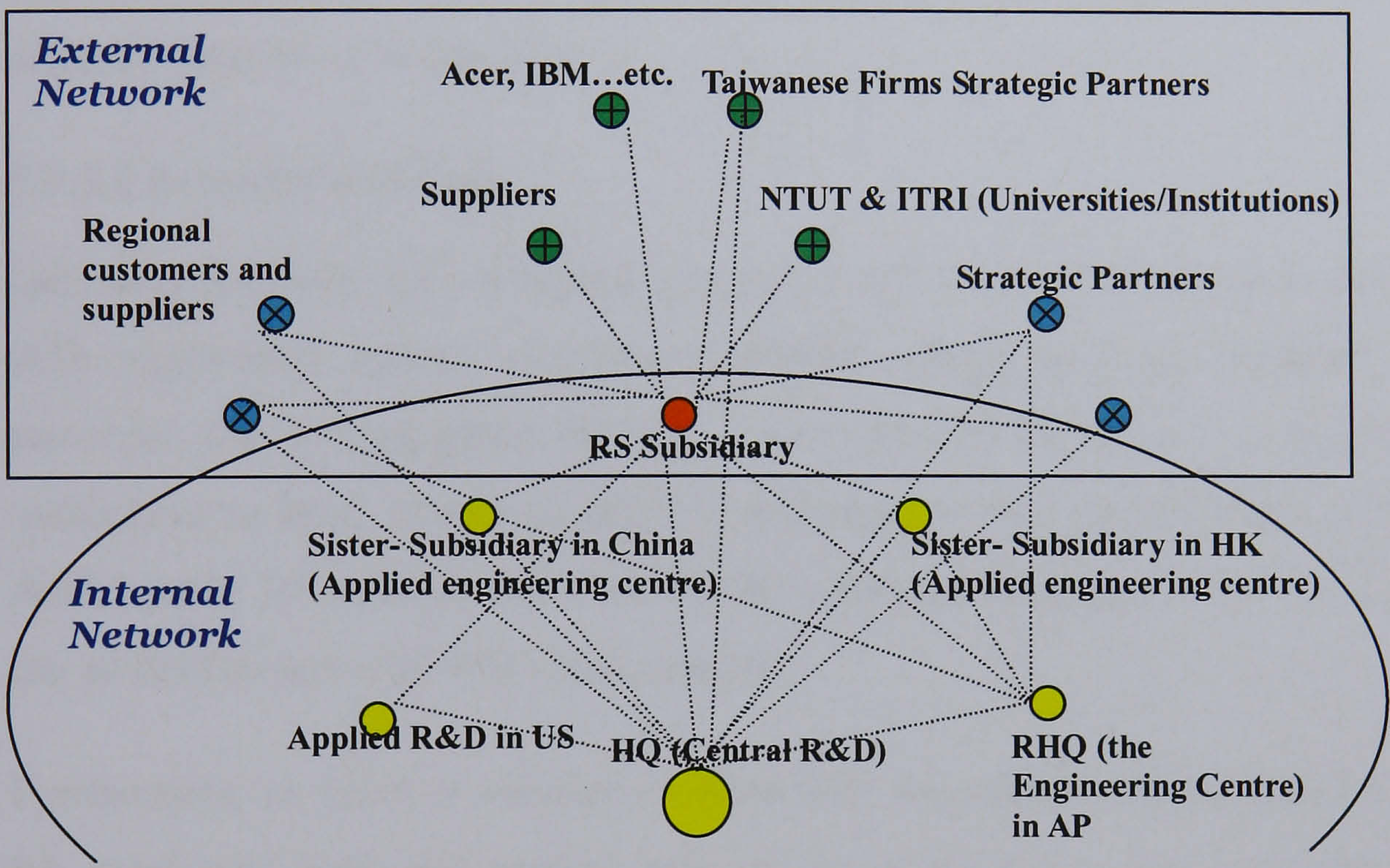

Figure 5.3 Internal and External Linkages of RS Subsidiary

5.2.3.1 Internal Network

The RS subsidiary was fully operational in Taiwan, comprising of a marketing & sales and engineering centre. Its main business activity was to develop customer relations with engineering centres to supply a variety of (system) solutions. More specifically, RS provided customers with application system solutions, using the HQ's semiconductor devices, and in association with engineering centres (applied R&D centres, showed in Figure 5.3), making customised changes and requirements. In addition, by connecting with sister-subsidiaries, RS delivered competitive customer services in the Great China region.

Given the unique expertise and capability of each engineering centre, such as Taiwan engineering centre's specialisation in PC/PC peripheral device and information appliances, RS cooperated with worldwide applied and central R&D centres (situated at the HQ, as shown in Figure 5.3) to provide highly-integrated technological system solutions for customers. Furthermore, RS engineering centre continuously developed its technological capability through R&D projects with RHQ, applied R&D in the US and central R&D HQ (see Figure 5.3) to acquire different degrees of technology.

5.2.3.2 External Network

Generally speaking, RS's assigned role was to provide local or regional customers with application system solutions; therefore, using local or regional based resources was advantageous for RS, as presented in Figure 5.3. It specifically outsourced to local Taiwanese firms to undertake locally based design activities. Additionally, RS collaborated with regional Japanese strategic partners to develop the product design with HQ's involvement.

Furthermore, in order to enhance its capability, the engineering centre of Taiwan RS conducted basic and applied research work in science and technology, for instance, in the areas of energy saving, IA application, with NTUT (a public universities) and ITRI in Taiwan.

5.2.4 Subsidiary Decision-Making Autonomy

RS's parent company started business operations on 1, April 2003, and its HQ was situated in Tokyo. It incorporated several divisions: technology sales and solutions organisations, marketing & sales and applications engineering. In parallel with the HQ, the technology sales and solutions organisations managed customer relations by providing substantial semiconductor designs, manufacturing, sales, services and supports (See Figure 5.3). Moreover, due to the fact that semiconductor application had become increasingly versatile through the recent progress of information technology (Company Published Documentation, 2004); the RHQ of the system solutions organisation was established in Singapore for efficient management of the Asian market.

In particular, the HQ decided on a clear direction for RS business and continues to provide leading-edge technological innovations in semiconductors. RS technology sales were responsible for accurately understanding customers' needs by providing end-to-end solutions from technology development. Each of the solutions organisations defined as the engineering centre focused on giving semiconductors' application development and design through the HQ's semiconductor technologies in collaboration with technology sales, and local/regional counterparts.

5.2.4.1 Financial Decisions

The majority of the financial decisions were made at the HQ. In particular, capital investment, new investment and/or annual budget decisions were obviously the domain of the HQ. Other decisions, such as on-site expenditure and/or working capital, were made in the local subsidiary, but were allocated by the HQ. Interestingly, according to a study respondent, the financial source and decisions at the RS engineering centre were made and allocated by the RHQ, although it was allowed to have certain amounts of on-site expenditure (Show in Figure 5.3).

5.2.4.2 Purchasing Decisions

As stated by the interviewee, the purchasing decisions were the domain of the HQ. Specifically, procurement related to RS's business scope (See Table 5.4) was subject to the HQ's purchasing guidelines. In principle, the HQ was the main purchasing source for RS by virtue of the unification of its procurement strategy and the facilitation of its suppliers.

5.2.4.3 HR Decisions

With respect to country differences, RS had autonomy for making HR decisions. More specifically, recruitment and training were conducted in RS with clear job-description advertisements and induction activities. It also actively evolved in national HR seminars and local industrial training courses. With regard to the promotion of personnel, the HQ retained authority for selecting the heads of department and subsidiary. The president of the subsidiary and the head of the financial department, for example, were Japanese selected.

5.2.4.4 Marketing Activity Decisions

In terms of supporting system solutions development, RS played a local autonomous role in providing customer and application specific support that was tightly linked to its marketing & sales activities. More exactly, RS serviced local customers with a close linkage back to the HQ for design and manufacturing, and with engineering centres for customised application engineering. This linkage allowed RS to link the intensity of marketing support and the nature of technological complexity.

In terms of the market scope of RS, focus was principally on the Taiwanese market, although RS also supplied 10% of sales to the Chinese market, due to the fact that a number of Taiwanese firms were situated in China. This resulted in coordination with regional sister-subsidiaries (See Figure 5.3) for the distribution of products.

5.2.4.5 Product-Development Decisions

The development of key products, for example those related to microcomputers, multi-purpose semiconductor devices and memory (Detailed in Table 5.2), was supported at each phase in the form of application engineering, design technologies, production technologies and technology marketing & sales. In this respect, RS discussed with local customers and used the global network. More accurately, it initiated the product specification with a customer and sought technological collaborations and integrations with its sister-units across the world.

> *'We (RS) customise products for Taiwanese customers, who market to the global and in turn to integrate our technology, production and design network that span the globe.'* Director of the Technology Marketing

5.2.4.6 Collaboration Decisions

RS's parent company was committed to retaining the core technologies and organised its businesses into three main categories of application products, as described in Table 5.4. This business structure allowed the hierarchical technology units to evolve a close collaboration.

More importantly, the RS subsidiary maintained autonomy through connecting its technology marketing & sales with local engineering centres and with linkages back to the HQ and other application engineering centres.

With regard to external collaboration, RS promoted local operations by providing end-to-end solutions from applied technology development. Particularly, by pursuing this business operation, one interviewee said: *'One product can be distinguished into ABCD technologies; we are best in A and B technologies, but local firms are really good at C and D, we will collaborate with them in developing the semiconductor system solutions.'*

5.2.4.7 Subcontracting Decisions

With regard to subcontracting decisions, it related to different degrees of technology developments. More specifically, advanced technology, for example relating to LSI chips was contracted out to two Japanese corporation laboratories and the decision was made by the HQ (Company Published Documentation, 2004).

On the other hand, the applied technology relating to local customer needs was pursued at the RS subsidiary. Particularly, some application designs were subcontracted out to local firms that had supplementary competences to RS. One respondent informed: '*We subcontract some application designs to local firms as long as the counterpart has a supplement capability to RS and its capability is aligned with our technology and product.*'

5.2.4.8 Change in Operational Processes

The HQ played the role of strategic planner and for defining a clear direction for the MNE, and in this regard particularly worked on a corporate mission statement, the company philosophy and strategic business planning. Accordingly, RS had little autonomy for these aspects. It focused instead on its assigned business activities, but from time to time, made suggestions on product and technology developments for local needs to the HQ. A senior director expressed the following: '*RS has won great recognition for our performance from the HQ, in turn, the HQ has always valued our proposals.*'

5.2.4.9 Technology Decisions

The HQ disclosed that in future, all sorts of different products will incorporate semiconductors and utilize them in ways that affect all aspects of our daily lives and network together to create a better way of life and intelligent chips (Company Website). In this regard, in the field where RS's parent company had many years of technology experience, the HQ reserved technology decision-making by way of selection and concentration of technology resources. RS, in turn, developed tight linkages with application engineering, design technologies, production technologies and central R&D to conduct its business operations in accordance with the HQ's technology mission statement.

5.2.5 Building Subsidiary Technological Capability

The RS subsidiary had long experience in the semiconductors industry even before the formation of the join-ventures. In particular, it had been involved in micro-computers, memories and multi-purpose IC etc through tight collaboration with global/regional technology units and applied technology centres. Table 5.5 shows a breakdown of RS's technological capabilities into marketing capability and design capability, each of which evolved internal and external linkages to fulfil business operations and technology support.

Table 5.5 Building RS Subsidiary Technological Capabilities

Type of TC / Phase	Theme	Main Processes	Internal and External Linkages	Outcome Assessments
Marketing Capability	Phase 1: *Survey*	Customer Needs and Wants	Business unites sets the product strategy with reference to the market/industrial information/trend.	Customer requirements/orders
	Phase 2: *Initiation*	• Preparation short-term products • Proposal for middle-term product developments • Precedence for long-term product developments	• Product development meeting-all range of products review with the business operation units and overseas technology marketing & sales	• Strategic products development • Business Roadmap/Plan
	Phase 3: *Definition*	• Feasibility study-technical and cost aspects • Drawing Framework/Working Sample • Project Management	• Annual product plan is reached in the product development meeting and the tasks are allocated. • Cross-levels collaborations	• Industrial standard test • Product Life-cycle Schedule.
Design Capability	Phase 4: *Design*	• Product Specifications • Design Review/Reference Sample • Procurement material, tool or pilot equipment	• Co-design with customers, sister-subsidiaries...external and internal partners. • Cross links- technology collaboration • Exploit Existing Technology • Identify and replace existing/old technologies	• Time to market • Number of Patents • Default Rate

5.2.5.1 Marketing Capability

Considering that the objective of RS MNE was to become an intelligent solution provider for the ubiquitous networking world, the parent company retained the core technologies that were the bases of its semiconductor business. Therefore, at each phase, the development of key products was supported through the production and technology unit, LSI product technology unit, three main product divisions and sales & marketing unit (Company Internal Documentation, 2004). In particular, the RS subsidiary became involved in exploring new product developments by communicating local customers' needs to the parent company and influencing the strategic product plan. Most importantly, the RS subsidiary developed a close collaboration between RS technology marketing and the engineering centre to provide customers with specific applied technology support. In essence, the RS engineering centre conducted a feasibility study with customers for semiconductor system solutions.

5.2.5.2 Design Capability

As depicted in Table 5.5, support for the design phase was provided by LSI technology and manufacturing technology in tandem with the central R&D centre to clarify the elemental technologies, as sketched in Figure 5.4. An important part of the design process was the provision of application engineering design.

In so doing, each engineering centre developed its unique expertise, capability and strategic position. For the Taiwan engineering centre, the focus was on the IT and network application segment. Its main activities were to provide system solutions to customers through a worldwide design network. One manager reported that RS had evolved joint development projects with a sister-engineering centre in Singapore and the US in terms of mobile and server application on IKAP solutions. It had also collaborated with central R&D on the development of memory products.

In addition, the RS engineering centre developed a close collaboration with one of the Taiwanese public universities, the government industrial R&D institute (ITRI) and local PC Chip set and BIOS makers.

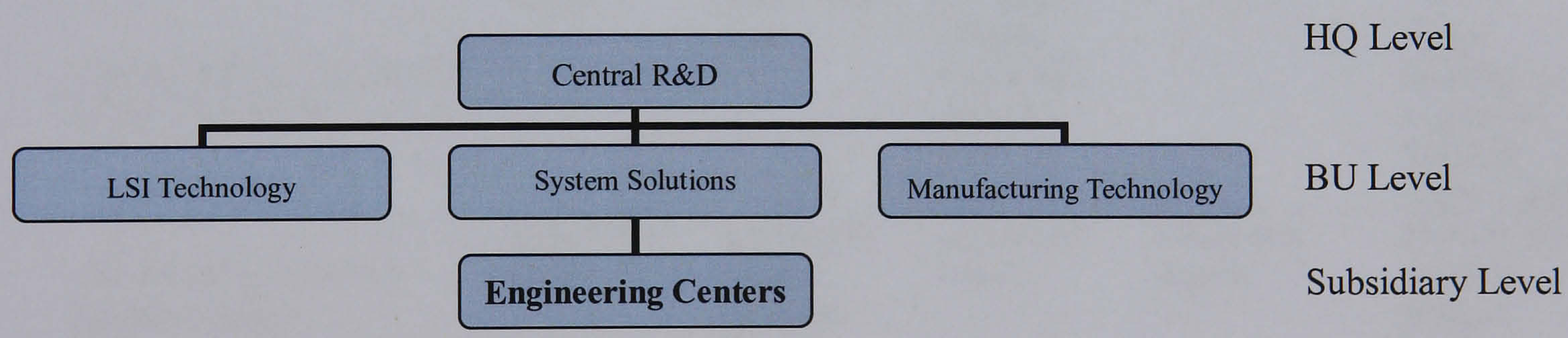

Figure 5.4 The Hierarchical R&D Organisations in RS Subsidiary

5.2.6 Subsidiary Communication Systems

In line with the network linkages of the RS subsidiary in Taiwan (Detailed in Section 5.2.3), Table 5.6 depicts a segmentation of the communication systems between the subsidiary and numerous partners internal and external to the RS networks. RS's Taiwan-based subsidiary coordinated with regional sister-subsidiaries with regard to business transfer and delivery on daily to weekly bases. Furthermore, the engineering centre of the RS subsidiary established very close collaborations with other engineering centres and central R&D in developing system solutions (application engineering products) by means of very frequent modes of communication. Other frequent communications within the RS subsidiary was with the HQ, and in particular, with the different business units. As for relationships with the customers and strategic partners, contact was maintained on a daily, weekly and monthly basis, with less frequent (monthly-quarterly-half of year) contact with local universities and research institutions.

Table 5.6 RS Subsidiary Communication Systems

Patterns of RS Subsidiary Communication	Daily	Weekly	Monthly	Quarterly	Half-Yearly
Internal Communication					
Sister subsidiaries	**Email/Telephone/Fax**	**Conference call/Net meeting**	----	----	----
Applied R&D centres (Sister-engineering Centres)	**Email/Telephone**	**Intranet**	**Intranet/ Net meeting**	**Face-to-Face meeting**	**Face-to -Face meeting**
Central R&D or the RHQ of Applied R&D	**Email**	**Conference Call**	**Personal visiting, Electronic report,**	----	**Face-to -Face meeting, Engineers training, Project report**
The HQ (For instance business units)	**Email/Telephone**	**Electronic report, Personal visiting**	**Electronic report**	**Electronic report.**	**Face-to-face meeting, Budget report,**
External Communication					
Local/regional customers	**Email**	**Telephone/ Fax**	**Personal visiting**	----	----
Local/Regional Strategic Partners	**Email**	**Telephone/ Fax**	**Personal visiting**	----	----
Local Universities & Research Institutions	----	----	**E-mail**	**Face-to -Face meeting**	**Electronic report**

5.3 Case Study 3: ST

ST was formed in June 1987, as a result of the merger between an Italian company and a French company, with a new name given to it in May 1998. Its corporate headquarters as well as the HQ for Europe and for Emerging Markets were in Geneva. The Company's US HQs were in Dallas, Texas; for AP in Singapore, while Japanese operations were headquartered in Tokyo.

ST became one of the top ten global semiconductors companies, designing, developing, manufacturing and marketing a broad range of semiconductor integrated circuits (ICs) and discrete devices (Gartner Dataquest, 2005). In particular, it had developed an unsurpassed capability to offer leading-edge solutions to customers in all segments of the electronics industry including telecommunications systems, computer systems, consumer products, automotive products and industrial automation and control systems.

ST employed approximately 50,000 people, working at 16 advanced R&D units, 39 design and application centres, 16 main manufacturing sites and 78 direct sales subsidiaries in 31 countries. In 2004, it made US$8,700 million sales globally with a distribution as follows: Europe (28%), North America (14%), Asia Pacific (49%), and Emerging Markets (9%).[10] Additionally, ST invested 17.5% of its sales revenues in R&D and capital expenditures, and filed 711 patent applications in 2004 (Company Website and Annual Report, 2004).

5.3.1 Subsidiary Background

ST Taiwan was formed in June 1990, organised into sales & marketing, application engineering, business management and was administered in association with geographical regions and product segments. More specifically, ST Taiwan lay embedded in a matrix of the AP region and product segments. The

10 This consisted of Eastern Europe, India, Africa, South America and Middle East.

sales & marketing activities were carried out by the RHQ supported by each product business, which included product development functions. The RHQ in AP provided central marketing, customer service and technical support, logistics, application laboratory and design services.

ST was fully supported by central functions, bringing all levels of management closer to the customer and facilitating communication among R&D, production and marketing & sales organisations (Annual Report, 2004).

There were approximately 150 employees in ST with sales amounting to US$ 43 millions in 2004.

5.3.2 Subsidiary Role and Development

Upon the formation of ST, the subsidiary was involved in sales and marketing activities carried out by the AP sales organisations, and collaborated with the product marketing conducted by each product division. This matrix system reinforced ST sales, marketing activities and field application engineering (FAE). In particular, its sales and marketing engineers worked directly with customers, as well as with the distributors, to meet customers' needs.

The ST subsidiary's business operations ran along product divisions through telecommunications, peripherals and automotive groups, consumer and microcontroller groups, memory products groups, and discrete and standard ICs group. However in 2005, it reorganised the business segments into application-specific groups, a memory products group and a micro, linear and discrete group (Table 5.7), for the purpose of increasing market focus and realigning the full product lines, technologies, and sales & marketing channels.

Table 5.7 Business of ST Subsidiary

Businesses (Segments)	Principle Product Groups
Application Specific	• Home, Personal and Communication: telecommunications and audio • Computer Peripherals: computer peripherals specifically disk drives and printers • Automotive Product: automotive applications
Memory Products	• Memories: application-specific memories, non-volatile memories • Smart card: phone card, SIM, pay-TV card
Micro, Linear and Discrete	• Discrete: bipolar, transistors, IGBTs, Schottky and ultrafast bipolar diodes • Standard ICs: standard microcontroller, industrial devices, programmable systems memories.

Source: Annual Report, 2004

5.3.3 Subsidiary Network Relationships

Figure 5.5 provides the simplest representation of the network of the ST subsidiary, which, from its perspective begins with the internal network in connection with RHQ in AP, HQ, R&D centres and sister subsidiaries, before moving on to the external network, depicting its local and global linkages.

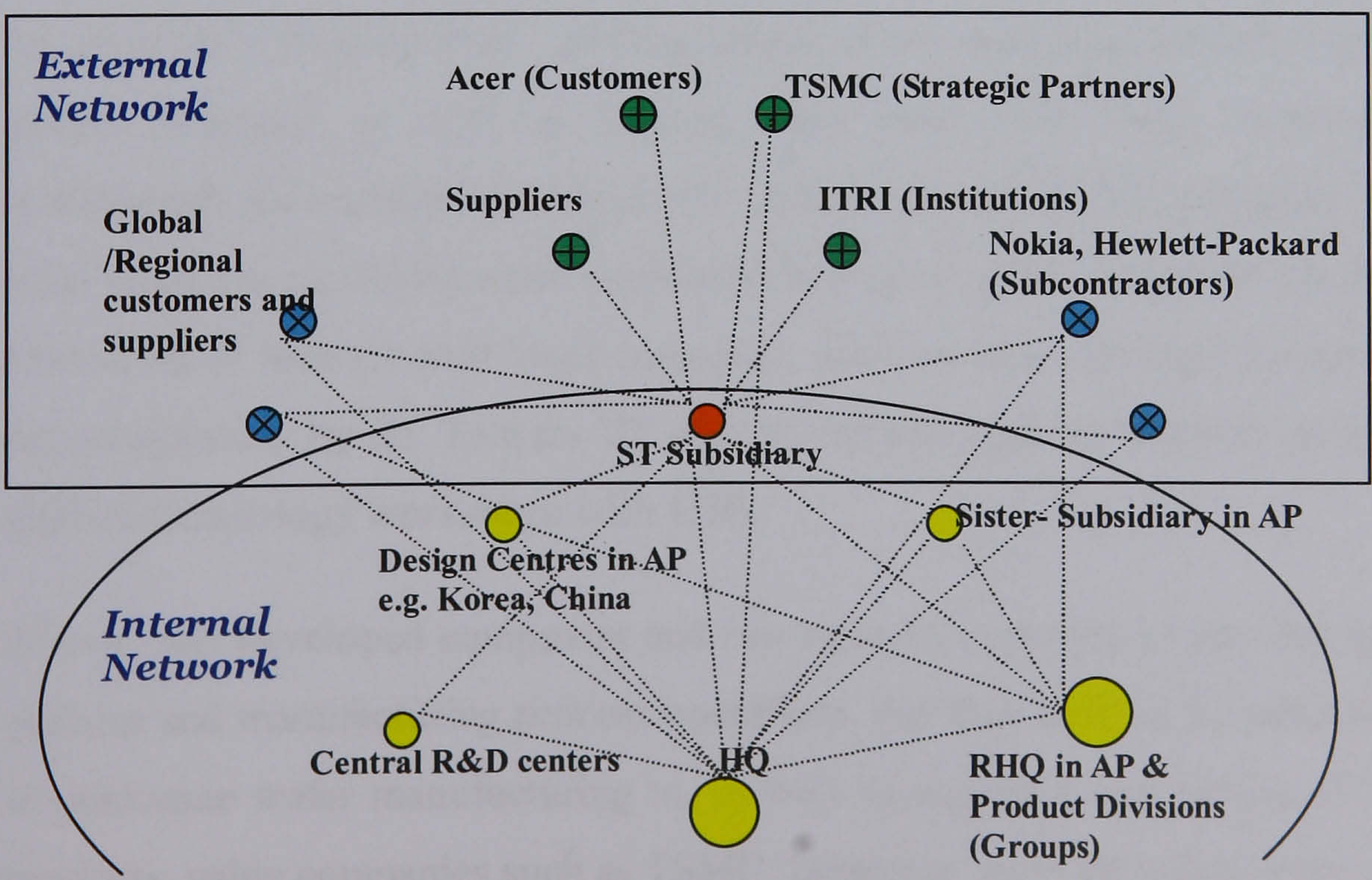

Figure 5.5 Internal and External Linkages of ST Subsidiary

5.3.3.1 Internal Network

The ST Taiwan subsidiary was an affiliation of RHQ in AP in terms of strategies and business operations. With a matrix organisational structure, ST was interacting with three main product segments/businesses and evolving communication and collaboration among central R&D centres, applied R&D divisions, and product marketing functions. Furthermore, major design centres and ST subsidiary's sales and marketing section were within close proximity of key customers. The HQ was to bring all level of management operations together and facilitate communication channels among all functions.

ST developed a close coordination and collaboration with applied R&D centres, particularly with Korean and Chinese centres, which provided an advanced range of key technological applications for the FAE. As well as connecting with sister subsidiaries in AP, European regions evolved product developments and built up customer relations.

In addition to applied R&D segments, the central R&D centre offered market driven and leading-edge products and technologies to key local customers with the assistance of the ST subsidiary.

5.3.3.2 External Network

ST acted as a 'local scanner', sending signals about changing demands back to the parent company as well as forging vital links with local customers and counterparts (as outlined in Figure 5.5). In this respect, the ST subsidiary pursued local market opportunities and exploited them on a global scale; for example, the central R&D worked with local customers, such as Acer, through introduction & communication by ST Taiwan. ST also developed applied research projects and applied technology workshops with ITRI.

ST not only developed equipment and raw material suppliers to provide front-end process and manufacturing process operations, but also built up its subcontractors to outsource wafer manufacturing to, as well as assembly and testing of finished products, using companies such as TSMC. However, these global/regional external suppliers and subcontractors were selected and managed by the HQ and/or RHQ in AP.

5.3.4 Subsidiary Decision-Making Autonomy

ST facilitated business operations along product lines, managing its revenues and internal operating income performance based on the three main product segments (See Table 5.7). Furthermore, in the AP region, each subsidiary was organised by country, managed from the RHQ and was embedded with product segments. Although the RHQ provided central marketing, customer services, technical support, logistics, application laboratory and design services for the AP region, each product segment and group conducted product development and product marketing. The following sections further illustrate the way in which a subsidiary made decisions.

5.3.4.1 Financial Decisions

ST's RHQ in AP had responsibility for central management and decisions. In particular, the RHQ allocated the working capital and on-site expenditure, although ST had authority for expenditure up to US$5000 for fixed-asset procurement, such as office equipment or small pieces of design equipment.

In addition to working capital and on-site expenditure, investment in applied engineering design was regarded as product development and made by each of the product segments. Therefore, ST had very limited autonomy for making capital investment decisions.

5.3.4.2 Purchasing Decisions

The purchasing involvement in the ST subsidiary was mainly related to sales & marketing. More specifically, the RHQ issued purchasing guidelines on the front end process, e.g. office stationery, and engineering testers, etc. for regional subsidiaries or offices.

In terms of the subsidiary's purchasing source, ST product segments (See Table 5.7) were the only sources for purchasing business products.

5.3.4.3 HR Decisions

HR decisions were very much aligned with the parent company's HR guidelines on manpower recruitment, training and promotion. However, reflecting country HR practice, the subsidiary had more autonomy for making HR decisions, particularly in terms of local recruitment, local salary and local training programmes. One manager stated that both promotion and expatriation were consolidated on the RHQ and product segments.

5.3.4.4 Marketing Activity Decisions

In respect of leveraging marketing strategy, the ST subsidiary carried out marketing activities with the RHQ and product segments, particularly with regard to product development. More exactly, ST strengthened its local experience and knowledge involving product development in the AP region and also collaborated with the European region to build market share in its targeted market segments, such as computer peripherals, automotives, etc.

Furthermore, ST was involved in the ST MNE logistic supply network, particularly in expanding customer databases and logistic support, with the focus on demand generation for new and existing applications, as well as on promotion of complete systems solutions.

5.3.4.5 Product-Development Decisions

A diversified product portfolio and a wide range of application products were built through general consensus in different product segments, and in this regard, every aspect of product-development decision-making was affected. Initially, the jobs of the product development were allocated into appropriate units. More precisely, product development began with the product specification phase before moving on to design through silicon publication and verification, which was then followed by dispersed technical centres (FAEs) collaborating with customers with regard to customised design. Hence, ST collaborated with other R&D sister-units on product-development.

5.3.4.6 Collaboration Decisions

As a consequence of ST being embedded in a matrix of RHQ and product segments, it developed cross-level and functional collaborations. This collaboration on product development was carried out by the product segments in association with affiliated subsidiaries such as applied R&D and FAE units.

Furthermore, the HQ established communication channels to introduce different levels of collaboration. In particular, the HQ and RHQs evolved several external collaborations with international semiconductor partners, such as Nokia, Hewlett-Packard, and Philips, etc. with the purpose of providing valuable systems and application know-how for joint technology development.

5.3.4.7 Subcontracting Decisions

Decisions regarding external subcontractors' were centralised at the HQ, which focused on outsourcing wafer manufacturing and assembly as well as the testing of finished products with local firms, such as TSMC.

5.3.4.8 Change in Operational Processes

The ST subsidiary had a relatively limited power in this regard. The HQ was committed to maintaining and increasing expenditure on core research and development projects as well as to integrating a manufacturing infrastructure capable of producing silicon wafers. The parent company, HQ or RHQ also developed relationships with outside contractors for foundry and back-end services, and enabled ST MNE to manage the supply chain to customers without a commensurate increase in capital spending (Company Internal Documentation, 2004).

5.3.4.9 Technology Decisions

One director stated, '*This is a very big decision for me which I like very much, but I need to get permission from my boss* [the head of product segment] *and the top* *executive* [the head of RHQ].' The general technology decisions were carried out by each product segment and RHQ in accord with product and sales & marketing channels.

5.3.5 Building Subsidiary Technological Capability

ST subsidiary's technological capability was built through technology exploitation and exploration in the central R&D centres and applied R&D units in product segments. In particular, the ST subsidiary evolved marketing and design capabilities embedded in a matrix structure of the RHQ and product segments and groups. The development of design capability, discussed in the following sections, had an especially strong internal intervention. Table 5.8 outlines key activities with regard to technological capabilities developed by ST.

Table 5.8 Building ST Subsidiary Technological Capabilities

Theme Type of TC / Phase		**Main Processes**	**Internal and External Linkages**	**Outcome Assessments**
Marketing Capability	Phase 1: ***Survey***	Customer Needs and Wants	RHQs and Product segments sets the product strategy with reference to the market trend.	Customer requirements/orders
	Phase 2: ***Initiation***	• Preparation short-term products • Proposal for middle-term product developments • Precedence for long-term product developments	• Product development meeting-all range of products review with the product segments and RHQs.	• Strategic products development • Business/Product Roadmap/Plan
	Phase 3: ***Definition***	• Feasibility study-technical and cost aspects • Drawing Framework/Working Sample • Project Management	• Clarify product definition with customers • Annual product plan is reached in the product development meeting and the tasks are allocated. • Cross-levels collaborations	• Industrial standard test • Product Life-cycle Schedule.
Design Capability	Phase 4: ***Design***	• Product Specifications • Design Reference Sample	• Major design made by product design centre • Cross links- technology collaboration • Co-design with customers, • Exploit Existing Technology • Identify and replace existing/old technologies	• Time to market • Number of Patents • Productivity Index, e.g. sales of volume

5.3.5.1 Marketing Capability

Corporate policy in the field of research and development was market-driven; therefore, each applied R&D unit affiliated to each product group developed close collaborations with local sales & marketing and FAE units. More specifically, in terms of developments of a new product, ST's product segments started by ensuring that its technology portfolio was in line with identified market trends in each product group. Then the local FAE was employed to define the specification with the customers.

In addition to developing new products, ST was involved in sales activities, in particular, fulfilling orders and gathering market information, which was mainly governed by the RHQ.

5.3.5.2 Design Capability

ST's R&D activities focused principally on the very large scale integration (VLSI) technology platform, new systems architectures, new product developments and emerging technologies in microsystems, nanotechnologies and photonics (Annual Report, 2004). These developments of the technology platform and new systems architectures were conducted by worldwide central R&D centres. New product R&D was conducted within each product group (such as telecommunication, peripheral and automotive) in conjunction with customers' needs. In particular, the local FAE was involved in minor and/or major design in defining and design phases of product developments in association with the product range.

For application specific products, a significant amount of proprietary endeavours was involved with the different hierarchical R&D units, such as, the central R&D, the applied R&D, and FAE (Showed in Figure 5.6). In particular, the FAE was involved in developing a design reference framework with local customers in collaboration with applied R&D units. In addition to application specific products, investment in standard products was made to fulfil particular purposes; thus, ST provided limited technical support and customer service.

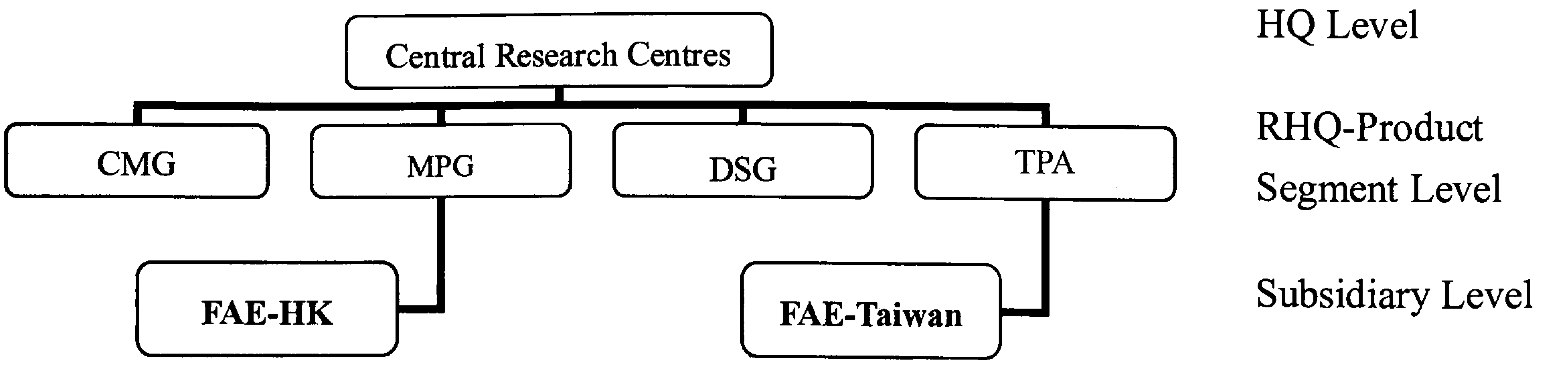

Figure 5.6 The Hierarchical R&D Organisations in ST Subsidiary

5.3.6 Subsidiary Communication Systems

Table 5.9 shows a breakdown of ST communication systems between the ST subsidiary and various groups both internal and external to the network. The ST subsidiary lay embedded in a matrix of RHQ and product segments, with very regular (both daily and yearly) communication with RHQ on the business operation and sales activities, necessary to coordinate product segments at product marketing and product development levels. Furthermore, the field engineering section of the ST subsidiary evolved a close collaboration by means of personal visits to design centres, applied R&D and central R&D centres, and also developed different modes of cooperation with the regional sister subsidiaries in business operations. In addition to internal linkages, ST established local links with customers, universities and local research institutions, by using engineer visits, seminars and workshops, etc.

Table 5.9 ST Subsidiary Communication Systems

Patterns of ST Subsidiary Communication	Daily	Weekly	Monthly	Quarterly	Yearly
Internal Communication					
Sister subsidiaries	Email/Telephone/Fax	----	Conference call/Net meeting on business management	Conference call-Business operational sharing.	Face-to-Fac meeting
Design Centres in AP or other applied centres in product segments	Email/Telephone	Personal visit particularly engineers visiting	Intranet/ Net meeting	Project report	Engineers training
Central R&D	Email	Conference Call	Personal visit, Electronic report,	----	Advance engineering training
The RHQ or HQ	Email and telephone	----	Intranet-business operational reports	Intranet-HR expense reports	Face-to-face meeting and Budget reports
External Communication					
Local Customers	Email/Telephone	Personal visit	Personal visit	----	----
Local/Regional Subcontractors or Suppliers	----	----	Personal visit	----	----
Local Universities & Research Institutions	----	----	E-mail/Seminars	Seminar or workshop	Conference

5.4 Case Study 4: MT

MT was founded at Yahata City in 1949 and was involved in the manufacture and sale of dyes. After the 1970s, the proportion of IC-related business grew rapidly, and the company took a further step towards globalization by including affiliated firms. MT changed its name in 1984, whilst remaining headquartered in Kitakyushu, Japan and started IC assembly operations.

MT was the world's foremost supplier of lead frames for ICs. Since its foundation, MT had evolved the philosophy of a corporation into the "root of technology", growing a trunk of "precision technology base" and spreading leaves. In particular, it had been producing various products centred on an "ultra-precision technology base" as the fruit of its efforts to improve and complete the education and personnel management systems that backed up the advancing technological developments.

MT manufactured and sold dyes that were unrivalled anywhere for durability and precision, and put the same expertise to work in a successful line-up of machine tools. MT built up its manufacturing and sales & marketing facilities with 30 affiliates in more than 13 countries around Asia, Europe, Africa, and USA, serving customers through an international network.

MT had approximately 3000 employees, and enjoyed annual sales in excess of US$3563 million in 2004 (Annual Report, 2004 and Company Website).

5.4.1 Subsidiary Background

Established in 1998, the MT subsidiary was located in Kaohsiung, Taiwan. It had chosen Taiwan for IC assembly manufacturing, in particular for its manufacture of lead frames for the leading chip-scale integrated circuit package, such as the Micro Ball Grid Array (μBGA), ChipMOS and involving sales & marketing of IC lead frames. As the General Manager articulated, *'Since MT have a number of customers in Taiwan, the parent company decides to set up MT Taiwan to provide* *very efficient services to our customers.'* The HQ had initially identified MT Taiwan's main function as serving a local production provider.

Within the MT subsidiary, the general management board was given responsibility for operations and decision-making, which consisted of a group of senior managers including one senior director from the parent company, one president, one general manager and one sales & marketing manager from the subsidiary.

MT Taiwan employed around 50 people, and annual sales amounted to US$71 million in 2004.

5.4.2 Subsidiary Role and Development

The role of the MT subsidiary changed along with its in-house capability. MT began as a trading company selling the products of the parent company (Detailed in Table 5.10). It then gradually developed its assigned operational role with regard to manufacture and sale of IC leadframes and IC assembly in particular, as well as sale of precision tooling and some other machine tools for the parent company.

At the initial phase in the development, MT transferred 90% of equipment and technologies relating to IC assembly and leadframes from the HQ to the subsidiary. The elite group of MT subsidiary engineers, who were fully trained at HQ, quickly implemented the HQ's technologies and set up equipment on-site. In 1999, it began to produce low-end and IC leadframe simple pins for the MNE. In 2000, MT started making profits for the parent company, continuously exploiting the in-house capability. In 2003, MT developed a newly applied IC leadframe product using its in-house capability for local customers, attaining annual sales of US$18 million. As the General Manager stated:

> *'Over the past few years of the MT subsidiary, we had mainly relied on the parent company and sister subsidiaries for acquiring technology and components. Since 2003, we have exploited our in-house capability and upgraded our production technology to more sophisticated and higher level IC leadframes and assembly. We are fully prepared for our future*

performance; additionally, a new capital investment will increase the manufacturing capacity and bring more profits in the next few years.'

Table 5.10 Business of MT Subsidiary

Businesses (Segments)	Principle Products
IC Assembly	• Leaded packages like QFP, SOIC and TSOP, and no-lead packages QFN and SON, • Customised BGA packages, with thicknesses ranging from 2.1mm to 0.9mm.
IC Leadframes	• Standard frames ranging from 8 to 240 pins • Stamped from ferro-nickel alloy 42, or copper alloys.
Precision Tooling and Parts	• Motor core dyes • Leadframe dyes • Mold dyes • Trim and form dyes • Ceramic punching dyes
Machine Tools	• Manual • Semi-Automatic • Automatic • Computerised Numerical Control (CNC)

Source: Company Website

5.4.3 Subsidiary Network Relationships

Figure 5.7 shows the internal and external network linkages of MT subsidiary in Taiwan. In particular, it begins by investigating the internal linkage from the MT subsidiary perspective, and then follows on by indicating its external linkage both locally and regionally, as elaborated in the following sections.

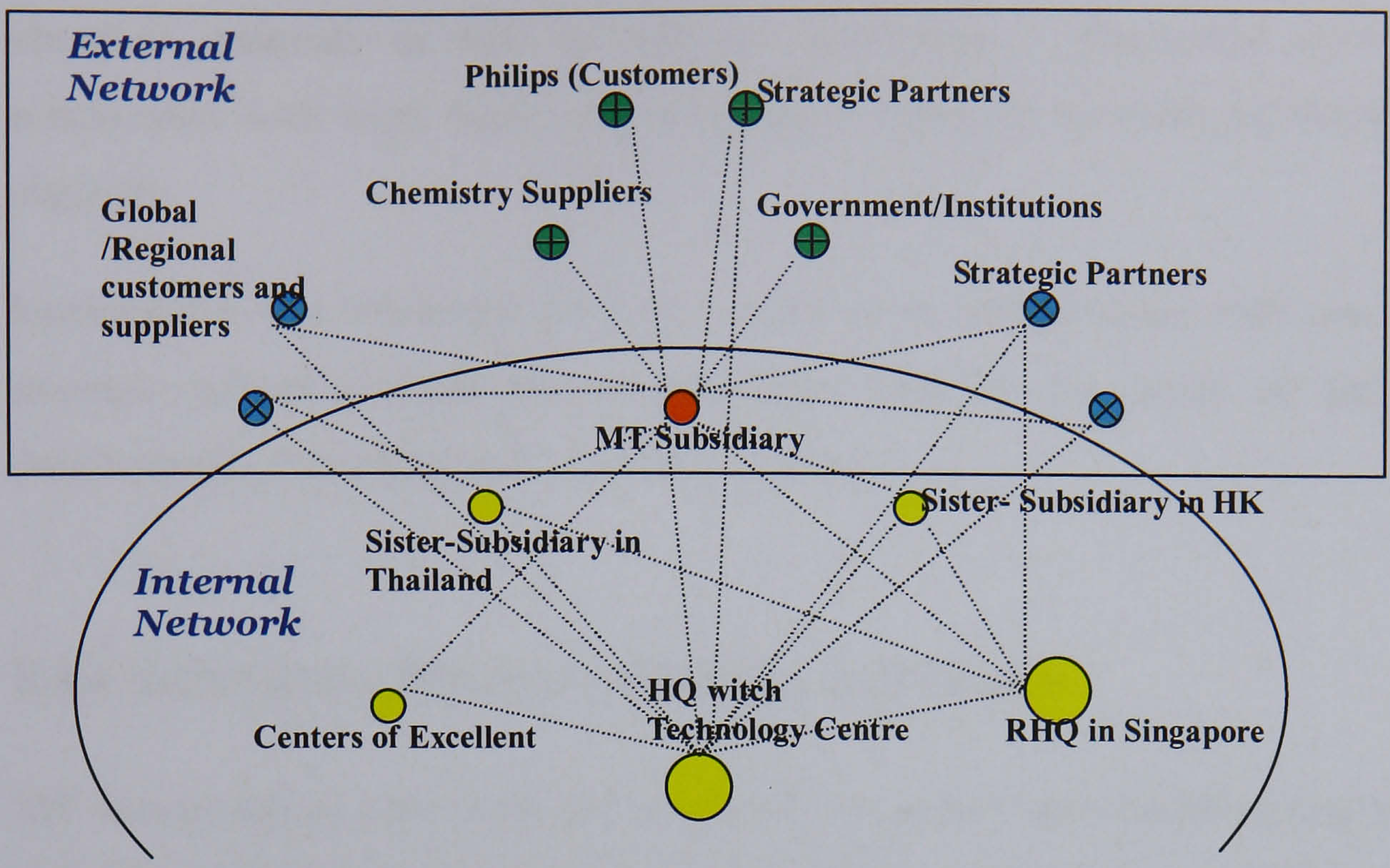

Figure 5.7 Internal and External Linkages of MT Subsidiary

5.4.3.1 Internal Network

Since MT's establishment, it has been involved in the marketing, sales, manufacture and assembly of IC leadframes, as outlined in Table 5.10. Regarding marketing & sales activity, MT developed a close collaboration between different groups, such as the sister-subsidiary in Hong Kong (HK), the RHQ in Singapore and the HQ, especially in terms of product developments and product allocations.

Furthermore, the subsidiary associated with a technology centre to resolve on-site technical problems. As well as continuously learning advanced production technology with centres of excellence in Japan, MT moved towards middle-and high-end production, transferring low-end engineering and production technology to its regional subsidiaries, and becoming involved in delivering related expertise.

5.4.3.2 External Network

MT subsidiary had built up a good relationship with the Taiwanese government with regard to import and export products and financial issues. It also actively involved Taiwan's semiconductor community in sharing industrial knowledge and development. The local supplier played a relatively important role in providing chemical materials to MT, as well as developing a trustworthy customer relationship with local firms, providing good customer services and technical supports.

Furthermore, the subsidiary evolved a very close collaboration with one key strategic partner-international semiconductor firm in the areas of product development, technology and knowledge sharing.

5.4.4 Subsidiary Decision-Making Autonomy

MT was an independent high-tech subsidiary organised into manufacturing plant and sales & marketing sections. Its crucial decision-making in accordance with corporate strategy was undertaken by the general management board. Furthermore, MT subsidiary developed close sales & marketing links with sister subsidiaries in the East–Asia Block headed by the RHQ in Singapore. The HQ was also involved in subsidiary operations, particularly in the areas of finance, technology and core-strategies, as detailed in the following sections.

5.4.4.1 Financial Decisions

In MT, the most crucial financial decisions, particularly in terms of capital investment decisions, were made at HQ. However, the general manager stated that '*The HQ has been very much supportive of capital investment plans in the past few years*', and in this regard, MT was permitted to decide its on-site expenditure and working capability up to an amount of US$40,000.

5.4.4.2 Purchasing Decisions

The manufacturing tools used by MT in the back-end process, including grinders and other specialised equipment, were purchased from the parent company. In addition, the manufacturing processes used many raw materials, including leadframe, mold and ceramic packages, which were delivered from the HK sister subsidiary.

However, MT developed a long-term local supplier relationship to provide chemicals for the manufacturing process, devolving some of its purchasing autonomy to achieve this.

5.4.4.3 HR Decisions

HR decisions were made largely by the general management board in MT subsidiary. In particular, HR practice was carried out by the MT subsidiary, devolving recruitment, salary scheme and personnel promotion. However, the training programmes, especially for senior engineers, were undertaken in the centres of excellence in the parent company. In addition, the decision to promote senior managers was made at the HQ. Interestingly, three out of four members in the general management were Japanese appointments.

5.4.4.4 Marketing Activity Decisions

In MT, the strategic marketing position, particularly with regard to core-product development and market scope, was managed from the RHQ in Singapore. The regional logistic distribution was delegated to MT subsidiary and involved sister-subsidiaries in HK, Thailand and Philippines, both of which supported each other in the sales and marketing activities. In particular, MT preserved autonomy for developing local customer relations, fostering close collaboration with regard to product development.

5.4.4.5 Product-Development Decisions

MT manufactured and marketed a range of IC assembly and leadframes products using different engineering and processes to produce standardised and customised products. More specifically, decisions regarding the standardisation of products were included in the product development remit made at RHQ and HQ, resulting in relatively low decision-making autonomy for MT in this respect. In terms of customised products, MT was permitted to collaborate with customers and to satisfy customers' needs by making product decisions on-site with customers.

5.4.4.6 Collaboration Decisions

One manager stated that '*autonomous collaboration with regional subsidiaries allowed MT to share some process technologies and manufacturing infrastructure, and in this regard, permitted costly manufacturing resources to be shared to mutual advantage for joint manufacturing technology development.* '

In accordance with the mission of the parent company HQ, it was essential to develop a close collaboration with key-customers, and to that end, MT subsidiary was provided with access to markets, sharing some of the risks of product development.

5.4.4.7 Subcontracting Decisions

As the parent company HQ had considerable expertise in IC production serving as the world's foremost supplier, it identified its global business scope and established long-term subcontracting partners in the home country. In this regard, the HQ actively integrated its international resources, particularly with regard to process technology and manufacturing capacity, so as to closely serve customers through collaboration with core-customers in order to achieve the best synergy and profit. Accordingly, subcontracting decisions were mainly centralised, as one senior manager stated:

> *'The parent company has built on long-term and trustworthy external subcontractors in Japan since MT started operations.'*

5.4.4.8 Change in Operational Processes

With regard to MT's decision-making process, the general management board in MT subsidiary decided on its subsidiary operational development, which accorded with the strategy of the parent company. One manager from the general management board asserted:

> *'Any new operational development can result in a good synergy of the East-Asia block; it will be appreciated by the MT MNE.'*

5.4.4.9 Technology Decisions

Since the foundation of MT, various products had been made which were based on "ultra-precision technology" as the fruit of efforts to improve and complete the education and personnel management systems in order to back up the advanced capability in technology (Company Website). In accordance with the corporate philosophy pertaining to technological development, MT subsidiary deployed its technology resources under the 'High-tec Tree'.[11] Thus, technology was rooted in the parent company and exploited by the MT networks. One senior manager stated:

> *'If decisions about new technology can provide the best results in a technology synergy of the MT network, we will persuade the HQ to invest in the project.'*

5.4.5 Building Subsidiary Technological Capability

Table 5.11 shows two types of technological capability existing in MT. While most of MT's products were customer-made to order, there were also a number of standardised products. Customer information was essential before deciding on specifications or drawing up designs. The sharing of such information was integrated with the production system and technology innovation to provide 'high-quality and accurate' products to MT customers. The next two sections consider the technological capability of MT.

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[11] This metaphor refers to technologies that accumulate under various education and personnel management systems, becoming forms of nutriment, absorbed by a tree through the 'root of technology'. This tree has as its trunk a 'precision technology base', which facilitates the spread of leaves, essential for the bearing of fruit, the company products (Company Website).

Table 5.11 Building MT Subsidiary Technological Capabilities

Type of TC / Phase		Main Processes	Internal and External Linkages	Outcome Assessments
Marketing Capability	Phase 1: ***Survey***	Customer Needs and Wants	The HQ sets the product strategy with reference to the customers and market	Customer requirements/orders
	Phase 2: ***Initiation***	• Preparation short-term products • Proposal for middle-term product developments • Precedence for long-term product developments	• Product development meeting-all range of products review with the business segments • Worldwide Technology innovation supports	• Strategic products development • Business/Product Roadmap
	Phase 3: ***Definition***	• Feasibility study-technical and cost aspects • Drawing Sample	• Annual product plan is reached in the product development meeting and the tasks are allocated to each site • Cross-levels learning new technology	• Industrial standard test • Scheduling time
Production Capability	Phase 5: ***Production***	• Pilot production • Production Management • Continuous improvement process	• Collaboration with internal and/or external links on engineering and process.	• Yield rate • Capacity Production Index (CPK)

5.4.5.1 Marketing Capability

In terms of demand, MT subsidiary made standardised and custom-made products. In particular, customer-made products required customer information to establish specifications and to draw up samples, which provided the basis for the design phase, the most advanced of which was undertaken in Japan and/or the US.

With regard to standardised products, sales & marketing in MT subsidiary worked with HQ's strategic product planning and technology innovation to understand customer needs and identify the market trend for the purpose of creating brand-new or 'upgraded' products in collaboration with worldwide manufacturing plants. MT was assigned to the production of new or existing 'standardised' products accordingly.

5.4.5.2 Production Capability

In the production phase, *'This sharing of information [from the client] may have some difficulties, for example, with shared information from a client as to what kind* *of IC is necessary; we then can produce either an IC or an IC leadframe'*, commented an MT senior manager. This phase of production often involved in engineering and processes collaborations with the internal and external network linkages.

More specifically, the manufacturing tools used by MT, such as stamping and photo etching and other specialised equipment, came from the parent company. During manufacturing processes, a large number of raw materials were used, including leadframes, ceramic packaging and chemicals, etc. Overall, 80% of raw materials were acquired from the HK sister-subsidiary, the remainder being obtained from Japan and/or local suppliers.

In terms of engineering collaboration, the elite of the engineering group started up the manufacturing plant when MT was established. This group worked very closely with the centre of (manufacturing) excellence on problem-solving and technical innovation, leading to an accumulation of in-house technical knowledge in MT. In the words of one respondent:

> *'Recently, we have succeeded in manufacturing a 'high-pin' IC leadframe product for small and complex chips using our accumulated engineering and manufacturing knowledge.'*

5.4.6 Subsidiary Communication Systems

Table 5.12 displays a breakdown of the mode of communication systems between MT subsidiary and various groups' internal and external networks. It shows the internal communication by sister subsidiaries, the centre of excellence, the technology centre and HQ/RHQ. MT fostered frequent communication with the centres of excellence and technology in the form of personal visits and/or other means of communication.

In addition, MT built up regular communication with local customers, institutions & government and local/regional suppliers and strategic partners using different means to exchange information and acquire knowledge.

Table 5.12 MT Subsidiary Communication Systems

Patterns of communication used by MT Subsidiary	Daily	Weekly	Monthly	Quarterly	Half -Yearly
Internal Communication					
Sister subsidiaries	**Email/Telephone/Fax**	----	**Material report**	----	**Face-to-Face meeting**
Centre of Excellence	**Email/Telephone/Fax**	**Personal visiting particularly engineers visiting**	**Personal visit or On-site training**	----	**Engineers training**
Technology Centre	**Email/Telephone/Fax**	----	**Personal visit**	----	**Technology meeting**
HQ or RHQ	**Email and telephone**	----	**Personal visit Operational report**	----	**Budget meeting & reports**
External Communication					
Local Customers	**Email/Telephone**	----	**Personal visit On-site collaboration**	**Project report**	----
Local Institutions & Government	----	----	**E-mail/Seminars**	**Seminar or workshop**	**Conference**
Local/Regional Supplier	**Email/Telephone/Fax**		**Material report**	**Personal Visit**	
Local/Regional Strategic partners	**Email/Telephone/Fax**	----	**Personal visit**	----	----

5.5 Case Study 5: HT

Founded in 1910, HT was a leading global electronics company with headquarters in Tokyo, Japan. The company offered a wide range of systems, products and services in market sectors, including information and telecommunication systems, electronic devices, power and industrial systems, digital media and consumer products, high functional materials and components, and other services.

In 2004, HT formulated a new 3-year medium-term management plan and reshaped its business portfolio into 7 product segments, as depicted in Table 5.13. The HQ further integrated management at the corporate level in order to improve the overseeing of Group company management[12] in parallel with product segments (Annual Report, 2004).

Table 5.13 Businesses of HT

Businesses (Segments)	Principle Products
Information & Telecommunication Systems[(a)]	Systems Integration, Software, Disk Array Subsystems, Hard Disk Drives, Servers, Mainframes
Electronic Devices[(a)]	LCDs, Semiconductor Manufacturing Equipment, Testing and Measurement Equipment, Medical Electronics
Power & Industrial Systems[(a)]	Nuclear Power Plants, Thermal Power Plants, Hydroelectric Power Plants, Industrial Machinery and Plant Construction, Automotive Products, Construction Machinery, Elevators, Escalators, Rail Vehicles, Air-conditioning Equipment
Digital Media & Consumer Products	Optical Disk Drives, TVs, Mobile Phones, LCD Projectors, Room Air Conditioners, Refrigerators, Washing Machines, Batteries, Video Tapes, Information Storage Media
High Functional Materials & Components	Wires and Cables, Copper Products, Semiconductor-related Materials, Printed Wiring Boards and Related Products...etc.
Logistics, Services & Others	General Trading, Transportation, Property Management
Financial Services	Loan Guarantees, Insurance Services, Leasing

(a): They are main business functions in HT subsidiary.

Source: Annual Report, 2004

[12] There are 10 group companies: High-Technologies, Medical, Construction Machinery, Plant Engineering Construction, Maxell, Chemical, Metals, Cable, Transport System and Capital.

In 2004, the MNE had approximately 1000 companies and subsidiaries around 23 countries and employed 347,424 staff, the highest headcount being in information & Telecommunication Systems and Power & Industrial Systems. The annual revenues totalled US$84,365 million across a global distribution: Europe (7.86 %), North America (9.99%), Asia (15.58%), Japan (63.69%) and other Areas (2.87%).

High-Tech Corporation

High-Tech Corporation was an integrated organisation that developed manufactured, marketed and serviced equipment and systems in the emerging field of technology. It consisted of 37 firms to promote its position on a global scale along with product segments. In 2004, the annual sales amounted to US$8,756 million for electronic device systems (24.47%), information system & electronic components (33.07%), life science (8.96%) and advanced industrial products (33.50%).

5.5.1 Subsidiary Background

HT subsidiary, established in 1967, was one of the earliest foreign High-Tech firm in Taiwan, which consisted of sales & marketing, technical support centre, electronic device & components manufacturing plants.

In 2003, with China's increasing economic development, the subsidiary, consisting of operational management, sales & marketing and an electronic devices manufacturing plant, was integrated into the East-Asia (Great China) block, becoming affiliated with other business segment operations in Taiwan.

The subsidiary had 1300 employees in total, around 1200 of whom worked in the electronic device for liquid crystal displays (LCD) manufacturing plant. The subsidiary enjoyed annual sales amounting to US$ 196 million in 2004.

5.5.2 Subsidiary Role and Development

Subsidiary business development changed along with the development of the Mainland Chinese market and the evolution of the electronics industry in Taiwan.

From its foundation onwards, it manufactured mainly low-end electronic devices for TV, before moving on to manufacture liquid crystal molds (LCM) and LCD.

In the 1970s, it brought in all the components manufactured at the plant before shipping the products abroad. In the 1980s, it began to carry out technical design and production on 5-8 inches and 12.1 inches of LCD. Meanwhile, the country operational management office, especially in the sales & marketing and international procurement sectors, were set up in Taipei. Today, it has co-developed its MNE network, using the parent company's patented technology such as Super-IPS (In-Plane Switch) for LCD production, 40-50% of products being supplied to Asia market, the rest being distributed worldwide.

In addition to the manufacture of LCD, HT subsidiary was also responsible for the sales & marketing of power & industrial systems, information systems and electronics device & components (detailed in Table 5.13), as well as for building up customer relations with product segments.

5.5.3 Subsidiary Network Relationships

The following section explores internal and external subsidiary networks. From the HT subsidiary perspective, Figure 5.8 provides an overall picture of the HT network relationships. The internal network is then discussed before an examination of the nature of HT subsidiary's external network relationships.

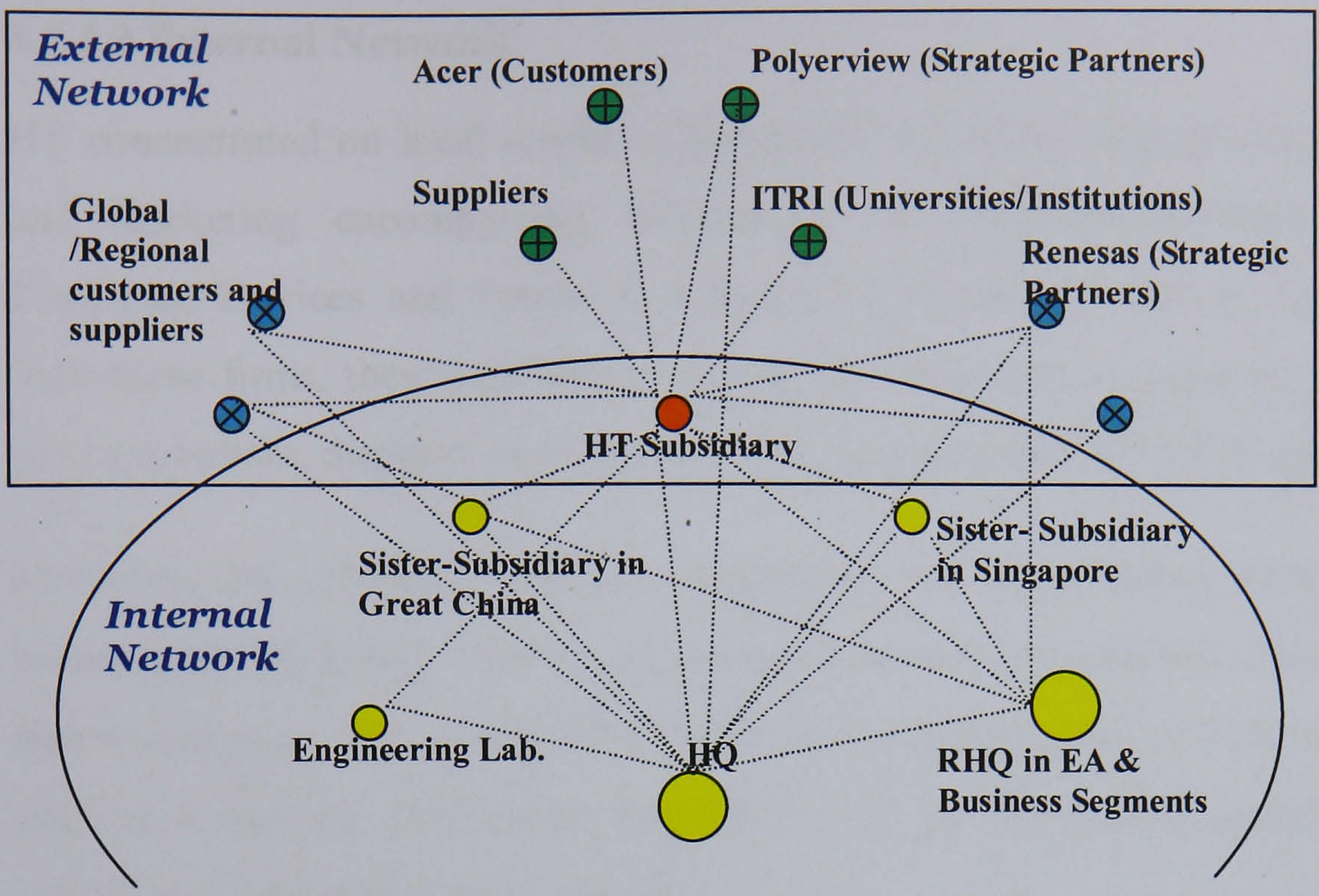

Figure 5.8 Internal and External Links of HT Subsidiary

5.5.3.1 Internal Network

Taiwan subsidiary was the 'hub' of the HT East-Asia (EA) block and was linked to Great China in terms of business operations. In particular, HT interacted with three main product segments, having responsibility for the local procurement of personal computer products for the business operations around the world. Furthermore, it was involved in a business operational coordination with sister-subsidiaries in Great China, [13] for the purpose of serving regional customers.

In addition, HT manufacturing plant developed a close collaboration with the production engineering research laboratory working on the development of advanced manufacturing techniques and process management improvement.

[13] Great China includes Hong Kong, Mainland China, and Taiwan.

5.5.3.2 External Network

HT concentrated on local market development by taking charge of coordination and marketing encompassing Information & Telecommunication Systems, Electronic Devices and Power & Industrial Systems. As well as calling upon Taiwanese firms, they were able to supply products such as personal computers, semiconductors, displays, and digital media systems to the HT MNE networks.

Moreover, the subsidiary played a significant role in gathering Taiwan market information regarding Taiwan High-tech industrial developments back to the parent company, particularly with regard to the introduction of Acer with which built up a regional distribution agreement with the information system business operation (Company Internal Report).

In addition, HT sponsored ITRI to develop advanced industrial research as well as to participate in regular conferences on Taiwanese industrial development.

5.5.4 Subsidiary Decision-Making Autonomy

In association with HT China/East Asia block and different business segments (shown in Table 5.13), the HT subsidiary coordinated the responsibility of business developments with its internal network, and collaborated with its business functions, such as sales & marketing, design, and manufacturing. Specifically, this meant executing business plans made by active business departments at the subsidiary, as well as joining projects by business segments. In addition, the HT subsidiary provided information consulting services in various aspects of Taiwanese law, investment environments for the HT parent company and business segments. The following were some key-indications of the degree of autonomy for decision-making enjoyed by the HT subsidiary.

5.5.4.1 Financial Decisions

In terms of financial sources, the RHQ in EA block provided working capital and expenditure to the HT subsidiary. The subsidiary had permission to decide upon working capital of US$30,000.

Capital investment decisions were made at HQ. One manager stated, '*In 2002, HT corporate withdrew US$1 billion investment in expanding the Taiwanese manufacturing plant, because the HQ had re-allocated its regional resources.*'

5.5.4.2 Purchasing Decisions

With regard to purchasing decisions, the HT manufacturing plant purchased key LCD components from the parent company. In addition, it established a local procurement network, although the purchasing decision was mainly the domain of the High-Tech corporation in the EA block.

Furthermore, the global procurement department in the HT subsidiary was involved in acquiring substantial Taiwan high-technological market information and forwarding proposals to the parent company as well as delegating local strategic procurement activities.

5.5.4.3 HR Decisions

HT subsidiary initially referred to the corporate philosophy of recognising the value of human resources. It had been guided by a corporate HR strategy with national specifications, and in particular, recruitment and training developments were undertaken in the subsidiary.

Nonetheless, the RHQ and HQ retained the power to decide the head of the subsidiary, and to review the heads of subsidiary departments.

5.5.4.4 Marketing Activity Decisions

With respect to regional marketing strategy, the subsidiary carried out marketing activities with its sister-subsidiaries in EA, particularly in the Great China region. It coordinated with sister-subsidiaries to distribute products to the Chinese market and to build-up customer-relations. Furthermore, the manufacturing plant integrated into the EA region to produce standardised products for the Asia market.

5.5.4.5 Product-Development Decisions

Product-development decisions relate to product development and manufacture of equipment being critical to each stage of the electronic device manufacturing process. This process integrated marketing, design and manufacturing aspects into the product development. In particular, the HT subsidiary coordinated with its value-chain, such as the design centre and manufacturing plants, in order to formulate the product-development decisions. One respondent asserted that '*HT had provided the amount information regarding local market needs as well as facilitating its integrating networks to satisfy local customer requests.*'

5.5.4.6 Collaboration Decisions

The HT High-Tech Corporation was developing its business based on an integrated operating structure from product development and manufacturing to marketing & sales and service. In particular, the HT subsidiary collaborated with design and manufacturing functions that exploited their technologies with the sales & marketing unit to deliver products to customers.

Furthermore, the HT subsidiary leveraged its sales & marketing function with local or regional manufacturing plants and business partners, for instance, suppliers, strategic partners, in order to support the customer base.

5.5.4.7 Subcontracting Decisions

In terms of subcontracting decisions, the HT subsidiary was an important player for the parent company in the Taiwanese industrial market. One respondent stated '*The HT parent company subcontracted 10% of its chip production to one company in Taiwan. It was decided and announced by the HQ.*'

5.5.4.8 Change in Operational Processes

The HQ had restructured the group internally, and had entered alliances, formed joint-ventures and acquired and sold companies. More specifically, the business groups carried out business strategies with subsidiaries in accordance with the HQ's domain. One interviewee explained, '*One subsidiary in Taiwan has join-ventured to manufacture expitaxial wafers for LED, which is based on the HT parent company's technology, and collaborates with numerous local players concentrated in the region.*'

5.5.4.9 Technology Decisions

The HQ, in conjunction with the business segments, were boosting the share of overseas subsidiaries' business by developing its affiliated networks for production, sales and services, in particular, in America, Europe, China and the East Asia block. In so doing, the business segment concentrated resources in core-businesses, such as Hard Disk Drivers, LCD panels for PCs and TVs by using joint-development between subsidiaries and various research laboratories, as well as by cooperating with the HT MNE networks in order to utilise the HT's various technologies.

5.5.5 Building Subsidiary Technological Capability

HT focused on market-led technology exploitation in association with affiliated units internal and external to the MNE. In particular, HT subsidiary was involved in the development of marketing and production capabilities in collaboration with sister-subsidiaries in the Great China region as well as with local business partners. The following sections elaborated up this and Table 5.14 provides a breakdown of the way in which HT developed its technological capabilities using different types of technological sources.

Table 5.14 Building HT Subsidiary Technological Capabilities

Type of TC / Phase	Theme	Main Processes	Internal and External Linkages	Outcome Assessments
Marketing Capability	Phase 1: *Survey*	Customer Needs and Wants	The HQ with Business Segments sets the product strategy with reference to the customers and market	Customer requirements/orders
	Phase 2: *Initiation*	• Preparation short-term products • Proposal for middle-term product developments • Precedence for long-term product developments	• Product development meeting-all range of products review with the business segments • Worldwide Technology innovation supports	• Strategic products development • Business/Product Roadmap
	Phase 3: *Definition*	• Feasibility study-technical and cost aspects • Drawing Sample	• Annual product plan is reached in the product development meeting and the tasks are allocated to each site • Cross-levels learning new technology	• A profit system: identifying scheduling time, industrial standard.
Production Capability	Phase 5: *Production*	• Pilot production • Production Management • Continuous improvement process	• Collaboration with internal and/or external links on engineering and process.	• Yield rate • Capacity Production Index (CPK)

5.5.5.1 Marketing Capability

The HT subsidiary carried out its marketing activities with different business segments and operating structure, including research & development and manufacturing, with a key focus on customer needs, particularly on high-tech fields (an indicated in Table 5.13). In doing so, a specific profit system for identifying trends in the market and customer needs in association with other business segments was introduced to the subsidiary. In particular, the subsidiary was involved in product initiation and definition with cross-level collaborations including regional product development & design to initial product production, resulting in a synergy that it was able quickly to respond to the market.

Furthermore, the HT subsidiary sales & marketing activities developed business coordination between different sister-units in Great China and the EA Block in order to provide quality customer services and to respond to regional market demands properly.

5.5.5.2 Production Capability

The HT subsidiary had evolved over years into an important production centre, which included LCD and flat panel displays for PCs and TVs, to provide products to the markets of Europe (30%), America (30%) and Asia (40%) as well as the local laptop market.

With regard to HT manufacturing operations, based on the parent company's semiconductor technology, it developed an internal technological collaboration for the acquisition of key-components, manufacturing techniques, problem-solving and product quality improvement. In particular, it collaborated with the production engineering research laboratory to develop advanced manufacturing techniques in large sized (over 30 inches) LCDs and flat panel displays.

With the demand for LCDs poised to increase, Taiwan was becoming one of the world's largest LCD production hubs, with numerous players concentrated in the region. The HT subsidiary facilitated its external MNE network, such as Polyerview, to exchange manufacturing engineering knowledge, particularly with regard to the LCD driver IC, mass production of large LCD panels for TVs, etc. One manager stated, '*We were allotted for the start of mass production of large LCD panels for TVs in joint-development with our internal engineering Lab and Taiwan strategic partners in 2004.*'

5.5.6 Subsidiary Communication Systems

Table 5.15 provides a brief overview of the subsidiary communication systems used in HT subsidiaries, in accordance with the internal and external networks presented in Figure 5.8. HT subsidiary evolved business operations and management information systems with the sister-subsidiaries in the EA region and/or Great China through the frequent use of various communication channels. In particular, the subsidiary had very regular communication with HQ and/or RHQ regarding business operations and operational reports. In addition, there were frequent communications with the engineering research laboratory with regard to problem-solving and project development.

Furthermore, in terms of the relationship with the external firms, the subsidiary had the responsibility for local market development, especially in terms of customer-, supplier-, and public-relations, the lead contact communicating via e-mail or telephone on a daily basis.

Table 5.15 HT Subsidiary Communication Systems

Patterns of HT Subsidiary Communications	Daily	Weekly	Monthly	Quarterly	Yearly
Internal Communication					
Sister Subsidiaries	**Email/Telephone/Fax**	----	**Conference Call /Net meeting for exchanged MIS information**	----	**Annual meeting**
Engineering Lab.	**Email/Telephone/Fax**	----	**Engineers visited to deliver technology or join-project development**	----	**Engineers training**
HQ or RHQ	**Email and telephone**	**Intranet for F&A and Sales & Marketing reports**	----	**Business Operational Reports**	**Budget meeting & Product marketing meeting**
External Communication					
Local Customers	**Email/Telephone on problem-solving**	----	**Personal visit On-site collaboration**	----	----
Local Institutions	----	----	**E-mail/Seminars**	**Seminar or workshop**	**Conference**
Local Supplier	**Email/Telephone/Fax for exchanging information**	----	**Personal Visit**	----	----

5.6 Concluding Remarks

In this chapter, which covers the cases of the five subsidiaries, we have described the background of the parent company and each subsidiary, following with the subsidiary relationship with the MNE networks, highlighting the decision-making powers of the subsidiary to initiate innovation activities. We have also identified the technological capabilities developed by each subsidiary as well as the communicative capacity of the subsidiary.

Through this within-case analysis, we have been familiarised with the five subsidiaries, and gained a number of insights into multinational subsidiary capabilities. In particular, it the nature of the subsidiary, which is embedded internal and external the MNE network, has been indicated. After explaining how a subsidiary develops its technological capability through internal and external network linkages, subsidiary autonomy was used to identify the relationships between the subsidiary and the parent company, HQ or RHQ, in order to examine and simplify the complexity of the subsidiary initiates and development patterns. This was particularly useful in clarifying the types of technological capability present at the subsidiary level and the way in which the subsidiary drove its technology development. We also recognised that the subsidiary networks connected by a set of social relationships in terms of internal and external linkages of communication systems, involving different modes and frequency of formal and informal communication.

Having become thoroughly familiar with each subsidiary, it is possible to look beyond the surface impressions of these cases to interpret the evidence presented through our empirical framework, so as to make cross-case comparisons.

CHAPTER SIX

CROSS-CASE COMPARISONS

In this chapter, we look beyond initial impressions of the five cases and apply the comparative empirical framework to examine the relationships between subsidiary technological capability and subsidiary autonomy, in association with internal and external MNE networks. The aim is to derive explanations of what characteristics of subsidiary autonomy (SA) and communication systems (CS) influence subsidiary technological capability (TC). The thematic framework, presented in Figure 6.1, is aimed at providing a mechanism for analysing the themes of SA, TC and CS. We also move on to consider the relationships of SA, TC and CS in order to speculate about the meaning of these relationships and make conjectures about the significant patterns.

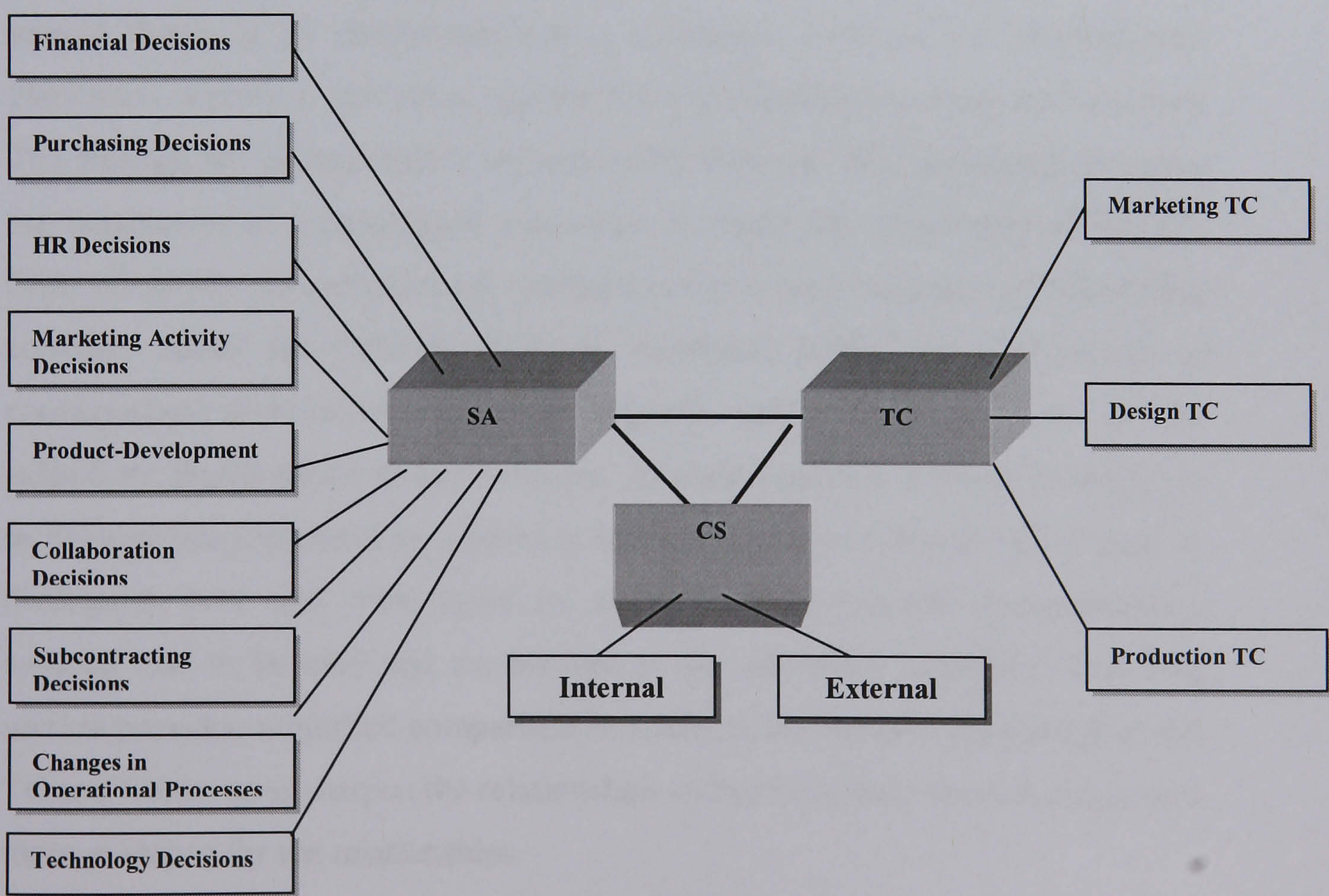

Figure 6.1 The Thematic Framework of SA, TC and CS

The framework that emerges from our analysis has constructs of the SA, the TC, and the CS. The construct of CS has an influence on SA and TC as suggested by the literature (Discussed in 2.1.5.1). The SA refers to the degree to which a subsidiary has the power to make its own decisions regarding financial, purchasing, human resource (HR), marketing activity, and product development, collaboration, subcontracting, changing operational process[1] and technology. The TC is related to the outcome of a subsidiary generating from its technological innovation activities in terms of marketing, design and production. Moreover, communication systems are measured across a number of dimensions including the modes, frequency and reciprocity. They are used for gauging the density of interaction across internal and external partners in each of the subsidiaries.

This chapter has three main themes. The first theme is the SA findings, which examine the different degrees of decision-making autonomy across the cases. Comparisons are made to illustrate similarities and differences, and to evaluate the degree of SA. It is our aim to identify which characteristics determine the SA. The second theme is to understand how a subsidiary develops its technological innovation activities, and what reasons drive a subsidiary to learn/develop new TCs through the internal and/or external MNE network. We particularly examine the taxonomies of technological innovation to assess the complexity of the TC. Each subsidiary's capabilities are clustered in the form of operational/functioning activities before the different TCs are positioned behind the multi-levels of coordination/collaboration, including internal and/or external links of the subsidiary. Based on the first two themes, the main objective of the third section is to demonstrate the extent to which CS has influences on SA and TC. It aims to distinguish how and what types of internal and/or external communication systems tend to be used and are evolved in the subsidiary capability. The final section provides simplified comparison matrices of the thematic framework of SA, TC and CS, so as to sharpen the relationships of the three main themes and to seek more evidence for the relationships.

[1] These concepts have been debated in the literature review. Please refer to Chapter two.

6.1 Comparisons of SA

Through the within-case analysis in Chapter 5, this research identified and compared the different characteristics across the sample subsidiaries, and accordingly presented a summary of the SA. We positioned them with respect to similarities and differences revealed across subsidiaries according to the H, M, or L ranking. The subsidiary had highest autonomy if it had relative freedom to make a certain number of decisions, and was ranked with 'H'; in contrast, the subsidiary was ranked with 'L' if it did not have relative decision-making freedom. The subsidiary which enjoyed autonomous decision-making power between these two positions was ranked with 'M'. Using this evaluation, the positioning for the SA is elaborated below. Furthermore, the score was totalled up, in order to undertake a comparison of decision-making autonomy across subsidiaries.

Table 6.1 A Summary Comparison of Subsidiary Autonomy (SA)

Subsidiaries / Characteristics	PH	RS	ST	MT	HT
Financial Decisions					
Capital Investment	M	L	L	M	L
Working Capital & Expenditure	H	M	L	M	M
Purchasing Decisions					
Purchasing Materials & Equipment	L	L	L	H	M
Local Purchasing Sources	M	L	L	H	M
HR Decisions					
Employee Recruitment & Training	H	H	L	M	M
Personnel Promotion & Expatriatism	H	M	L	M	M
Marketing Activity Decisions					
Strategic Market Position	L	H	H	L	L
Logistic Distribution	L	H	M	H	L
Management Customer Relationship	L	H	M	H	L
Customised Product Decision	L	H	M	M	L
Product-Development Decisions					
New Product Development	M	H	M	M	L
Initiative New Product Development	M	H	M	M	L
Making-Changes in Product Development	M	H	M	M	L
Collaboration Decisions					
Internal Collaboration	M	H	L	H	L
External Collaboration	M	H	L	L	L
Subcontracting Decisions					
Local Counterparts	M	H	L	L	L
Change in Operational Processes					
New Operational Activity	M	L	L	L	L
Technology Decisions					
Building Subsidiary Technology	H	M	L	L	L
Total Scores[(a)]	35	43	26	36	23

(a)Each score of the SA are added to the sum of H, M and L up, each of which represents 3, 2, and 1 point, respectively.

6.1.1 Financial Decisions

High financial autonomy at the subsidiary level was indicated by the extent to which financial power could be facilitated at the subsidiary level. The subsidiaries showed similarities in terms of the source of finance from the HQ or RHQ.[2] Capital investment, such as expansion of the plant and/or equipment investment, required formal approval from the parent company, such as the HQ or RHQ, although PH and MT revealed some successful experience in acquiring new investment (detailed in Chapter 5). Therefore, we gave 'medium' scores to PH and MT, and 'Low' scores to the others, as illustrated in the following quotations.

> *'We evolved an investment of US$1 million to expand the production lines 2004, all finance for which was from the HQ.' (MT manager)*

> *'The capital investment is required to win the approval of the HQ.' (RS respondent)*

However, the subsidiaries differed significantly in terms of the amount of working capital and the annual expenditure for the on-site operation. The largest amount of working capital and highest autonomy to facilitate the annual expenditure were found at PH, which had authority to spend approximately US$90,000 without the need for approval for on-site expenditure. In contrast, HT, RS and MT were authorised to have working capital limits of US$30,000, US$20,000 and US$40,000 respectively, being required to obtain approval for on-site expenditure from the HQ. ST was allowed to have US$5,000 working capital, and if any expenditure exceeded this amount, the RHQ's approval was required, thus qualifying ST for a 'Low' score. The following quotations reflect this situation.

> *'... if we need millions of US dollars to operate this site, for which we do not need the approval [of the RHQ].' (PH senior manager)*

> *'When the amount of the [annual] expenditure is more than US$5,000 [the amount of the working capital], we need to win the approval of the RHQ.' (ST manager)*

---

[2] In some cases, RHQ also referred to the product division (PD).

6.1.2 Purchasing Decisions

High level of purchasing autonomy at subsidiary level identified the degree to which key purchasing decisions were made by the subsidiary. It was not always autonomous in making purchasing decisions at the subsidiary level, as the result of difficulties in the negotiation power with suppliers for the purpose of achieving cost reduction and reliable long-term purchasing mechanisms. At the same time, some of the parent companies' HQs or RHQs centralised the purchasing decision-making and the purchasing sources, to ensure cost-effective purchasing activity. Accordingly, a purchasing guideline was normally applied to the subsidiaries. The cases of PH, RS and ST had the least autonomy to make purchasing decisions. They were compelled to follow the purchasing guideline and rely on the global supply-chain to acquire components, materials or equipment.

> *'The RHQ centralises demands for components, materials and equipment from different sites (sister subsidiaries) and applies our strong demanding power to acquire trustworthy suppliers worldwide and build reliability, cost-efficiency and long-term supplier relations.' (PH senior manager)*

> *'The purchasing strategy is governed by the HQ; even one of the products is priced cheaply in the [semiconductors] market [and] the subsidiary is not allowed to purchase our own main components or materials, but rather to apply the purchasing guideline.' (RS vice president articulated)*

Even though PH, RS, and ST were not permitted to develop its local external network of suppliers, PH was actively involved in seeking local strategic partnerships through procurement activities with the parent company. It was revealed that PH had relatively more autonomy for purchasing decisions than RS and ST.

In MT and HT, the subsidiaries were somewhat involved in the purchasing decision-making with the HQ or the RHQ regarding equipment and material procurement. The subsidiaries were undertaken to gather the related local substantial market information, such as material prices, and front-end products to the HQ. There was significant similarity between MT and HT in the extent of the main components and/or equipment purchased from the HQ. Nonetheless, there was an exception at MT, which was more autonomous than other cases to decide on the extent of its procurement of main materials from the sister-subsidiary and some low levels of materials from local suppliers.

> *'There is a [managerial] committee in the MT; we make the purchasing decision at the subsidiary in reference to the purchasing guideline. Besides, the main equipment and materials are purchased from the HQ and our sister-subsidiary because we are in the same corporation and make a big profit for our corporation, which is our aim.'*

6.1.3 HR Decisions

According to the level of devolved HR decision-making, there were a number of indicators that allowed us to rank the subsidiaries. All five subsidiaries retained their autonomy for employee recruitment and the general employee training programme. In particular, personnel training of, or internal promotion to, the department head were undertaken by the HQ or the RHQ. The case of RS illustrated an example of this perspective:

> *'We (RS) have freedom to decide our own manpower and training programme without winning the approval of the HQ, apart from the promotion of the head of the department, which does require the approval of the HQ.'*

Despite most HR decision-making being permitted to be made at the subsidiary, the decision with regard to the heads of the subsidiaries in all five cases was made by the HQ, demonstrating the way in which HQ strengthened the local implementation of central decisions. In contrast, a significant difference was found in PH which had relative autonomy to adopt local HR practices, and had autonomy to use engineers expatriated to the sister-units.

> *'If there is a shortage of manpower, we will start on the recruitment on site (PH). In addition, we (PH) currently play a role as a technical support centre, and if a sister plant in AP requests engineer support from us, we will deliver our engineers to the sister plant.'*

The lowest degree of autonomy was found in ST, where employees were recruited at the request of each of the product segments (at the RHQ).

> *'Each of the product segments will decide its demand for manpower and will pass this on to the RHQ for approval and then it will deploy their requests to each subsidiary.'*

6.1.4 Marketing Activity Decisions

All the subsidiaries were initially allocated a specific market by the parent company which they were mandated to serve. In particular, RS, ST and MT were granted local market scope, and PH and HT regional/international market scope. A combination of local experience and knowledge enabled RS and ST to expand their market scope more than others; thus, a 'high' score for autonomy in terms of market strategic position was given. There were two interesting quotations from RS and ST respondents, respectively.

> *'RS sells the different types of semiconductor products to Taiwanese customers, but a lot of Taiwan's customers transferred their [manufacturing] plants to China, and therefore the customers required products to be delivered to China. We (RS) coordinated the logic distribution network with the sister-unit in China to distribute the products to the customers.'*

> *'On one conference-call meeting, I was discussing with a senior manager in Europe to do some market-sharing in certain products. But I couldn't agree the outcome because they had decided by themselves to make some new products without our agreement. Then, I told him: 'Sorry, you may be able to sell in Europe, but not in Asia', because I have been in Asia for many years and understand this market better than other people in ST.'*

Even though subsidiaries were integrated with regional and/or international marketing strategy, a number of subsidiaries were encouraged to initiate the particular strategic marketing activity in terms of managing distribution channels and customer-relations. RS and MT particularly had autonomy to coordinate their distribution channel and customer-relation system with their regional sister-units and customers in the Mainland China region. ST was involved in the logistic supply network with its MNE network but was permitted to build up customer-relations through product developments together with product segments.

In contrast, HT showed a very close connection with the regional marketing activity, particularly with respect to the management of distribution channels and customer-relations. PH was integrated into its MNE networks and acted as a manufacturing centre to supply semiconductor products to the worldwide sales offices. Both of the two cases indicated relatively lower autonomy in terms of making marketing decisions.

'As a manufacturing centre, we (PH) discuss the factories' capacities with the marketing group, receive orders from the BU [Business Unit at the RHQ] and administer the manufacturing plants or technology development...; afterwards, products are distributed to the RSO [regional sales office] in AP, EU and/or US.'

As with other dimensions of marketing strategic autonomy, RS revealed its relatively higher autonomy for initiating a customised product in association with the HQ to serve the global market.

'We (RS) had proposed an initial mini-camera solution marketing project as a reference design to the HQ which reconciled the demands of the Taiwanese market and the global market, and it succeeded in winning the project. The manufacturing plant in Japan was working at half capacity for the product..., and the product sold to the global market too.'

In addition, ST and MT developed customised products with the customers and other sister-units in the internal MNE networks. However, PH and HT had very little autonomy for the customised product initiative. They were tightly integrated into their MNE networks, functioning in the value chain as the manufacturing centre and marketing sales along with the global marketing strategy.

6.1.5 Product-Development Decisions

MNE network integration and the degree of product development were two important elements influencing product development decision-making at the subsidiary level. It was recognised that all five subsidiaries integrated into the MNE network, being part of the value-adding chain, as well as being involved in making new product decisions with the parent company and with the related sister-subsidiaries. In particular, PH, RS, ST and MT were actively involved in making different types of the new product decision with the parent company and the related sister-subsidiaries. HT was the least active in this regard, and had relatively limited involvement in this kind of decision-making.

In comparison with other subsidiaries, RS had evolved into a very active development centre, proposing a range of new product projects and taking on responsibility for minor and major changes to the product design for local and regional customers, without intervention from the HQ, indicating a higher autonomy for initiating new products.

> *'We have been proposing a lot of the new product projects to the R&D centre to share the Taiwan and Great China market trends in order to satisfy the customers' needs and market demands for the HQ. In addition to that, we are making some applied changes to the design of a customised reference platform (reference model) for our customers, on which we have quite substantial freedom to make any decision.'*

Whilst PH, ST and MT clarified the specification of new product designs with their worldwide customers, and made some of these product changes in-house, there was not the same degree of independence as in RS. The quotation from ST Director illustrates this:

> *'We normally make a minor change which involves about 10% of the decision-making in the product development. The main job is to identify specification of the product with the customer. While we define the customer's specification, we coordinate with other people (sister-units) to manufacture the products that are somewhere in the world, such as Shenzhen and Milan, wherever the product divisions are located...... Here (ST), sometimes, we not only provide minor change of the product, but also make the product from scratch, everything is for the customer - so-called customised products.'*

6.1.6 Collaboration Decisions

Decisions regarding collaboration were recognised both internally and externally, being either initiated or implemented at the subsidiary level. Initial internal collaboration began from the cross-level of business functional activities to product or process development. RS and MT initiated the internal collaboration with regional sister-subsidiaries and R&D centres on the product design and/or process technology development. RS also developed collaborative partnerships with local research institutions, universities and local firms for new product design and development. One director involved in this practice stated:

> *'We (RS) have developed a very close collaboration with the RS engineering design centre, which have conducted 95% of product design projects for us. The rest of the projects have been done in collaboration with Taiwanese firms to co-develop incremental system design.'*

In comparison, PH, ST and HT developed a similar collaboration with the applied R&D and central R&D centres on product design and new applied technology. However, there was not the same degree of autonomy as in RS and MT, a difference associated with the degree of embeddedness in the internal MNE networks and the extent of particular subsidiary initiatives. One ST senior director illustrated this in the following way:

> *'We (ST) have collaborated with each unit very well. The strategy of the corporation is max-market, where we attempt to hold all the organisation. We (ST) do it through the corporation (the HQ) with all different product divisions (the RHQ) by means of what we call problem-solving applications, which will gather each product group and people from each group to the customers.'*

In addition to that, however, PH devolved close and frequent interactions with regional and local sister-subsidiaries, suppliers and customers across this network, and developed collaborative partnerships with the local institutions and universities for incremental and new product development which benefited PH's access to various design and production capabilities. However, it had less power to establish relationships inside and outside the network than RS appeared to have, as reflected in the following quotation:

> *'Most of high-end technology projects are distributed to PH and we take charge of product and technology developments with the R&D centres; but sometimes, the technology is related to technology complexity, in which case, the collaboration with the R&D centre at the corporate level is undertaken through the RHQ...... In addition to that, we (PH) collaborate with local universities and ITRI to develop basic chemical and material technique.'*

6.1.7 Subcontracting Decisions

With regard to subcontracting decisions, they were made both formally and informally, as well as being either centralised or devolved. When ST, MT and HT required certain technologies for design or production purposes, the appropriate contractor tended to be decided by the parent company HQ/RHQ. Whilst PH was embedded within a network of alliances between local, global and regional subcontractors that had been established by the parent company and opted for appropriate subcontractors to develop incremental product and process innovation at the subsidiary level, there was not the same degree of independence as in ST, MT and HT. One director suggested that the subcontracting practice benefited PH's technological accumulations of design and production capabilities:

> *'If one new product is not in great market demand, the RHQ makes the subcontract-out decision. As soon as the market demand increases, PH is devolved to collaborate with the subcontractor on the development of the product and manufacturing technology in order to build up this in-house capability.'*

By comparison, RS managed to autonomously subcontract out some product design activities to local firms, showing relatively higher autonomy for subcontracting decisions than in PH. One senior manager involved in this practice stated:

> *'We subcontracted out approximately 18-20% design projects to the local third parties (the local counterparts). Considering technology X is not a pivotal technological capability, we generally subcontract out to competitive local firms. This results in speeding up our time-to-market without expanding our own facilities.'*

6.1.8 Changes in Operational Processes

All five subsidiaries tended to be able to initiate new business projects only when they were in accordance with the central corporate strategy and with the parent company's approval. There were however, a small number of examples of subsidiary initiatives which did not entirely accord with corporate expectations, but were allowed to proceed, and others where the subsidiary took on a larger role or range of responsibilities than its formal remit allowed. These kinds of examples assisted us in comparing relative levels of autonomy across the sample.

An interesting example was provided by PH, illustrating how PH had recently designed and manufactured a new image sensor for production through collaboration with internal sister-units and external partnerships. This had been in line with HQ-led product strategy, but had gone against the HQ plan which had earmarked other units to take the lead on the project; therefore, PH was given a 'medium' score ranking:

'....Last year, PH strove for project success in designing and manufacturing a brand new product of image sensor which was part of a new product strategy being released at the HQ; and a new design team and manufacturing operation was set up in PH. Meanwhile, a different collaboration between the parent company and external partners has been undertaken.'

In short, whilst RS, ST, MT and HT initiated some business projects in accordance with corporate strategy, and proposed new initiatives in line with assigned roles and development, there was not the same degree of autonomy in this regard as in PH.

6.1.9 Technology Decisions

All five subsidiaries remained dependent on the parent company for all the core technologies, but had varying degrees of autonomy to source non-core technology, and expertise for maintaining or developing their design and production activities. In particular, some subsidiaries evolved technology initiatives in line with the corporate technology strategy alongside specialists across the internal and external networks.

MT and HT provided the same degree of dependence on the internal MNE, particularly on the core technology in terms of equipment, product and process. While PH, RS, and ST initiated incremental technological innovation associated with experts across the internal and external networks, there was not the same degree of independence as in MT and HT.

By comparison, RS demonstrated a relatively high level of autonomy in this aspect of decision-making. It had some degree of discretion as to which internal R&D centres it would work with for developing more core technologies, and had a range of local and external collaborations for associated technology sourcing activities. One respondent in RS illustrated this:

'...In order to satisfy our customers' needs, we have coordinated quite a lot of applied designs with the local counterparts and the engineering centres in Asia Pacific to meet the customers' specifications.'

Whilst PH possessed 90% of in-house capabilities in terms of design and production, and autonomously collaborated with the worldwide R&D centres and external strategic partners in the building 'new' technological capabilities, there was not the same degree of technological autonomy as in RS. One senior project manager illustrated this in the following quotation, suggesting that decisions about core or 'new' technology were made through discussion involving specialists across internal and external networks.

> *'...Our existing technology is embodied in established products we have produced, with the exception of the success of new product projects, such as COF (chip on film) and COM (chip on image), which have been coordinated with the innovation centre [at the RHQ level], the centre of technology [at the group HQ level] and the R&D centre at the corporate level and also with outsourcing partners. Overall, we have access to any technology resources to achieve our project targets.'*

6.2 Comparisons of TCs

Table 6.2 gives a summary of the technological capabilities reported by five-Taiwan based subsidiaries involved in technological innovation. This table categorises the existing technological capabilities evolved by the five subsidiaries. The three types of technological capabilities related to marketing, design and production were identified by subsidiaries' functioning/organisational activities. Key industry-standard measures of design and production capabilities were given by respondents, which can be used as quantitative evidence to compare technological capabilities with different case study subsidiaries.

The summary in Table 6.2 provides a clear insight into the different types of TCs which the five subsidiaries were involved in and their different functioning activities. PH subsidiary reported three types of TCs, in comparison with RS and ST subsidiaries, both of which described two types of TCs, similar to the cases of MT and HT. However, these differences were considered while we made a cross-comparison of the aggregate of technological capabilities.

Table 6.2 A Summary of Subsidiary-level Technological Capabilities

Subsidiaries / Types of TCs	PH	RS	ST	MT	HT
Marketing TC	○[a]	○	○	○	○
Design TC	○	○	○	Neg.	Neg.
Industry-Standard Measures	No of patentable cases: 7 Time to Market: 7.5-14ms R&D investment: 2%	No. of Patents:2 Time to Market: 6-14 ms Applied R&D investment: 3.5%	No. of Patents: 0 Time to Markets: 7-10ms Applied R&D investment: 2%-3%	Neg.	Neg.
Production TC	○	Neg.	Neg.	○	○
Industry-Standard Measures	Yield Rate: 99% CPK: 1.67 Manufacturing investment: 15%-30%	Neg.	Neg.	Yield Rate:83% CPK: 1.33 Manufacturing investment: 5-10%	Yield Rate: 95% CPK:1.5 Manufacturing investment:10%

(a): They indicate the different types of TC evolved by the five Taiwan-based subsidiaries.

Table 6.3 shows a summary ranking of the five Taiwan-base subsidiaries across the three categories of technological capabilities we examined. Each is ranked as relatively High (H), Medium (M), Low (L) or negligible (Neg.) in terms of autonomy for developing TCs and the level of task performance related to independence from the internal and external MNE networks. These are internally valid, relative constructs rather than absolute measures of subsidiary-level technological capabilities.

Table 6.3 A Summary Comparison of Subsidiary Technological Capabilities

TC Dimensions \ Subsidiaries	PH	RS	ST	MT	HT
Marketing TC					
Marketing Management	L	H	H	M	M
Internal and External Linkage	L	H	M	M	H
Learning Capability	L	H	H	M	M
Sub-total Scores[a]	3	9	8	6	7
Design TC					
Self-Assessment	H	M	L	Neg.	Neg.
Minor/Major Change	H	M	L	Neg.	Neg.
Internal and External Linkage	H	M	L	Neg.	Neg.
Learning Capability	H	M	L	Neg.	Neg.
Sub-total Scores[a]	12	8	4	Neg.	Neg.
Production TC					
Self-Assessment	H	Neg.	Neg.	L	M
Production Management and Engineering	H	Neg.	Neg.	L	M
Minor/Major Change	H	Neg.	Neg.	L	M
Internal and External Linkage	H	Neg.	Neg.	L	M
Learning Capability	H	Neg.	Neg.	L	M
Sub-total Scores[a]	15	Neg.	Neg.	5	10
Total Scores	30	18	12	11	17

[a]Each score of the TC is added to the sum of H, M and L, each of which represents 3, 2, and 1 point, respectively.

In the following sections, we examine each type of TC in turn to validate the above relative rankings, justify how each relates to a particular range of the internal and external network linkages between types and levels of capability, as well as provide evidence and illustrative examples from the five case study subsidiaries.

6.2.1 Marketing TC

Marketing TC related to the customer-led product design and incremental production changes. The marketing scope and sales region for which the subsidiary had responsibility were amongst the measures used here, but more importantly, we compared the in-house processes, resources and expertise to connect customer requirements to innovation activities at the subsidiary level and elsewhere in the MNE.

As such, we analysed the marketing TC in the five subsidiaries. There were several criteria to evaluate the marketing TC in the five cases. The first criterion was the ability to undertake marketing. The second criterion was the linkage capability for acquiring marketing TC from the internal and external MNE network. The third indicator was learning capability, which considered what marketing TC had been developed.

6.2.1.1 Marketing Management Capability

Subsidiaries RS, ST, HT, and MT showed that they had strongly developed marketing TC. They all had a prominent marketing & sales role, acting as intermediaries between other partners inside the MNE and local or regional customers. This remit led them to develop expertise and experience in monitoring and predict market trends and prioritising of customer requirements. Interestingly, we found that PH was relatively more dependent on internal and HQ-based marketing departments for linking its innovation efforts to customer needs and for its sales and distribution activities. All five subsidiaries had evolved procedures to monitor and feed back customers' evaluations, as well as to propose design and production changes in response to client needs.

Comparing different dimensions of marketing TC, we ranked RS and ST higher than MT and HT because they were involved in developing local and regional marketing strategies in collaboration with HQ-based marketing departments. This role encompassed product design and manufacturing as well as product price, promotion and distribution channel planning, requiring superior marketing expertise. We therefore concluded that PH had the lowest level of marketing TC relative to others.

6.2.1.2 Internal and External Linkage Capability

Different types of linkages and collaborative partnerships had been developed by each of the subsidiaries, related to the levels and types of marketing TC they had evolved. RS, HT and MT had a very close linkage with other internal production units as part of a combined regional delivery channel. ST and PH were dependent on a regional marketing & sales office and shared logistics, product delivery and stock management with other units.

RS, ST, MT and HT had strong linkages with marketing departments at HQ and RHQ levels, and participated in product development and related marketing development activities. This compared with weaker linkage to PH, where the focus was on the product design and production activities, led by marketing expertise based elsewhere. PH, RS and HT were involved to some extent with local firms and institutions for market research purposes.

6.2.1.3 Learning Capability

Internal collaboration with marketing groups and product development teams at RHQ and HQ levels was the most frequently cited learning resource for all five subsidiaries. Some subsidiaries had learnt 'by doing' through joint marketing activities, product promotion and/or product logistics management.

RS, ST and HT had participated in the local high-tech industry society in Taiwan and some product workshops organised by local intermediaries to learn about local market trends and customers. RS, ST, HT and MT had also accumulated some prior experience, in that most of the managers had worked either in state-owned trade organisations and/or other areas of the electronics industry for some time and had developed a good deal of regional market expertise. Some senior managers had formal marketing training. Moreover, RS and ST had developed a more sophisticated marketing TC than the other subsidiaries, because of their wider range of local links with local customers and specialist industry organisations, through which they were more actively learning about the current and future needs of these customers and the related market trends for the products that used their IC systems. Over time, they had accumulated more prior experience in tracking customer changes and providing feedback to guide design and production changes.

6.2.2 Design TC

As presented in Table 6.2, PH, RS and ST had evolved design TC, whereas MT and HT had not. Several criteria were managed to evaluate the existence of design TC in the PH, RS and ST. The pronounced industry-standard measures from the three cases were used to compare the design capabilities in each of the subsidiaries. There were effectively self-assessments by subsidiary respondents, who referred to the most commonly accepted benchmarks for comparing performance and capability across firms in this industry. The ability to make a minor or major change in product design as well as the linkage capability and learning capability for gaining the design TC from the internal and external MNE networks were used to make a comparison of different subsidiaries' design TC.

6.2.2.1 Industry-Standard Measures

PH had been awarded 7 patents, including patentable cases, as a result of these advances, compared to 2 for RS and 0 for ST in this measure. Its average time-to-market stood at 7.5-14 months, but for a more sophisticated range of re-designed products compared to RS, with an average 6-14 months, and ST with 7-10 months. This provided a clear measure of the more advanced nature of PH's design capability. Furthermore, the figure for applied R&D investment for PH of 2% (US$42 million in real terms) was a proportion of RHQ turnover (aggregated across a range of subsidiaries for a specific range of products), whereas for RS (US$84 million) and ST (just US$40,000-60,000) it was a percentage of their respective subsidiary-level turnovers. The HQ and RHQ MNE hierarchy, within which PH was positioned, was more complex than those of RS and ST. Whilst a perfect match was not possible because each subsidiary was involved in developing slightly different types of products and product changes, the respondents viewed these measures as a meaningful way of gauging capability differences, and our conclusion was that the respective figures in Table 6.2 provided an industrially valid comparison.

6.2.2.2 Minor or Major Change Capability

Three subsidiaries were found to have significant minor change in design capability. They were all able to adopt components from the HQ and carry out improvements or customise designs for local customers. ST and RS had made various improvements to integrate IC devices with its external applications to increase the functionality, efficiency and usability of the IC system for customers. More specifically, RS had redesigned the software system in the IC device to connect with the digital camera and engineered modifications such as creating an external electronic connection to an LCD flash, adding a new function to the product. Working with a customer to fulfil their specific requirements, ST had changed the connection between an IC and an external electronic application to amplify the sound of a monitor. PH, however, had managed more sophisticated levels of design changes than either of these subsidiaries. It had created an entirely new IC package design, replacing the traditional lead package with a BGA package. It had also developed innovative chip-scale-packages.

Both RS and PH had developed patented and patentable designs, indicating a higher level of technological capabilities than the other subsidiaries. PH had managed to develop more advanced designs and appeared to have more expertise for creating associated process technologies and improving the manufacturability of new product designs. For both subsidiaries, the higher levels of R&D, design and engineering capabilities were reflected in the range of collaborative partnerships they were involved in.

6.2.2.3 Internal and External Linkage Capability

PH, RS and ST were all involved in a range of collaborative ventures with R&D centres around their respective internal MNE networks. The most regular links were 'problem-led', where technical difficulties required specialist input from elsewhere in the firm, for engineering solution or ideas for customised designs, for example. A hierarchy of design projects and associated capabilities was discernable across the sample, leading us to rank the subsidiaries as shown in Table 6.3.

ST collaborated with the regional R&D centres to develop in-house design capabilities, but was less involved in more advanced projects. A respondent stated:

> *'A new product project is devolved from corporate, regional levels downwards to the local site [subsidiary], where each unit collaborates very closely. But the most complete, advanced system [product] is completed at the regional FAE (regional R&D centre).'*

RS was part of an optical driver device (ODD) project with central R&D to develop a new IC device and its system solution. The subsidiary took the initiative to develop the new product jointly with the R&D centre at the RHQ in order to enhance its in-house technological design capabilities. In addition, RS worked on the IC design configuration with other regional subsidiaries to ensure it would be suitable for supplying to the regional market.

PH generally acquired advance engineering technology and new process technology from the R&D centres at the HQ level, and consulted with applied R&D centres at product division level. PH had a more advanced internal structure and set of procedures for coordinating between its internal design innovation activities, quality and reliability functions and manufacturing plants. These, in turn, were connected with market-facing functions to facilitate feedback on defect rates, manufacturing quality and customer needs.

Both PH and RS had developed strong external linkages compared to ST, for instance, with local universities to undertake basic research, such as chemical and material analysis and support for engineering approaches. All three subsidiaries had links with the ITRI to share information on sustainable developments in the high-technological/electronics industry. Furthermore, RS and PH developed a range of partnerships with specialist engineering consultancies and technology organisations at local and global levels. RS, for instance, had technical contracts with local firms to co-work on SoC designs. PH had developed a close collaboration with several global subcontracting units, including ASE and Amako, for developing some specific packaging and testing products:

> *'PH collaborates with Amako to carry out the engineering technology of a new material and new process technology. Up to now, this technology has been used by a few large MNEs and Amako is one of the top leaders. This endeavour has shortened by 1/3-1/2 the product's time to market.'*

Altogether, this indicated different forms of internal linkage across the three subsidiaries and a more prominent role for independent, external connections for design capabilities in PH compared to the others.

6.2.2.4 Learning Capability

PH, RS and ST had developed these various capabilities through a combination of learning-by-doing, learning via internal and/or external collaborations, and learning by accumulating prior knowledge. It was significant that all three subsidiaries had long been involved in a variety of minor technical improvements and adaptation to IC design and/or altering the designs of process technologies to various product specifications. This had led to the gradual development of a range of in-house technical change knowledge, expertise and experience in all of them. Furthermore, repetitive 'trial and error' learning at RS and ST had made them increasingly confident about initiating minor technical change design. Conversely, PH could manage major changes in technological process and system design.

As regards prior accumulation of knowledge and experience, these capabilities had been initiated or supplemented by engineering recruits. PH had developed in-house technical process design specialists who could select the package configuration and link these to silicon designs. In contrast, discipline-based specialists were more the norm at RS and ST, who could only confirm that one or more predetermined parameters and specifications were being met by a particular configuration. These three subsidiaries differed in terms of the degree to which they had experience of acquiring particular technologies and their associated capabilities. They also differed in terms of the levels of collaboration with internal R&D centres and external counterparts that they had experienced. PH had experience of a long-running, close collaboration with the corporate R&D centre and a range of external (global, rather than local) subcontractors for the assimilation of advanced technologies for integrating IC design, packaging and testing processes. RS co-designed a new product design-ODD with its main corporate R&D centre and learnt device engineering and electronics technology with its RHQ R&D centre. ST, however, had only acquired lower applied technological knowledge, such as external IC device electronics and engineering, from its RHQ centres. In addition, both RS and PH were expanding their basic R&D expertise in chemistry, materials and design methods by working with local universities and ITRI to improve the system solutions, IC packaging or their ability to test input materials. Confirming these differences, greater recognition was given to engineering and electronics expertise at PH, where personnel had built up significant experience of the complexities of integrating different kinds of IC design.

6.2.3 Production TC

As demonstrated in Table 6.2, PH, MT and HT were more production-led subsidiaries with significant in-house capabilities for improving, adapting and upgrading their IC production processes. The key industry-standard measures from the three cases were used to compare the production capabilities in each of the subsidiaries. These were effectively self-assessments by subsidiary interviewees, who referred to the most widely accepted production, productivity and capacity utilisation benchmarks for evaluating performance and capability across firms or plants in this industry. The process and engineering capabilities were used to compare the continuous or incremental improvements across the three subsidiaries. The capacity to make a minor or major change in process production as well as the linkage and learning capability for acquiring the production TC from the internal and external MNE networks were also used to compare the different subsidiaries' production TC.

6.2.3.1 Industry-Standard Measures

Yield rate indicated how efficient a particular production line or plant was at turning inputs into outputs. More specifically, with the highest yield production, effective yield learning[3] and substantial improvements including comprehensive in-line defect inspection techniques with maximum semiconductor inspection efficiency helped minimise the cost. The capacity product index (CPI; although the abbreviation 'CPK' was the term used by some respondents) was an industry standard measure which combined a range of indicators of equipment and tooling-related skills and expertise, production expansion capabilities, capacity utilisation and overall productivity. Furthermore, manufacturing investment levels showed the relative amounts each subsidiary regularly re-invests to improve or upgrade the production system. These measures were used by production managers across the sample subsidiaries, and assisted us in establishing a benchmark for making meaningful cross-comparisons. It also provided an objective way to assess the scale and significance of plant upgrades and expansion initiatives, as well as to understand more about the change capabilities required for such initiatives. A range of projects at PH had led to an improvement of productivity and production capacity, such that it had reached a 99% yield rate, compared to 95% at HT and 83% at MT. In addition, PH's CPI stood at 1.67 compared to 1.5 at HT and 1.33 at MT, as demonstrated in Table 6.2.

6.2.3.2 Production Management and Engineering Capability

PH, HT and MT regularly operated, maintained and repaired IC equipment used to assemble IC semi-products, such as IC rigid packaging, multi-layer printed circuit board and lead-frame, using in-house expertise. There was a strong reliance on internal MNE networks as the source of most of the input materials across the three subsidiaries. PH, however, had recently initiated a major change in one of the input materials to reduce production costs. It had worked jointly with internal and external suppliers as well as materials R&D specialists to substitute gold wire bonding for traditional copper bonding wire:

[3] The respondents defined this as the learning process of improving the baseline yield for a given technology node from R&D yield level to mature yield.

> *'Three years ago, we began to change the material in the wire bonding (for the IC package process), substituting the copper material for gold, collaborating with the materials analysis team at the RHQ and the supplier to co-develop this and integrate it into the manufacturing process. In spite of the ductibility of the cooper material, it is not as good as gold wire.'*

Similarly, PH, MT and HT were all capable of conducting a range of quality assessments to ensure the high quality standards of products. PH, however, had set up a specific department responsible for quality, reliability, assessments and related problem-solving, which had developed a group of specialists connected to counterparts at RHQ and HQ centres.

6.2.3.3 Minor or Major Change Capability

It is important to be able to adjust production tooling, materials flow and chemical compositions to adapt to different product types, a capability which had evolved at PH, MT and HT. These are the basic requirements for a plant to be able to move from low-end to high-end IC product manufacturing.

MT provided an example of a minor change capability in an exercise to adapt a production line to produce a compact IC lead-frame:

> *'We adjusted the chemical process on the production line to produce a slightly more high-end lead-frame in order to increase our product price. This adjustment included tuning the machine tools, keeping the manufacturing process within particular parameters and applying appropriate reliability and quality testing.'*

The kind of change was more routine for PH, which was undertaking a major in-house change in the production process:

> *'We are capable of producing most products, including one of the core IC packages which requires a lot of new techniques in the manufacturing process. In particular, it requires three dyes [a raw material of ICs] and is connected with the circuit board substrates by electrical wire bonding.'*

PH was involved in on-going collaboration with internal R&D centres to produce new types of IC packages, including 'film chips' and 'vision chips'. These were considered radical new products at corporate HQ, development of which was led by the centre and required a range of new equipment investments. PH's involvement at the design and pilot production stages of these projects attests to its level of materials knowledge, engineering skills and production process capability.

6.2.3.4 Internal and External Linkage Capability

As manufacturers situated in broader value chains, PH, MT and HT all had strong internal linkage capabilities across different levels of applied R&D centres for solving technical problems and acquiring technological knowledge. PH collaborated with technology centres at RHQ to solve the technical difficulties of operating copper wire techniques, and with the HQ's R&D centre to study the new material features of, for example, COF products. HT had an internal network to support its attempts to improve processes for manufacturing multi-layer printed circuit boards. MT imported all of its plant equipment from the production function at HQ level, resulting in a close, continuous link to maintain operational efficiency and quality levels. These examples of levels and types of interdependencies provided the evidence necessary for ranking the relative production capabilities of each subsidiary.

In terms of external linkages, all three subsidiaries had participated in the local industrial society meetings to share information on changing trends in markets, technology and the industry. PH and HT stood out from the rest of the sample, due to their strong links with external contractors around the world (not just in Taiwan) for acquiring process equipment and materials alongside technical assistance. This provided both these subsidiaries with additional sources of expertise and knowledge to update their industrial manufacturing capabilities. PH in particular, had developed expertise and related specialist technologies for wide-dimension packaging and testing systems with a global subcontractor that specialised in advanced molding and plating processes. Partly in recognition of its advanced capabilities and range of independent linkages, PH gained a higher level of support (compared with industry-standard measures in 6.2.3.1) from its parent company.

6.2.3.5 Learning Capability

Again, we found distinctive differences between PH, MT and HT in terms of how various production capabilities were being developed. When starting its manufacturing and assembly operation, MT had seconded engineers to HQ to develop a range of technical skills for operating and maintaining the plant at the required levels. For the first three to four years, MT had been dependent on technical support for lead-frame production processes from a sister subsidiary together with engineering specialists from HQ. It had then moved towards more high-end lead-frame manufacturing processes, to improve quality levels and increase its end price to customers. To do this, a target was set to improve its in-house capabilities and reduce dependence on other units' expertise. The above-mentioned sister subsidiary had reached a level of 1.6 CPI and a 120% yield rate, which MT attempted to match by developing its own in-house expertise.

PH and HT had developed more sophisticated internal and external learning collaborations, some at the level of longer-term, advanced R&D in materials measurement tooling and process-control technologies. PH showed evidence of higher levels of learning capability, with a greater range of collaborative alliances, combining both internal and external specialists to achieve their production capacity targets. Respondents at PH cited the new chip-on-film production process as an example of 'learning-by-doing'. This required specialist engineers and support from internal R&D centres and external subcontractors in partnership, before necessary capabilities for on-going process maintenance and further development had evolved in-house.

PH and HT both recruited larger numbers of more qualified graduate and postgraduate engineers and technicians, and had developed expertise in total quality management assessment techniques and ISO certification through formal training. In this way, PH in particular, had become a centre of excellence for the internal MNE network for production technology and innovation.

6.3 Comparisons of CS

Table 6.4 presents a summary comparison of the five subsidiaries with the different units, both internal and external to the subsidiary. Each subsidiary was measured for the intensity of communication systems between a focal subsidiary and a vertical hierarchical link with the HQ, a horizontal link with sister subsidiaries or R&D centres, and external link with suppliers, customers, strategic partners or research institutions by means of a number of attributes including mode, frequency, informality, formality and density of communication. We ranked each subsidiary relative to others, as high, moderate or low in terms of a combined 'score' for the intensity of a multidimensional communication system which incorporated internal and external communication networks.

In this section, we provide our justification for the relative 'rankings' in Table 6.4 and give some illustrative examples from the five subsidiaries. Our aim is to identify the entire set of entities with which the focal subsidiary communicated. The links identified were: international communication- the HQ/RHQ, sister-subsidiaries, central R&D centre, applied R&D centre and any related affiliates; external communication - with local customers, suppliers, strategic partners, local research institutes and universities. In addition, respondents were asked to assess their modes and frequency of different communication paths, as well as the motivation for the reciprocal interactions.

Table 6.4 A Summary Comparison of the Subsidiary Communication Systems

Subsidiaries / Modes	PH	RS	ST	MT	HT
Internal CS					
E-mail	*Daily* used for business problem-solving with *sister subsidiaries, business units,* and *international R&D centres.*	*Daily* used for problem-solving with *sister-subsidiary, sister-engineering centres, Central R&D centres, and the HQ.*	*Daily* used for problem-solving or business operations with *sister-subsidiaries, design centres central R&D, RHQ or HQ.*	*Daily* used to *sister-subsidiaries, centre of excellent, technology centre or HQ* for problem-solving or operational business.	*Daily* used to *sister-subsidiaries, engineering Lab. and HQ/RHQ* for operational business activities.
Telephone/Fax	Almost *daily* used for urgent problem-solving with the *sister-subsidiaries*, and *business units.*	*Daily* used for problem-solving with *regional sister-subsidiaries.*	*Daily* used with *sister subsidiaries and regional design centres* for collaborative projects and urgent business activities.	*Daily* used to numerous internal partners for problem-solving.	*Daily* used with *internal sister-units and the HQ/RHQ* for problem-solving
Conference Call/Net Meeting	*Monthly* used for business plan. Production project managers *weekly* used for technological meeting with *international R&D centres.*	*Weekly /Monthly* used for collaborative projects with *sister-subsidiaries and central R&D or applied R&D RHQ.*	*Weekly/Monthly /Quarterly* used for collaborative projects with *sister subsidiaries and central R&D.*	Neg.	*Monthly* used to *regional sister-units* for exchanging MIS information.
Intranet	*Monthly* submitted various reports to the *business units. Weekly* shared to *business units* for production scheduling reports and technical and engineering technology.	*Weekly/ Monthly* used for collaborative projects with sister-engineering centres. Very regularly used to submit functional reports to the HQ and central R&D or applied R&D RHQ.	*Monthly/Quarterly* used for operational business or technical reports with *design centres and the RHQ/HQ.*	*Monthly* used for submitting material request or operational report with *sister-subsidiary and HQ.*	*Weekly/Quarterly* submitted operational reports, such as F&A and Sales & Marketing reports, to the RHQ.
Face-to-Face Meeting	*Quarterly* and *annually* used with the *business units, PD* and *R&D centre* for business road map.	Hold *Quarterly/Half-yearly* meeting with *sister-engineering centres and parent company* to discuss business plan.	*Yearly* used for annual business meeting and engineers training on 'new' technology with *design centres/R&D and the HQ/RHQ.*	*Half-yearly* used to internal sister-units for budget meeting and technology meeting.	*Yearly* used with *the parent company* for budget meeting, product marketing meeting.
Personal Visit	*Engineers* from parent company *monthly* visited the site to share knowledge and 'on-site' training.	*Functional departments* from the HQ *weekly* visited for operational discussions. *Engineers* from parent company *monthly* visited for collaborative projects or sharing knowledge.	*Engineers* from regional design centres or central R&D *weekly/monthly* visited for sharing technology or on-site training.	*Engineers* from centre of excellent or technology centre or HQ *monthly* visited for on-site technology learning and operational activities.	Engineers from *engineering Lab. monthly* visited to deliver technology or collaborative projects.
Internal Intensity	HIGH	HIGH	MODERATE	LOW	MODERATE

Table 6.4 (Continuous)

Subsidiaries / Modes	PH	RS	ST	MT	HT
External CS					
E-mail	*Daily* used across local or global suppliers and strategic partners for engineering process discussions	*Daily* used across *local customers and strategic partners* for collaborative projects or problem-solving.	*Daily* used across *local* customers for problem-solving	*Daily* used across *local/regional suppliers and strategic partners* for problem-solving	*Daily* used across *local customers and suppliers* for problem-solving
Telephone/Fax	*Daily/Weekly* used across local/global suppliers and strategic partners for information exchange.	*Daily* used across local *customers and strategic partners* for sharing market information or easier problem-solving.	*Daily* used across local customers for problem-solving.	*Daily* used across *local customers /regional suppliers /strategic partners* for problem-solving.	Daily used across local customers and suppliers for exchange information.
Personal Visit	*Monthly* used across local/global suppliers and strategic partners for sharing design or production process	*Monthly* visited *local customers and strategic partners* for information and knowledge exchange.	*Monthly* visited local customers or subcontractors or suppliers for knowledge sharing.	*Monthly/Quarterly* used across *local customers or local suppliers* for collaborative projects.	Monthly used across local customers and suppliers for sharing production-related technology.
Face-to-Face meeting/ Conference	*Quarterly* used across *local universities and ITRI* for knowledge exchange	*Quarterly* used across local universities or research for sharing knowledge.	*Occasionally* used across *local university or ITRI* for acquiring local market-led technology.	*Quarterly/Half-yearly* communicated with *local institutions and government* for market-led information exchange.	*Occasionally* used across *local institutions* for acquiring market-related information.
External Intensity	HIGH	HIGH	MODERATE	LOW	MODERATE

6.3.1 Internal CS

This set of internal CS garnered several characteristics of communicating modes, frequency, density and the type of information exchange with internal links in the focal subsidiary. The formal vertical link with the HQ/RHQ and horizontal link with sister-subsidiaries or global R&D functions were amongst the measures used across the five subsidiaries. However, more importantly, we compared the frequency, modes, density and the complexity of information exchange with these links to penetrate subsidiary dependence on the internal network for innovation activities at the subsidiary level.

Given the fact that we found similarities to five case-studies in Chapter 5, all five subsidiaries demonstrated they were in average daily communication with their 'mentors' or 'central account managers' (namely the HQ or RHQ) and 'sister-subsidiaries' by means of informal communication mechanisms in terms of E-mail and/or telephone/fax. Development of such informality derived them some benefit with their internal relatives across geographical and functional borders in terms of exchange of information and less complex problem-solving. In particular, the involvement of PH, RS, ST and HT with the dispersed R&D centres in technical collaboration led to technical and knowledge learning. They also developed 'formality' in terms of face-to-face meetings and personal visits to the HQ or RHQ for shaping and/or finalising business plans. Evidence of such activity may imply a centralised mode of management process in relation to the parent company.

PH and RS stood out amongst the five cases because they had developed a relatively high degree of formal communication with the parent company HQ or RHQ, global R&D centres by using face-to-face meeting, personal visits and the intra-net. Given the different communication patterns, they were mainly developed for exchanging knowledge at different phases of the collaborative-projects, product and technology developments and implementation of the business plan. This communication capacity in particular provided effectiveness in developing subsidiary innovation activities. One PH senior manager stated "*The intranet data-base gives a platform to seek out some resolutions, while we commence with the difficulty in the early stage of the pilot product development; in addition, the regular cross-level of R&D engineers' visits is an alternative way to advance our existing technology capability as the 'new' product development stage.*"

By comparison, MT had a less intense range of internal communications with the parent company HQ, regional sister-subsidiaries and technology centres. Communication with the parent company was limited to various business activities reports and business-plan meetings, and communication with sister-manufacturing or technology units were only involved in technical problem solving. Comparing different patterns of internal communication systems, we ranked RS and PH higher than ST and HT, and concluded that MT had the lowest intensity of internal communication relative to the others.

6.3.2 External CS

As shown in Table 6.4, all the subsidiaries had communication links with external customers, suppliers, strategic partners and research institutions. RS, ST and HT subsidiaries developed a close embeddedness in the local context, whereas PH and MT evolved a more international profile of communication.

Subsidiary RS, ST and HT involved some exchange of customer-led product or process improvements and technical problem-solving with local customers, local strategic partners, local suppliers and/or local research institutions. RS showed evidence of higher intensity of external communication systems in association with their local counterparts. In particular, it developed average daily communication via 'informal-modes' such as e-mail and telephone/fax with local customers and local strategic partners on joint-initiatives. Communication with local customers and strategic partners involved different levels of knowledge exchange from incremental product design to technical problem-solving and market information, together with monthly on-site visits to promote the exchange of dynamic ideas in joint-projects. Furthermore, RS developed communication capacity with local universities, particularly in terms of the applied research development of local initiative projects, as well as communication with research institutions. Likewise, ITRI related to some exchange of electronics global market trend and technology development.

By contrast, PH and MT were found to have communication with regional and/or global customers, suppliers, or strategic partners on product and/or process innovation activities; however, their communication links were predominantly built up by the parent company, HQ or RHQ. More specifically, PH had a strong communication link with local or global strategic partners and suppliers on engineering process improvements and on-going collaborative projects. It also maintained a connection with local universities with basic and applied chemistry and engineering researchers, as well as local institutions, such as ITRI with some exchange of industrial technology development through regular face-to-face meeting and conference modes.

Comparing different external modes, frequency, density and the degree of information exchange, we ranked RS and PH higher than ST and HT in terms of intensity, due to their development of strong communications in the local or regional/global context, and ranked ST and HT relatively higher than MT.

6.4 Concluding Remarks: Comparison Matrixes

The relationship between parent company, HQ or RHQ and subsidiary was a vital determinant of subsidiary autonomy, which had a significant effect on the levels and types of capability that developed in the subsidiary, and the mechanisms by which different capabilities developed. We found some specific dimensions (product-development, subcontracting, changes in operational processes and technology decisions) of subsidiary autonomy that were linked to subsidiary capability, as explored in Section 6.1. Overall, the subsidiaries which had less autonomy as regard particular kinds of decision-making were more closely dependent on internal, HQ-linked resources, capabilities and expertise in this aspect of decision-making. This correlation was expected, but we found the underlying relationships that led to this pattern were more complex than anticipated.

Figure 6.2 shows how we ranked each subsidiary in terms of overall level of autonomy from the parent company, HQ or RHQ, against a combined 'score' for technological capabilities, which encompassed different types of capability (design, production and/or marketing) discussed in Section 6.2. RS had a higher level of autonomy compared to PH and MT with medium levels, and ST and HT with low autonomy. Conversely, PH had a higher degree of technological capabilities in comparison with RS and HT with medium degrees, and ST and MT with lower capabilities. Whilst this figure showed a combined 'score' for autonomy and technological capabilities and simplified the various dimensions of autonomy and capabilities, strictly speaking, it did not display liner-relationship between subsidiary autonomy and technological capability. However, as suggested in the literature (e.g. Rugman and Verbeke, 2001), if we regard PH as an extraordinary case because it had evolved a full range of value-added activities, and thus neglect its influences on the relationship of subsidiary capability and subsidiary autonomy, as shown in Figure 6.2, it is apparent that RS stands out from the rest as the one with relatively 'higher' autonomous subsidiary with higher capabilities (in connection with two types of capability). By contrast, in our findings, the less autonomous subsidiary was not ensured for the lower technological capability, particularly in the case of HT. This simplistic linear relationship implies a complex or multidimensional nature of the subsidiary function in the MNE networks, as illustrated, for instance, by subsidiary PH. The underlying complexity of the subsidiary development of its specific advantages (i.e. technological innovations) must be considered and will be further explored in Chapter 7.

To understand better the relationships of subsidiary autonomy and subsidiary technological capability, we created a comparison matrix (see Figure 6.3) using SA, TC and CS to highlight the influence of the 'simplified' intensity of communication capacity (internal and external communication). What stood out was the subsidiary with the relatively high degree of internal and external communication capacity; it seemed to have effectiveness in creating and/or exploiting internal and external assets and capabilities to enhance the subsidiary organisational knowledge and capability, an issue formally addressed in Chapter 7. This chapter on cross-case comparisons helps us to verify our propositions and to seek more evidence for the specific subsidiary advantages in the perspective of subsidiary technological capability development.

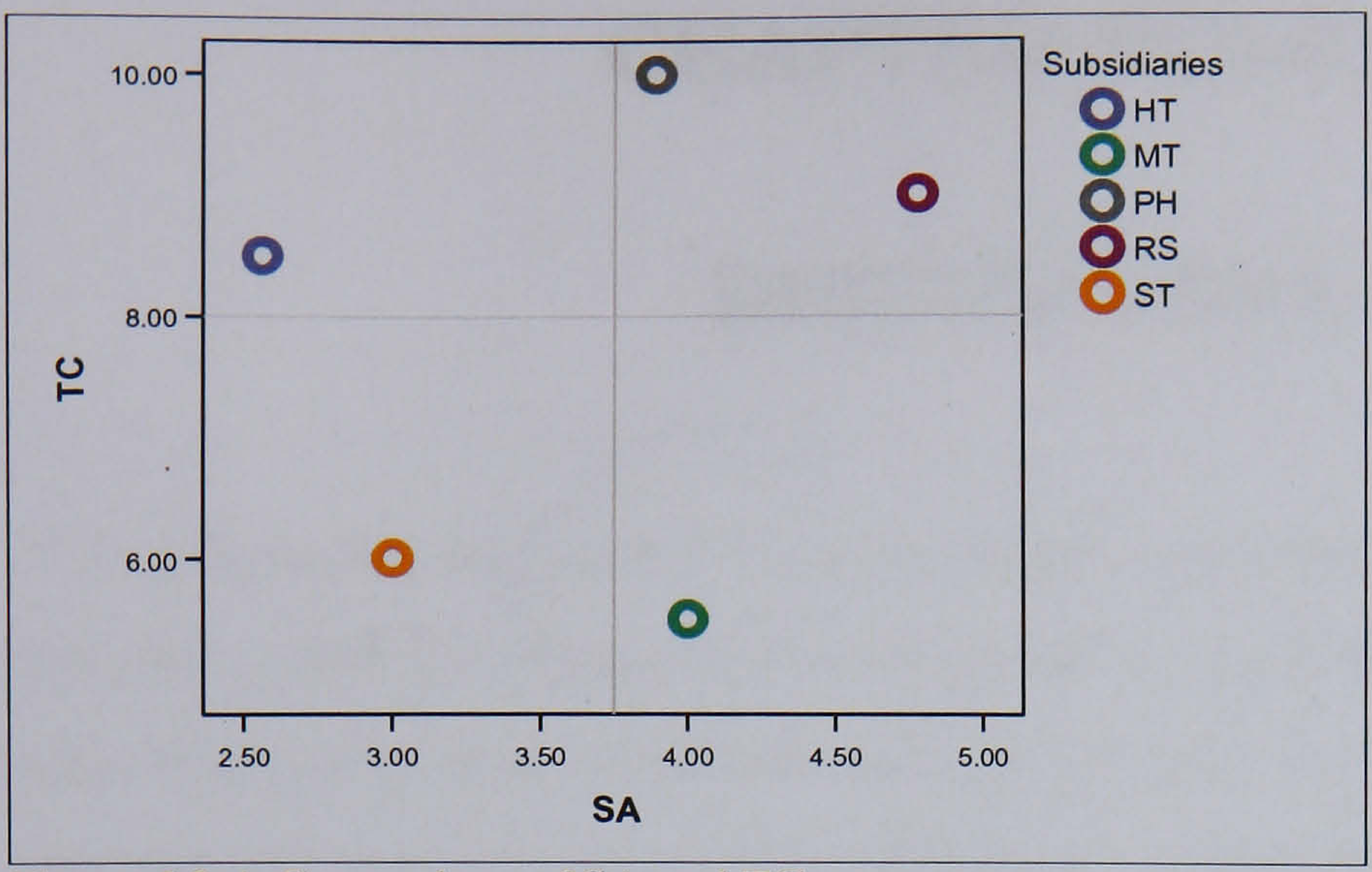

Figure 6.2 A Comparison of SA and TC

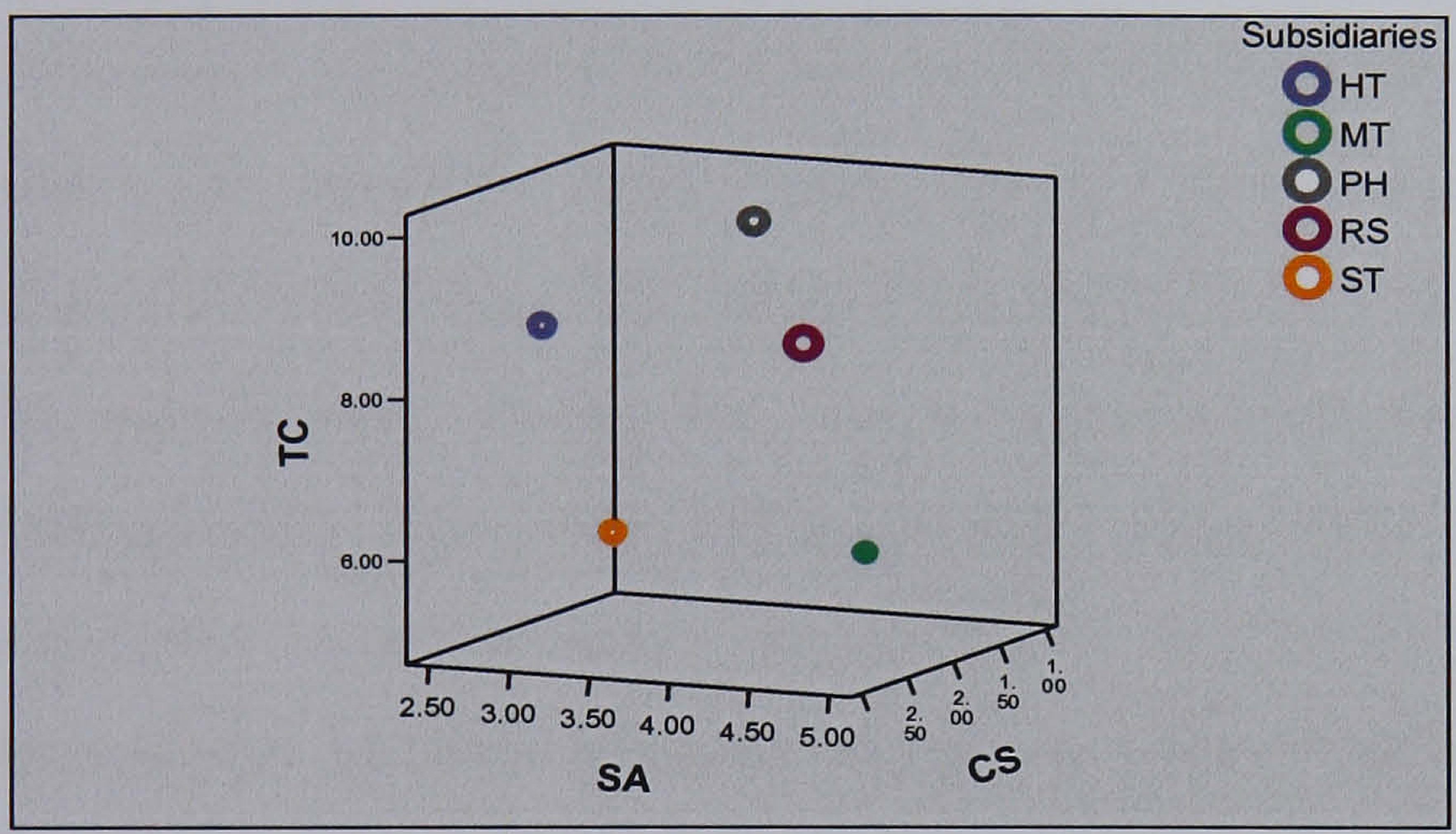

Figure 6.3 A Comparison of SA, TC and CS

CHAPTER SEVEN

DISCUSSIONS

The case studies and case-cross comparisons presented earlier gave some insight into the capability, competence-creating and/or exploiting of the subsidiary, and identified under what conditions subsidiaries used and communicated with their internal and external MNE network linkages. In this chapter, we will discuss the evidence gathered, and will present a further analysis and discussion of the main findings of this study. Whilst it is unrealistic to generalise from this small sample of subsidiaries, it is useful to compare some of the results to other empirical studies and wider literature; first, to assess their validity, and second, to interpret their importance in terms of the capabilities, competence-creating and/or exploiting done by subsidiaries. From this more wide-ranging discussion, it is logical to conceptualise the relationship between subsidiary autonomy and subsidiary capability or competence; in particular, it will be possible to outline some managerial recommendations aimed at improving the innovation regime for competence-creating and/or exploiting in the MNE network.

The principal objectives in this chapter are to discuss subsidiary capability, particularly in terms of technological capability development, to identify the interaction with the internal and external MNE network and the formal (legitimate) relationship with the parent company encountered in the management of subsidiary technological innovations or initiatives.[1] Our discussion of the critical issues around subsidiary technological capability development will be structured as follows. In Section 7.1, we will summarise the more theoretical findings from our study of subsidiary technological capability development in Chapters 5 and 6. In Section 7.2, we hope to move from the somewhat fragmented description of

[1] Technological innovation and initiative are somewhat interchangeable in the particular context of subsidiary value-added activities, although strictly speaking, there is a major difference in the types and degrees of technological development.

internal and external networks across five subsidiary studies in Chapter 5, to indicate technology sources existing for the everyday operational activities at the subsidiary level. Section 7.3 aims to build internal validity and raise the theoretical level with regard to subsidiary technological capabilities pertaining to marketing-related, design-related and/or production-related technological capability. In particular, these specific technological capabilities will be identified by subsidiary in-house specific ability, linkage capability and learning capability in the context of subsidiary value-added activities. The purpose of Section 7.4 is to address a number of generic decision-making issues between the subsidiary and the parent company. These underlying changes of autonomy must be clarified in order to establish the nature of the relationships between subsidiary autonomy and subsidiary technological capability in the context of the subsidiary differentiated network. Section 7.5 will demonstrate a key mechanism-communication to consider how a subsidiary uses internal and external communication systems to develop share and/or leverage its technological knowledge (e.g. Ghoshal *et al.*, 1994). In the final section, we will summarise the phenomenon of subsidiary technological capability development and outline a framework for interpreting the cyclical process of that development.

7.1 Summary of Findings

The interviews phase of the fieldwork soon illustrated the wide range of technology sources internal and external to subsidiaries' networks. Analysis of the internal and external linkages used by the subsidiaries differed in terms of the extent and availability of various technology sources. It was relatively straightforward to demonstrate that technology sources had clear connections between subsidiary autonomy and indigenous functioning capabilities in terms of marketing, design and/or production. While we found some differences in the subsidiary-level of technology sources, subsidiary technological capabilities and subsidiary autonomy amongst the five subsidiaries, the full details of the subsidiary specific capabilities of the five Taiwan-based subsidiaries described in Chapter 5, namely, capability-creating and/or exploiting, consistently were presented with the issue of information processing capability in terms of the intensity of communication (Gupta and Govindarajan, 1991).

Having compared the autonomy, technological capabilities and communication systems of the five Taiwan-based subsidiaries, the juxtaposition of the differences in subsidiary capability-creating and/or exploitation were most evident. Table 7.1 summarises the findings from our within case analysis (Chapter 5) and cross-case comparisons (Chapter 6). Each subsidiary is ranked relative to the others, high, moderate or low, in terms of the three kinds of technological capability examined regarding marketing, design and production. Column 3 comments on the relative levels and types of autonomy in each subsidiary, and Column 4 summarises key sources of technology, indicating how internal and external linkages differed across the 5 subsidiaries. The final Column indicates the intensity of communication between the internal and external linkages.

We now discuss the evidence gathered at this detailed level, in order to compare some of the results to other empirical studies and wider literature. This more wide-ranging discussion will allow a more detailed frame-breaking mode of thinking with regard to the subsidiary's specific advantages in terms of capabilities or competences-creating and/or exploitation.

Table 7.1 Technological Capability, Autonomy, Technology Sources and Communication System for the Case Study Subsidiaries

Firms	Technology Sources	Technological Capability	Subsidiary Autonomy	Communication Systems
PH	• 90% in-house technology and 10% from international sources • Initiates new technology with the innovation centre at RHQ and cooperates with technology centres at both group HQ and Corporate R&D centre • Technology also from global outsourcers	• Low in Marketing • High in Design • High in Production	• Moderate in overall level of autonomy, particularly in finance, purchasing, product-development, collaboration, subcontracting, and change in operational processes; but, higher autonomy in HR, technology decisions • Interdependent with HQ, RHQ and worldwide R&D centres. • A source of technology to other sister-units.	• High Intensity in Internal Communication • High Intensity in External Communication
RS	• 50% in-house technology (10%- 15% in collaboration with applied R&D centres), 40% from HQ, 5% co-designed with customers and 5% designed-out with local firms and manufactured in home country sister-plant • Participating in joint-projects with regional and central R&D units • Initiates applied product development with local customers and firms	• High in Marketing • Moderate in Design	• High in overall level of autonomy particularly in HR, marketing activity, product-development, collaboration and subcontracting but moderate in technology and low in purchasing and change in operational process • Interdependent with HQ, regional R&D centres and corporate R&D centre.	• High Intensity in Internal Communication • High Intensity in External Communication
ST	• 50% technology from product divisions (RHQ), 40% designed-in with customers, 10% from local firms or sister-subsidiaries and manufactured in sister-plant • New product projects devolved from the product divisions (RHQ), co-designed with the R&D centre	• Moderate in Marketing • Low in Design	• Low in overall level of autonomy, but moderate in marketing, product-development, and technology decisions. • Two Directors of product divisions are located at the subsidiary giving more autonomy in decision-making. • Interdependent with RHQ and R&D centres in product divisions.	• Moderate Intensity in Internal Communication • Moderate Intensity in External Communication
MT	• 80% technology from the HQ, 3% technology from the sister-unit, 17%	• Low in Marketing • Low in	• Moderate in overall level of autonomy, but higher autonomy in purchasing and	• Low Intensity in Internal Communication

	in-house technology • Exploits existing technology with sister-units and HQ	Production	internal collaboration and lower autonomy in subcontracting, change in operational process, and technology. • Interdependent with the HQ and corporate R&D	• Low Intensity in External Communication
HT	• 60% technology from the HQ,30% in-house, 10% from sister-units • Exploits existing technology with HQ R&D and manufacturing units	• Moderate in Marketing • Moderate in Production	• Low in overall level of autonomy, but moderate autonomy in purchasing, HR decision-making. • Interdependent with RHQ and regional networks, but provides regional marketing information to RHQ and HQ	• Moderate Intensity in Internal communication • Moderate Intensity in External Communication

7.2 Technology Sources

In this section, we compare the technology sources responses with the within-case analysis introduced in Chapter 5 and deliberate under what conditions a subsidiary has been granted access to multifaceted sources of technology using its internal and/or external linkages to develop its technological capabilities. This discussion concentrates on specific 'linkages', divided into 1)internal network built through technological innovation interactions between a focal subsidiary and other affiliated-units in the internal MNE network; 2) external network developed through interaction with local, regional or global entities beyond the boundaries of the parent company system. These network linkages exist in the everyday operational activities at the subsidiary level, affording many benefits in terms of creating and/or exploiting subsidiary capability or competence. Figure 7.1 illustrates the focal subsidiary developed through the internal and external network linkages.

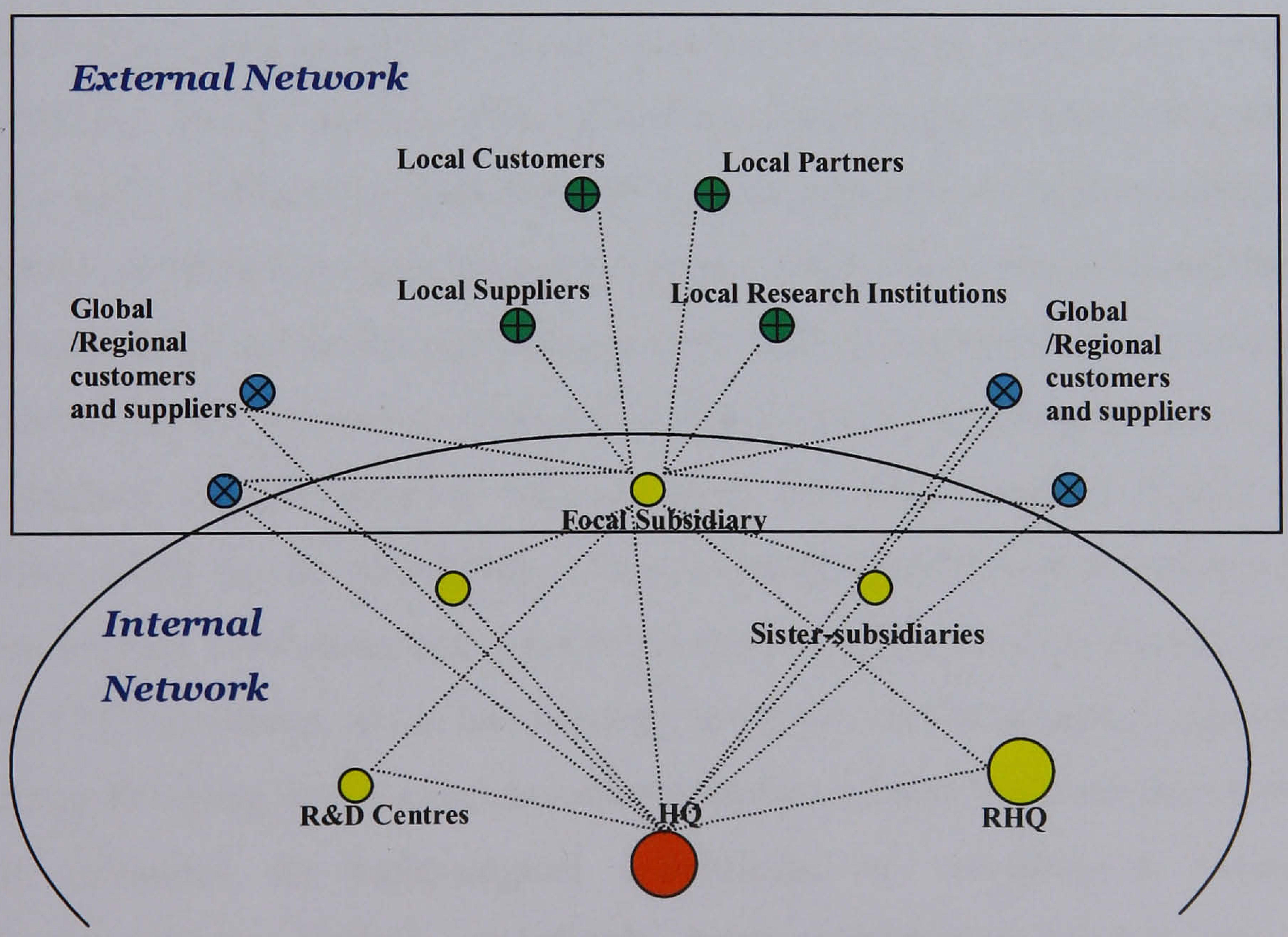

Figure 7.1 Conceptual Framework of the Subsidiary Network Linkages

7.2.1 Internal Network

Variations in the technology sources that existed across the five Taiwan-based subsidiaries revealed that the five subsidiaries studied were much more capable of initiating or carrying out technological innovation activity with regard to knowledge of the markets in which they were situated and through which linkages were established. In particular, the subsidiaries accessed their internal assets and/or resources or capabilities through a variety of internal multi-level linkages to create and/or exploit different types of technological capabilities, as described in Chapter 5. Interestingly, the links of all five subsidiaries were established through intensive coordination and collaboration with the internal MNE network, including vertical and horizontal linkages, as shown in Table 7.1; specifically, through formality (legitimation) and linkage (indicated in Chapter 5). For instance, HQ or RHQ affiliated hierarchical R&D centres or sister-subsidiaries co-developed the existing and/or new products or processes. In particular, for subsidiaries like MT and HT, over 60 % of core-technology was from the HQ or RHQ. They collaborated with sister-subsidiaries by using the in-house capabilities of each to make some market-driven and/or applied (minor) changes in product productions. Similarly, subsidiaries like ST and RS, 40% of the core-technologies of which was from the HQ or RHQ, collaborated with different product segments or operations (described as sister-subsidies) on applied product designs. These four cases revealed that their key knowledge and technology sources were from the parent company, reflected in the subsidiaries' exploiting of the technological assets of internal sources, or the capabilities' interdependence between them and those sources (Kogut, 2000; Zander, 1999) for the developing of core-competencies through the accumulation of proprietary technology and knowledge (Pavitt, 1990). An exceptional case was that of PH subsidiary, which had initiated new products and processes related to IC packing & testing in close collaboration with hierarchical R&D centres over time. This enhanced its technological capabilities or competences among its sister-subsidiaries, having, accordingly, been mandated to provide technology assistance to the regional sister subsidiaries. The case of PH shows that subsidiary initiatives make an effective contribution to resources deployment within the internal MNE network, an issue formally discussed in Sections 7.4.2 and 7.4.3.

7.2.2 External Network

Furthermore, the five subsidiaries built up local linkages with customers, suppliers and/or institutions, including universities (again, detailed in Chapter 5). A key difference among the five Taiwan-based subsidiaries, by their own accounts, was that the subsidiary facilitated the local linkages to make minor or customised changes, and/or develop applied technology as well as evolve basic technology research. ST and RS illustrated their vital linkages with local customers for the fulfilling of market-driven technology exploitation. In addition, PH and RS subsidiaries collaborated with local universities and institutions (e.g. ITRI) with regard to sustainable technology development in semiconductors. Our finding links the distinctive technological capabilities of multinational subsidiaries to local sources of knowledge and location of technological advantage (Cantwell, 1992; 1995; Dunning, 1994, 1995; Frost, 2001). Interestingly, we learnt from the cases of PH and ST that subsidiaries were granted access to the global outsourcers or subcontractors to develop distinct technology (e.g. design and/or engineering) for the MNE. Here, key is the insight gained by linking the specific capabilities of subsidiaries' innovations to sources of technology originating across local geographic location; an issue that will be elaborated upon in the next section.

Our finding draws the distinction between internal and external linkages on the subsidiary level. In particular, we point out that the subsidiary facilitates internal, local and regional /global technology sources to evolve its technological capability, leading to the creating and/or exploiting of assets and capabilities which empirically are proven technology generation, deployment, acquisition and diffusion, derived from internally and externally organised MNEs (e.g., Almeida and Phene, 2004; Frost, 2001; Manolopoulos *et al.*, 2005). The empirical finding illustrates that the parent company provided a source of technology for capability-creating and/or exploiting subsidiaries (e.g. Frost, 2001), as well as proposing that subsidiaries were strongly embedded in the local environment, which provided an advantageous position to absorb and combine new applied technical and market-driven knowledge in innovative ways (e.g., Håkanson and Nobel, 2001; Andersson *et al.*, 2002). According to our evidence, external (local/regional/global) technological linkage could be considered a crucial resource, which is in parallel with internal technological linkage, for the sustained competitiveness of the subsidiary and the MNE. Our finding also underscores the subsidiary's ability to build and/or exploit technological capabilities in association with internal and/or external linkages within the MNE networks, and thus, the multifaceted technology sources may have different drivers of subsidiary developments (e.g., Birkinshaw and Hood, 1998b), which require the necessary degrees of autonomy for the subsidiary to execute proactively on behalf of the subsidiary. It also highlights that the degree of subsidiary autonomy may vary in this regard as a result of the fact that subsidiary autonomy may evolve by means of bargaining between the parent company and subsidiary (e.g. Taggart, 1997). These issues will be further discussed in the following section.

7.3 Subsidiary Technological Capabilities

As discussed, subsidiaries combine internal and external sources of technology to create and/or exploit their technological capabilities or competences within the MNE networks. Whilst subsidiary capability development and involvement in innovation-related initiatives are constrained by the natural rate of growth of assets/capabilities and by the actions of the parent company to control access to resources (Anersson and Forsgren, 2000; Frost, 2001; Malnight, 1996), the stock of capabilities is maintained and developed by the subsidiary performing specific value-added activities to the MNE (e.g. Birkinshaw and Hood, 1998a; Papanastassiou and Pearce, 1994). By identifying subsidiary value-added functioning activities in terms of marketing, design and/or production in association with the mechanisms of each specific capability, the differentiation of the subsidiary technological capability amongst five Taiwan-based subsidiaries were assessed, as presented in Table 7.1. These indicators were derived from the within-case analysis in Chapter 5, and were further used to compare the five cases in Chapter 6. Table 7.2 summaries the key mechanisms of subsidiary technological capabilities developed to compare the five Taiwan-based subsidiaries. Each of the technological capabilities was underpinned by the following key mechanisms: 1) the capacity for specific (functioning) value-added activity; 2) internal and external linkages capability; 3) learning capability. These mechanisms reflect the subsidiary specific value-added activities, particularly in terms of functional proprietary assets and capabilities (e.g. Rugman, 1981), and indicate the capability exploitation and/or creating granted to the subsidiary from internal and external technology sources (e.g. Manolopoulos *et al.*, 2005). Moreover, learning capability is viewed as a functional based focus involving product-to-process learning for capability developments (Kim, 1997, 1998; Powell, 1998).

In addition, these 3×3 characteristics of technological capabilities may have influences that are industry- and context-specific (Cantwell, 1992, 1995; Dunning, 1994, 1995), resulting in generalising the creating or exploiting of subsidiary technological capabilities or competences. However, we are able to generalise the finding of our research setting (Miles and Huberman, 1994) - subsidiaries in the electronics industry in newly industrial economics (NIE) or latecomer countries, particularly in Taiwan.

Table 7.2 Types and Mechanisms Used for Subsidiary Technological Capabilities

Mechanisms Types of TCs	The Ability to Specific Value-added Activity	Internal and External Linkages Capability	Learning Capability
Marketing Capability	• Order-fulfilment, customer-evaluation and feedback processes • Local, regional or global market scope • Market research responsibilities, resources and expertise • Direct vs. indirect customer links.	• Internal Linkage: Level of subsidiary participation in marketing and/or new product development strategy development with the parent company, HQ or RHQ or sister-subsidiaries (e.g. R&D units) • External Linkages: the ability to fulfil the customer needs or requirements of market-driven technical skill.	• Learning by doing, particularly learning-by-operating marketing activities • Learning by collaboration to local intermediaries to learn about local market trends and customers. • Learning by prior accumulation of experience and specialists.
Design Capability	• Number of patents or patentable cases registered at the subsidiary level • Time-to-market • Applied R&D investment as a percentage of sales • Minor versus major change capabilities	• Internal Linkage: Level of subsidiary responsibilities for new product development scope, resources and expertise with the parent company affiliated sister-units. • External Linkage: Level of subsidiary collaboration on new product development resources and specialists with local, regional and/or global entities.	• Learning by doing related to incremental improvements. • Learning by internal and external collaboration on product designs and/or designs of process. • Learning by prior accumulation of experience and knowledge.
Production Capability	• Yield rate (industry-defined standard for plant productivity) • Capacity production index (CPI/CPK) (industry standard for productivity and capacity utilisation) • Manufacturing investment as a percentage of sales • Production Management and Engineering Capability • Minor versus major change capabilities	• Internal Linkage: Level of subsidiary collaboration on engineering and process of production technology • External Linkage: Level of subsidiary collaboration on process and engineering of production technology	• Learning by training on production management and process technology. • Learning by doing related to incremental improvements on production technology. • Learning by internal and external collaboration on engineering and process of production technology. • Learning by prior accumulation of experience and knowledge.

7.3.1 Marketing-related Technological Capability

In accord with the TC taxonomies proposed by Ernst *et al.* (1998), the subsidiary value-added functioning activities were analysed in relation to the subsidiary existing assets or capabilities and in what particular context. In particular, marketing-related capability was identified with the ability to undertake marketing activity, the linkage capability for acquiring marketing-related technological knowledge through internal and external networks and what marketing capability being developed at the five Taiwan-based subsidiaries, as showed in Table 7.2.

This type of capability relates particularly to technological opportunities, led by R&D, and commercial opportunities, determined by customer requirements. Our finding empirically supports the view that the subsidiary builds up a certain degree of technological capacity within its own value-added activities which exists in functional proprietary assets/capabilities reflecting subsidiary specific advantage (e.g. Rugman and Verbeke, 2001). RS, a subsidiary with relatively high marketing capability in comparison with the other subsidiaries (summarised in Table 7.1), is competent at marketing management, marketing experience and knowledge, particularly at decision-making autonomy for product price, promotion and distribution channel planning for local-focus market scope. In addition, it is competent at dealing with demand patterns with regard to local (Taiwan) and Great China regional marketing trends relating to customer-led technical supports and market-driven R&D technology. In contrast, PH subsidiary was relatively more dependent on internal and HQ-based marketing departments for linking its innovation efforts to customer needs, and for its sales and distribution activities. More importantly, through this particular functional capability, it advances the current studies (Zou and Cavusgil, 2002; Hewett *et al.*, 2003) in terms of in-house processes, resource and expertise to connect commercialisation to innovation activities being elaborated at the subsidiary level and elsewhere in the MNE (presented in Chapters 5 & 6).

The extent of marketing capability-creating and/or exploiting from internal and external linkages is examined by identifying the different types of internal and external linkages and the levels of marketing-related capabilities. In particular, our finding attests that most subsidiaries (e.g. RS, ST, MT) were legitimately and structurally involved in internal marketing coordination or collaboration on supply chain management where the roles of subsidiaries were assigned. Moreover, they were granted participation on R&D and product development committees and meetings to understand and help shape central strategy. In contrast, PH subsidiary was relatively lacking in terms of in-house marketing capabilities, and took its lead from marketing expertise elsewhere in the MNE network. Our findings are partially consistent with Hewett *et al.*'s (2003) study, namely that subsidiaries develop vertical supply chain linkage with the internal network for effectively marketing activities in association with the roles of subsidiaries. However, some of our findings contradict their study with regard to whether or not participation in goal-setting affects certain product-related decisions. RS, HT and MT subsidiaries illustrated that subsidiaries developed a variety of external connections with local customers to drive new product developments and customise designs for the local market, which is in line with a number of existing studies (e.g. Andersson *et al.*, 2001; Edwards *et al.*, 2002). In addition, our findings imply that the subsidiary with relatively high marketing expertise and local/regional market knowledge initiates local or regional focus marketing activities that somewhat expand the subsidiary's scope of responsibility. This may result in a subsidiary fighting for more autonomy from the parent company, an issue that will be formally discussed in Sections 7.4.2 and 7.4.3.

Furthermore, this research specifically examines how a subsidiary effectively exploits and/or builds internal and external linkages of technology sources through its capacity for learning. Our empirical evidence shows that internal collaboration with marketing and product affiliated departments at the parent company, HQ or RHQ was the most frequently cited learning resource for the subsidiaries. The wider range of local links with local customers and specialist industry organisations help subsidiaries to develop more sophisticated marketing capability. As illustrated by RS with its high marketing capability, and ST with its medium capability, they learnt 'by doing' through joint regional marketing activities, product promotion and/or product logistics management in order to enhance marketing capability in terms of order fulfilments.[2] In addition, RS and ST subsidiaries had initiated a number of marketing research projects to better-understand local or regional

[2] As respondents stated, in comparison with ST subsidiary, RS achieved order fulfilment approximately 5% more to 100% in 2004.

customer requirements and market trends. Our findings are consistent with other studies, namely, that the subsidiary performs specific value-added activities which are fundamentally 'embedded' in their respective host-countries' knowledge systems (Dunning, 1996; Jarillo and Martinez, 1990, Kuemmerle, 1999).

In short, this marketing capability distinguishes not only routine marketing activity, such as the process of developing promotional campaigns and engaging in distribution (e.g. Zou and Cavugil, 2002; Hewett *et al.*, 2003), but also marketing innovative activities involving customer-led product developments and local marketing initiatives (e.g. Birkinshaw, 1997, 1999, 2000). Our empirical evidence indicates that a subsidiary with relatively high marketing capability, such as RS or ST, initiated certain marketing decisions and strategic activities of local or regional scope; meanwhile, it also developed an internal dependence and participation in marketing goal-setting with the parent company. This highlights that technological development at the subsidiary level does not rely on internal sources alone, but also on external sources, a finding in line with the work of Manolopoulos *et al.* (2005).

7.3.2 Design-related Technological Capability

Subsidiaries such as PH, RS and ST had capabilities in design-related value-added activity within MNEs' networks in tandem with the legitimately hierarchical R&D organisations. In particular, this type of design-related capability includes a wide range of activities aimed at planning and designing procedures, technical specifications and other user and functional characteristics for new products and/or processes (e.g. OECD, 2005). It is an integral part of the R&D activities (e.g. OECD, 2002), as displayed in Figure 7.2. They were involved in a range of IC design-related capabilities and related collaborative linkages, both internal and external, and several forms of learning mechanisms.

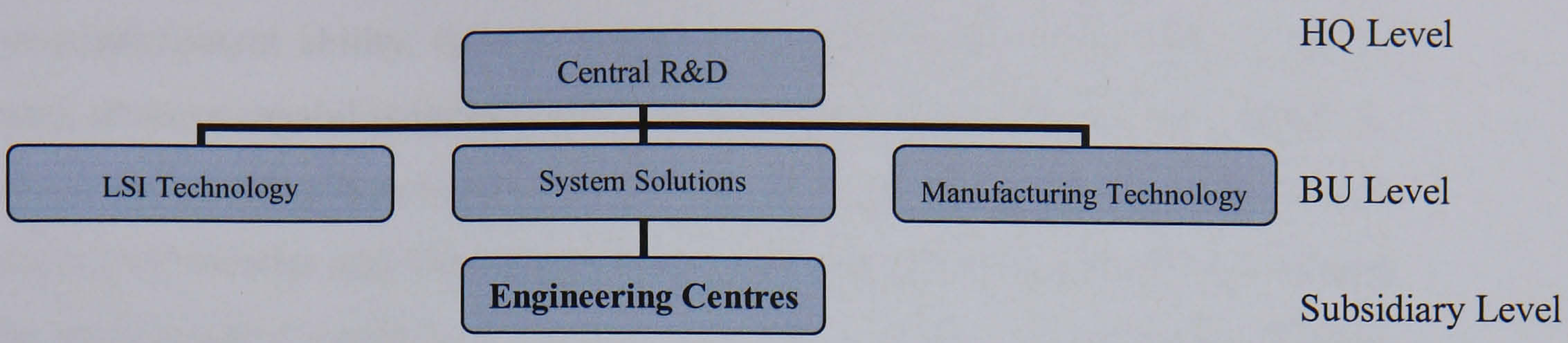

Figure 7.2 The Hierarchical R&D Organisations (Illustrated from the case of RS)

The growing importance of R&D activity outside the home country highlights that multinational subsidiaries play an increasingly important role in the creation of new capabilities or competences in the MNE network (Cantwell and Mudambi, 2005; Dunning, 1994; Papanastassiou and Pearce, 1994; Cantwell, 1989; Pearce, 1989). The studies suggest that subsidiaries are 'home-base exploiters' for the MNE. However, our findings illustrate that subsidiaries are not only 'home-base exploiters' (e.g. Kuemmerle, 1999; Kogut, 2000), but also 'host-country creators'.

The three subsidiaries PH, RS and ST adapted/exploited core-components from the parent company and were involved in different degrees of R&D activities in terms of product and process innovation using in-house capabilities and/or external resources (e.g. assets or capabilities). In particular, a subsidiary with relatively high design-related capability, such as PH, exploited internal resources from the parent company, for instance, core-component (e.g. wafer/dye), and used its in-house capabilities to undertake IC package improvements as well as initiating major changes in the design of the IC package. Over an extended period of time, PH had accumulated experience and knowledge and built an entirely new IC package design, replacing the traditional lead package with a BGA package. Our empirical evidence indicates that a subsidiary that is also involved in the different degrees of R&D activities in the MNE network cannot only be a capability-exploiter, but also a capability-creator, a finding consistent with other subsidiary studies (e.g. Birkinshaw, 1997; Cantwell and Mudambi, 2005; Papanastassiou and Pearce, 1999).

Furthermore, our subsidiary studies indicated some quantified scores of the in-house capacity for design-related activity, such as the industrial patentable/patent ability, time to market, productivity index (e.g. asset turnover rate), advance capability index and turnover of innovation (illustrated in Chapter 5), which were used as benchmarks for comparing performance and capability across (sister) subsidiaries and case-study subsidiaries. These industry standard measures for technological capabilities can be a meaningful way of gauging capability differences in order to resolve the difficulty of obtaining subsidiary-level technological innovation data from a representative sample of MNE (Kogut and Chang, 1991) and the drawbacks of using patent data (e.g. Almeida and Phene, 2004; Frost, 2001). Nonetheless, it may not provide a perfect/general comparison across the subsidiaries due to the fact that they were involved in different types and degrees of products and/or process development.

Subsidiaries exploit and build design-related capability through the extent of internal and external collaborative linkages. The recent study advocates that subsidiaries link the external resources in creating subsidiary-specific advantages (e.g. Andersson *et al.*, 2002; Almeida and Phene, 2004; Frost, 2001). Our findings present an interesting insight into the collaborative linkages between internal and external technology resources. Subsidiaries such as PH, RS and ST were granted access to the legitimately hierarchical R&D centres (as shown in Figure 7.2) to obtain different kinds of technology. In particular, these subsidiaries acquired different degrees of technology in collaboration with worldwide R&D centres for reasons ranging from solving 'problem-led' technical difficulties to acquiring advance engineering technology, particularly for the PH subsidiary, involving the translation of technical information into processes, equipment or manufacturable products (detailed in Chapters 5 and 6). These internal collaborative linkages were connected to market-driven functions to exploit internal resources to optimise the capabilities and efficiencies of the MNE, as well as to avoid any reinventing of the wheel and to achieve collaboration gains (Doz, 1986; Prahalad and Doz, 1987). At the same time, subsidiaries with high or significant design-related capability develop strong external linkages with local universities and research institutions, as well as local competitive firms or global subcontractors in collaboration on basic and applied technology developments. For example, RS had technical contracts with local firms to co-work on system-on-a-chip designs. Interestingly, we found PH subsidiary (presented in Chapters 5 and 6) was granted a contributing mandate to collaborate with regional and/or global subcontractors on the development of 'new' technological innovation in terms of product and/or process and leveraging of its resources to the MNE. These kinds of linkage provided useful sources for the creating up of subsidiary specific-capability and competence.

Our empirical evidence partly contradicts the work of Almeida and Phene (2004), who suggested that 'semiconductor MNEs' learning-oriented subsidiaries are in quest of novel knowledge and linkages to the MNC may provide redundant knowledge…' (Almeida and Phene, 2004). Our finding highlights that the subsidiary, for instance, PH or RS, with high design-related capability, owns reciprocal technological leverage internally and externally (e.g. Manolopoulos *et al.*, 2005; Rugman and Verbeke, 2001). An explanation of our finding is that the electronics industry, particularly the semiconductor industry, is a highly capital-intensive sector in which very large MNEs[3] tend to dominate and own advance technology, and generate a high percentage of their worldwide patents in their home countries (Cantwell, 1995; Dicken, 2003; Dunning, 1977, 1999; Patel, 1995; Pavitt, 1984). However, it is a sector in which some parts of the production chain are geographically dispersed and vertically integrated on a worldwide scale (Dicken, 2003; Ernst, 1987, 2000b) (discussed in Chapter 4). Furthermore, our study confirms that subsidiaries acquire the kinds of advanced capabilities, particularly of firm's core-competitive resources, from the parent company, HQ or RHQ (e.g. Frost *et al.*, 2002); at the same time, subsidiaries with distinctive capability link to local or external sources of technological knowledge, including research institutions and local competitive firms (e.g. Frost, 2001; Cantwell and Mudambi, 2005).

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[3] Our research context was the top 10 large MNEs in the electronics industry, particularly in the semiconductor industry, the details of which are discussed in Chapter 3.

Moreover, we are interested in understanding what learning methods subsidiaries use to build or exploit the design-related capability over internal and external technology sources. In accord with the learning categories presented by Bell (1984), we identified that design capability creating and exploiting subsidiaries develop a combination of learning-by-doing, learning via internal and/or external collaborations, and learning through the accumulation of prior knowledge. More specifically, we recognised that subsidiaries with relatively lower design capability, such as ST, used discipline-based specialists and repetitive 'trial and error' learning approaches to obtain market-functioning technological knowledge in collaboration with experienced internal R&D centres. By contrast, a subsidiary with higher design capability, such as PH, develops in-house technical process design specialists in collaboration with both the internal worldwide R&D centres and a range of global subcontractors for the assimilation of advance technologies. In line with other studies (e.g. Frost *et al.*, 2002; Cantwell and Mudambi, 2005), our finding is that the development of subsidiary capability is as a cumulative, path-dependent process shaped by both internal and external factors, for example, subsidiary and MNE, and/or local infrastructure including the education system, research institutions, and/or regional and global competitive partners.

Taken together, subsidiaries can be R&D relative capability exploiters and creators. In particular, subsidiaries exploit the core-competitive resources (e.g. assets and/or capabilities) from the parent company and closely collaborate with hierarchical R&D centres. In addition, they build up local, regional and global collaborative linkages to acquire 'new' technology, which refers to the subcontracting out to the counterparts, or which differs from the existing technology. Our evidence supports the view that these had incrementally increased competence-creating at the subsidiary (e.g. PH) over time, underpinned by a contributing mandate or initiative. In turn, we believe that subsidiary autonomy for capability-creating will have been increased over time; an issue that will be discussed in the following section.

7.3.3 Production-related Technological Capability

Since MNEs have established international networks for combined cross-border technological development (Cantwell, 1989), it involves a coordinated change in production structure or technological change in its broadest sense conducted at an international level (Cantwell, 2001). This section is typically concerned with production-related-capability exploiting and/or creating Taiwan-based subsidiaries in the electronics global production chain (presented in Chapter 4).

It is evident that production-related capability exists in the subsidiaries. More specifically, three out of the five subsidiaries had distinctive in-house production-related technological capacity in terms of operating manufacturing plants, managing shop floors and joining production management and production engineering initiatives. However, these subsidiaries owned the different proprietary resources in terms of the degree of change being undertaken and the internal and external collaborative linkages and learning mechanisms used to facilitate these technology change activities.

When a subsidiary is involved in assembly-type productions for local (regional) market-oriented related to a competence-exploiting mandate, the subsidiary has more technologically creative activities, as well as a higher level and greater complexity in its R&D-related involvements in relation to a competence-creating mandate (Cantwell, 1987; Cantwell and Mudambi, 2005). This perspective is based on the ability of subsidiaries to differentiate their technological scope and competence in ways that earn them distinctive positions within their MNE (White and Poynter, 1984; Roth and Morrison, 1992; Papanastassiou and Pearce, 1997). Our findings confirm that a subsidiary, such as MT, with relatively lower production capability, involved a relatively lower capacity production index at 1.33[4] (see Chapters 5 and 6) and undertook a minor process change for

[4] In comparison with our case-study subsidiaries, MT was relatively lower than other cases. It was also lower than its benchmarking sister-subsidiary in the Asia-Pacific region, with a capacity production index of 1.60.

local-market oriented, particularly evolved in in-house process engineering skills and minor market-led production process developments in collaboration with the internal MNE network. By contrast, the subsidiary with higher production capability developed not only routine, but also innovation activities. For example, PH daily exploited core-components from the internal network, and was involved in ongoing collaborative projects with internal material R&D specialists and external suppliers and/or subcontractors on major production process innovations. In addition, it initiated a major change in one of the input materials to reduce production costs. This high production-related capability-creating subsidiary facilitates internal and external technology sources involving continual interaction between the creation of technology and its use in production in terms of capability or competence-creating mandate.

Nonetheless, either production-capability exploiting or creating subsidiaries interact regularly with internal R&D centres for the purpose of problem-solving and troubleshooting. Our finding confirms that subsidiaries acquire the core technologies from the parent company to prevent the risks of leakage or spillover, as well as to ensure technological synergies and the leveraging of economies of scale in R&D across the MNEs. This notion is in line with that of Frost *et al.*, (2002) and Papanastassiou and Pearce (1997). Furthermore, subsidiaries with higher production-capability develop external linkages (not only locally) with subcontractors and local supply networks to gain process equipment and materials alongside technical assistance. This exploitation of local/external technological resources leads subsidiaries to build networks with local research institutions so as to take advantage of local ideas and technology developments (e.g. Bartlett and Ghoshal, 1986; Cantwell and Mudambi, 2005; Frost, 2001; Manolopoulos *et al.*, 2005).

In effect, the worldwide R&D units are one of the contributors to the learning process at the subsidiary level that are characterised by innovation and facilitate the creation of new technology (e.g. Cantwell, 2001; De Meyer, 1992; Pearce and Singh, 1992). For example, a subsidiary with higher production-related capabilities may be involved in obtaining specialist production expertise from the group R&D units and joint-developments in process engineering. Furthermore, empirical evidence given by respondents at PH subsidiary provided the new COF production process involving specialist engineers and support from internal R&D centres and external subcontractors as an example of 'learning-by-doing'. This learning process is not only for the purpose of information sharing, but also assists in collaborative efforts where the paths of learning followed are complementary to one another (e.g. Mowery *et al.*, 1998; Cantwell and Colombo, 2000).

In short, our evidence supports the view that R&D related technology has an impact on aspects of the production process; a subsidiary with high production capability is involved in the level and complexity of R&D related production technology, and develops intensively internal and external linkages for interaction in technology and the channels of the learning process. This is in line with the so-called 'capability/competence-creating subsidiary mandate' (Cantwell and Mudambi, 2005). We learnt from our empirical evidence that a production capability-creating subsidiary contributes its distinctive capability or competence in close collaboration with internal and external linkages to the MNE over time, and in turn, is granted greater autonomy to undertake production-related initiatives for the MNE.

Taken together, this section builds on that of the pervious chapters (5 and 6) by broadening our understanding of technological capabilities-creating and exploiting at the subsidiary level. Specifically, our study has identified three types of functioning-related technological capabilities at the subsidiary level. In addition, it has recognised that a subsidiary is competent at exploiting and creating different levels and types of subsidiary-specific capabilities. As expected, the subsidiary exploits the internal assets and capabilities, creating those capabilities using external including local, regional/global resources, on marketing, design and production-related capabilities. In particular, the subsidiary with high marketing, design and/or production-related capability exploits the core-competitive resources from the parent company and uses its existing in-house capacity through a process of learning mechanisms in collaboration with internal and external counterparts to build on its specific advantages. Furthermore, our empirical evidence contradicts the established MNE innovation development perspective in that certain innovation capabilities are retained by the parent company, HQ or RHQ (Cray, 1984; Garnier, 1982; Gates and Egelhoss, 1986; Hedlund, 1981; Otterbeck, 1981), but accords with the view that subsidiaries with distinctive technological capabilities can contribute to MNEs in relation to internal and external linkages (e.g. Birkinshaw, 1997, 2001; Frost, 2001; Cantwell and Mudambi, 2005). Our findings also confirm that the conception of the MNE as a differentiated network should consider both internal and external linkages (Nohria and Ghoshal, 1997; Andersson *et al.*, 2002). This is consistent with other studies that demonstrate that the internal and external linkages have great benefits for the subsidiary-creating and exploiting capabilities or competences (Andersson *et al.*, 2002; Manolopoulos *et al.*, 2005).

At a higher level of abstraction, our empirical evidence supports the notion of a subsidiary as a 'centre of excellence' (e.g. Frost *et al.*, 2002), a view reflected particularly in the case of PH subsidiary[5], which had incrementally increased its design and production-related capabilities and competences over time. In addition, it was recognised by the MNE as an important source of value creation, having the intention to permit these capabilities to be leveraged by and/or disseminated to internal and external counterparts of the MNE. This view implies that the stock of available assets/capabilities owned by this kind of subsidiary may affect the degree of its autonomy (e.g. Manolopoulos *et al.*, 2005), and if the subsidiary possesses more competences, may encourage the subsidiary to take on more initiatives (e.g. Birkinshaw and Ridderstråle, 1999). Thus, it will provide us with a way of understanding the relationship between technological capability and subsidiary autonomy.

[5] PH subsidiary began with a manufacturing operation and had evolved a series of technological accumulation becoming as a manufacturing centre in Asian Pacific region, described in Chapter 5.

7.4 Subsidiary Autonomy (SA)

Earlier discussion of subsidiary technological capability-creating or exploiting in terms of marketing, design and production value-added activities highlights that subsidiaries had incrementally built up their capabilities or competences over time. Accordingly, subsidiaries enhanced their proprietary assets and/or capabilities, underpinned by internal and/or external (including local and global) technology sources and multifaceted mechanisms. These, in turn, would gradually grant the subsidiary greater autonomy for decision-marking and innovative activities or initiatives. The present section aims to investigate specifically what these influences are and how they affect subsidiaries' capability-creating.

In our analysis and comparison of subsidiary autonomy in Chapters 5 and 6, some specific dimensions of subsidiary autonomy were examined and the varying degree of subsidiary autonomy amongst five multinational subsidiaries were evaluated, as detailed in Table 7.1. A number of dimensions of subsidiary autonomy were identified according to subsidiary operational and strategic decision-making in relation to value-added activities. In Section 7.4.1, we will specifically discuss the business activity or scope of responsibility in which a subsidiary is involved, and whether its resources are internal or external to the focus subsidiary. In addition, the relationship between parent company and subsidiary is assessed in the context of subsidiary capability-creating or exploiting.

In Section 7.4.2, we will focus on subsidiary initiatives with regard to subsidiary autonomy, which is considered as a factor in subsidiary initiative in terms of expanding the subsidiary's range of responsibility within the parameters of the MNE's strategic aims (Birkinshaw, 2000). In particular, first, we explore the distinction between assigned and assumed autonomy in association with subsidiary initiative, in order to clarify the nature of driven subsidiary initiative or autonomous innovation activities. We will also discuss our assumption that subsidiary initiative takes to the extreme subsidiary autonomy. In Section 7.4.3, we will then move on to look at what relationships, if any, exist between subsidiary autonomy and subsidiary capability-development in terms of three types of technological capabilities. The subsidiary evolution perspective (Bikinshaw and Hood, 1998b; Birkinshaw, 2000) will be examined and compared with the issue of subsidiary capability-creating/enhancement and subsidiary autonomy.

7.4.1 The Dimensions of SA

A number of dimensions of SA in relation to subsidiary strategic and operational decision-making in the context of functioning value-added activities were derived from within-case analysis and cross-comparisons of case-study subsidiaries in Chapters 5 and 6. In this section, we will concentrate on each dimension of SA in relation to strategic and operational decision-making taken by a subsidiary itself, and whether this decision-making expands the scope of responsibility of the subsidiary, a viewpoint similar to that of subsidiary initiative (Birkinshaw *et al.*, 1998; Birkinshaw, 2000). In particular, we will use the findings pertaining to the relative degree of subsidiary autonomy assessed in Chapter 6 to compare with the existing literature in order to develop a theoretical level of subsidiary autonomy. Table 7.3 summarises the key dimensions of subsidiary autonomy from the case-study subsidiaries, and is structured as follows: in Section 7.4.1.1, financial decision autonomy focuses on the relationship between parent company and subsidiary in terms of capital investment, and working capital and expenditure. In Section 7.4.1.2, purchasing decision autonomy concentrates on decisions related to the selecting of suppliers and the developing of external networks of suppliers. In Section 7.4.1.3, HR decision autonomy discusses employee recruitment and training, as well as personnel promotion and expatriatism. In Section 7.4.1.4, marketing activity decision autonomy is examined, with particular attention being paid to marketing activity undertaken on the basis of a subsidiary's own decision to expand its particular scope of responsibility. In Section 7.4.1.5, product development decision autonomy elaborates on strategic new product development decisions made by the subsidiary itself. In Section 7.4.1.6, collaboration decision autonomy explores the conditions under which the subsidiary makes such decisions. In Section 7.4.1.7, subcontracting decision autonomy examines the conditions under which the subsidiary makes this decision instead of expanding its investment in association with the parent company. In Section 7.4.1.8, changes in the operation process decisions will help us to understand under what conditions a subsidiary can expand its scope of responsibility beyond corporate expectations. In Section 7.4.1.9, technology decision autonomy will focus on the circumstances in which a subsidiary makes this specific decision in order to build or exploit its technology. These dimensions of SA have significant effects on the levels and types of capability that develop in the subsidiary, and the mechanisms by which different capabilities develop.

Table 7.3 Key Indicators and Dimensions for Measuring Subsidiary Autonomy

Decision-Making Indicators	Dimensions
Financial Decisions	Capital Investment
	Working Capital & Expenditure
Purchasing Decisions	Purchasing Materials & Equipment
	Local Purchasing Sources
HR Decisions	Employee Recruitment & Training
	Personnel Promotion & Expatriatism
Marketing Activity Decisions	Strategic Market Position
	Logistics Distribution
	Management Customer Relationship
	Customised Product Decision
Product-Development Decisions	New Product Development
	New Product Initiative Development
	Making-Changes in Product Development
Collaboration Decisions	Internal Collaboration
	External Collaboration
Subcontracting Decisions	Local Counterparts
Change in Operational Processes	New Operational Activity
Technology Decisions	Building Subsidiary Technology

7.4.1.1 Financial Decisions

Garnier (1982) and Harzing (1999) suggest that financial resource is a crucial commitment by the subsidiary to expand its operation and/or develop innovation activities. A dilemma exists between the parent company and the subsidiary with regard to the fight over financial decision-making in terms of capital investment and working capital and expenditure. Birkinshaw (2000) indicates that although the financial resource at the subsidiary is formally deployed from the parent company, the subsidiary can propose its requirements to the parent company, normally leading to the authorisation of some additional financial support for the high value-added subsidiary. Our research evidence shows that expenditure on routine activities (such as working capital), although capped, generally required minor or no formal approval from the parent company. Expenditure or investment on what we defined as innovative or non-routine activities did require approval of various kinds (detailed in Chapter 6). In addition, our study confirms that relatively higher financial autonomy is related to the value of the subsidiary role or local development in the parent company's perceptions, as shown by MT subsidiary, which increased its demand for complex IC leadframes for the local market and required an expansion of production, leading to the subsidiary's receipt of more capital investment. PH subsidiary illustrated a contributory mandate for the MNE network, being granted significant flexibility for routine financial requests, as well as for a number of innovative activities that were consistent with the strategic goals of the MNE.

7.4.1.2 Purchasing Decisions

This decision, relating to the selection of suppliers and the developing of external networks of suppliers, is used as another decision-making indicator of autonomy. Our interest in this characteristic is in identifying the local or external suppliers salient to subsidiary autonomy and to subsidiary innovative activity. This study recognises that core-components and key equipment purchasing decision-making are retained by the parent company. The cases of RS or PH illustrate how strongly they were compelled to follow internal purchasing guidelines and to rely on the appointed global suppliers for components, materials and equipment. By contrast, MT had a greater degree of autonomy in local purchasing decisions for production inputs, although core inputs were still purchased via the parent company. Our empirical finding presents an interesting contrast regarding the external network, such as supplier network, showing it to play an important role as a source of subsidiary innovation and new business ideas (Birkinshaw *et al.*, 1998; Forsgren and Johanson, 1992; Gupta and Govindarajan, 1991; Nohria and Ghoshal, 1997; Papanastassiou and Pearce, 1999). For this reason, it is difficult for the HQ to retain such knowledge. A reason provided by the respondents for this evidence was that MNEs recognised the advantages of controlling purchasing centrally to gain bargaining power with suppliers and to maintain long-term supplier-relations. Whilst purchasing decision-making is retained by the parent company, the subsidiary is granted access to these suppliers and collaboration with suppliers, as illustrated by PH subsidiary, which was involved in seeking local strategic partnerships and tuning up specific equipment or adjusting manufacturing process for innovative activities.[6]

7.4.1.3 HR Decisions

International business literature recognises that the management of human resources is a mechanism for the selection and training of subsidiary managers to reach the objective of controlling subsidiaries. It involves high-level executives at subsidiaries with expatriates, the training of subsidiary mangers by the parent company HQ or RHQ, rotation of top managers among subsidiaries (Youssef, 1975; Doz and Prahalad, 1984) and selection of subsidiary managers based on demographic or personality attributes (Gupta and Govindarajan, 1991). Our finding confirms this aspect, in so far as the subsidiary head was assigned by the parent company. In addition, recruitment of, or internal promotion to, department head had to gain parent company approval. This demonstrates the way in which the parent company strengthened the local implementation of central decisions. However, subsidiary managers stated that this leverage in their role as informants of the local environment allows them to negotiate centrally decision-makings and to secure local flexibilities. Furthermore, recruitment and training below department head

[6] These innovative activities refer to 'new' activities for the PH subsidiary.

level was done in accordance with a varying combination of MNE strategy and local HR procedures. A key determinant of autonomy was the local availability of particular manpower capabilities. A senior manager at PH illustrated how they 'expatriated engineers to the regional sister-units for assisting in their engineering technology.' Recognition as a source of particular expertise gave PH a greater degree of autonomy for its recruitment and training procedures in this particular capability area; in so doing, this particular local expertise provided PH subsidiary with a continuous inflow of new knowledge and skills to upgrade their technological capability (e.g. Kim, 1998).

7.4.1.4 Marketing Activity Decisions

The finding confirmed that a specific market was initially allocated for subsidiaries which they were mandated to serve (e.g. Edwards *et al.*, 2002; Ghoshal and Bartlett, 1988; Hedlund, 1981; Taggart, 1997; White and Poynter, 1984; Young *et al.*, 1985), but a combination of marketing capabilities and innovation capacity enabled some subsidiaries to change or expand their market scope more than others. This was shown by RS subsidiary, which had developed considerable marketing experience along with a certain degree of autonomy to customise products for local markets, and had expanded into the Mainland China region on its own initiative. An example from a Director at ST subsidiary similarly illustrated how they had '*extended their market scope from local to regional by collaborating with regional sister-units on new product development projects and sharing marketing knowledge to enhance their design capabilities.*' In this context, our finding supports the view that the subsidiaries mature with specific proprietary capabilities or assets, and build upon endogenous growth interactions with local and regional/global resources or knowledge and the resulting development of market and/or technological capabilities (e.g. Rugman and Verbeke, 2001; Verbeke and Yuan, 2005; Cantwell and Mudambi, 2005).

In addition, our empirical study corroborated the view that whilst subsidiaries were integrated with regional and/or international marketing (strategy) activities, this was not an obstacle to undertaking innovative marketing activities, as demonstrated by RS, which was integrated with regional marketing activities, but had relatively higher autonomy for initiating a customised product in association with the parent company for design and manufacturing to serve the global market. This is consistent with the finding of Hewtt *et al.*, 2003.

7.4.1.5 Product Development Decisions

The literature tends to assume that the HQ facilitates its MNE network to integrate its global product developments for worldwide markets, whereas the reality is that the local environment and external relationships within the subsidiary seem to have influence on the MNE's product strategies and decision-making (Anderson and Forsgren, 2000; Nohira and Ghoshal, 1997). Our case-study findings highlight that subsidiaries used their knowledge of local or regional markets involved in initiating new product development projects with the parent company and with the related subsidiaries. This is shown in the case of RS subsidiary, which had evolved into a very active development centre, proposing a range of new product projects and taking on responsibility for minor and major changes to the product design for local and regional customers, without intervention from the parent company. By contrast, HT subsidiary was the least active in this regard and had more limited involvement in this kind of decision-making. This evidence partially contradicts the findings of Hewett *et al.* (2003), namely that although the subsidiary takes part in goal-setting, it may not affect certain product-related decisions because the HQ is considerably involved in developing products and implementing product mix elements. There were two explanations for this contrast from two respondents. One explanation given by an ST Director was, '*This (semiconductor) industry is very dynamic and market-driven; we normally make a minor or customised change which engages about 10% of decision-making in the product development.*' Another explanation provided by an RS Director was that '*We customise products for Taiwanese customers, who market globally and in turn, integrate our technology, production and design network that span the globe.*' Our findings therefore, support the view that the difference in product-development autonomy was closely associated with differences in particular types of capabilities held by each subsidiary, and perhaps the kind of context, such as industry, in which a subsidiary is located.

7.4.1.6 Collaboration Decisions

The literature argues that the more complicated the coordination network, the less flexibility the subsidiary has to react to local environment (Cray, 1984). Empirically, Roth and Nigh (1992) conclude that subsidiary managers do not see coordination as a constraint on their autonomy. In both studies, coordination was described as granting integration of subsidiary and parent company HQ activities through intra-organisational linkages rather than the use of authority, which is in line with our definition of collaboration. According to our empirical evidence, this recognised collaboration, both internally and externally, was either initiated at the subsidiary or implemented at the subsidiary level. In particular, these internal and external collaborations enhance the proprietary capability of the subsidiary to develop or expand its responsibilities. This is illustrated by RS subsidiary, which initiated the internal collaboration with regional sister-subsidiaries and R&D centres on product design and/or process technology development, and also developed collaboration partnerships with local research institutions, universities and local firms for new product design and development. A further illustration in this respect can be found in the case of PH, which devolved close and frequent interactions with regional and local sister-subsidiaries, suppliers and customers across this network, as well as developing collaborative partnerships with the local institutions and universities for incremental and new product development, facilitating PH's access to various design and production capabilities. Our finding also supports a perspective found in multinational literature, namely that subsidiaries performing specific value-creating activities are embedded in the host countries (e.g. Cantwell, 1995; Rugman and Verbeke, 2001). The breakthrough in such decision-making supports this idea by showing that the difference in collaboration autonomy was related to the embeddedness in the local or external MNE networks, and particularly to the subsidiary's own initiative in the host country.

7.4.1.7 Subcontracting Decisions

Decisions regarding subcontracting partnerships were made both formally and informally, and tended to be centralised or devolved. Our finding reveals that while subsidiaries required certain technologies for design or production purposes, the appropriate contractor tended to be assigned by the parent company, a finding that is in line with conventional multinational business, particularly from the HQ perspective (e.g. Garnier, 1982; Gate and Egelhoff, 1986; Young *et al.*, 1985). Nonetheless, our findings support the subsidiary initiative viewpoint (e.g., Birkinshaw *et al.*, 1998; Birkinshaw, 2000), namely that subsidiaries have a series of autonomous actions that seek to develop the value-adding scope of responsibility in accordance with the strategic aims of MNEs. This is illustrated by the case of RS, which autonomously subcontracted out some product design activities to local firms: '*considering technology X is not a pivotal technological capability, we generally subcontract out to competitive local firms. This results in speeding up our time-to-market without expanding our own facilities.*' By way of contrast, PH had close and frequent interactions with global and local subcontractors, which had been established by the parent company, with regard to the development of the product and manufacturing technology so as to build up its in-house capability. The important finding here supports and extends the argument (e.g. Almeida and Phene, 2004) that subsidiaries of different MNEs in the same location may develop varying autonomous actions or initiatives for the enhancement of capabilities.

An explanation provided by our above-mentioned evidence is that the value-adding subsidiaries (e.g. RS subsidiary) located in a technologically flexible host country, such as Taiwan (discussed in Chapter 4), are moving towards efficiency-seeking cooperation with local innovative firms, avoiding 'expanding their investment' in order to increase their capabilities and broaden their scope of responsibilities. This is in line with other studies (e.g. Cantwell and Mudambi, 2005; Manolopoulos *et al.*, 2005; Almeida and Phene, 2004). Another explanation is that the capability-creating subsidiaries have built upon endogenous growth over time, and are more mature and closer to being granted access to wider sources of internally generated technology, particularly more international collaborations or integrated relationships, as in the case of PH. In so doing, it will fit with the corporate goals, avoiding 're-inventing the wheel' and leveraging particular synergies between specialist centres, particularly in the semiconductor industry (detailed in Chapter 4).

This finding goes somewhat against the finding advocated by Almeida and Phene (2004: 858), but accords with the study by Cantwell and Mudambi (2005).

7.4.1.8 Change in Operation Process Decisions

The overall subsidiaries tended to be able to initiate new business projects only when they were in accordance with the corporate strategy and, with HQ's approval, in alignment with the perspective of subsidiary initiatives (Birkinshaw *et al.*, 1998; Birkinshaw, 2000). There were however, a small number of examples of subsidiary initiatives which did not entirely fit corporate expectations, but were allowed to proceed, and others where the subsidiary took on a larger role or range of responsibilities than its formal remit permitted (illustrated in Chapters 5 and 6). An interesting example is provided by PH subsidiary with its relatively higher autonomy amongst others in this regard. PH designed and manufactured a new image sensor for a production line through collaboration with internal R&D centres and external partnerships. This had been in line with HQ-led product strategy, but had gone against the HQ plan, which had earmarked other units to take the lead on the project. In contrast to the case of PH, HT and MT initiated a small number of business projects in accordance with corporate aims and proposed new initiatives in line with their scope of responsibilities. This empirical evidence confirms that to some extent, the resources and capabilities of subsidiaries are very poorly understood by the parent company (Birkinshaw *et al.*, 1998; Birkinshaw, 2000), and that again, to a certain degree, subsidiaries themselves are far more aware of their resources-local market knowledge and capability-specific skill than anyone else. Subsidiaries need to be encouraged to proactively create/explore some ways of facilitating their resources and capabilities, and to undertake more autonomous innovative activities in order to leverage their capabilities or competence to MNEs.

7.4.1.9 Technology Decisions

Our finding here reinforces the view of that technology in MNEs is not entirely internally or externally driven, and that there is a need to consider the 'differentiated' networks and the relative roles they play (e.g. Almeida and Phene, 2004; Frost, 2001; Manolopoulos *et al.*, 2005). As illustrated by all case-study subsidiaries, they remained dependent on the parent company for all the core-competent technologies, but had varying degrees of autonomy to source non-core technology, namely market-driven technology, and expertise for maintaining or developing their design and production activities. Our study both supports this view in exploiting internal and external technology sources to enhance subsidiary capabilities, and extends this issue, in so far as this particular context was the degree to which decisions for combining various internal and external sources of technological capability to optimise the production system and related innovation were either devolved to the subsidiary or controlled from the centre. This is demonstrated in the case of RS, which had a degree of discretion as to which internal R&D centres it would work with to develop more core technologies. In addition, it had a range of local and external collaborations for associated technology sourcing activities. Another example was that of PH subsidiary. Respondents at PH suggested that decisions regarding core technology development were made through discussion involving specialists across the internal network, reflecting the ideal 'differentiated network', rather than being simply led by HQ-based personnel.

To conclude this discussion, a number of dimensions of subsidiary autonomy within value-added activities in relation to subsidiary technological capabilities have been addressed. In particular, the relationship between parent company and subsidiary is a vital determinant of subsidiary autonomy, which has an effect on the levels and types of capability that develop in the subsidiary, and the mechanisms by which different capabilities develop. We found some specific dimensions of subsidiary autonomy that were linked to subsidiary capability. Overall, the subsidiaries which had less autonomy as regards particular kinds of decision-making were more closely dependent on internal, HQ-linked resources, capabilities and expertise in this area of decision-making (e.g. Bartlett and Ghoshal, 1986). This correlation was expected, but we found the underlying relationships that led to this pattern were more complex than anticipated.

The viewpoint on complexity between assigned and assumed autonomy is allied to the dimensions of the subsidiary autonomy in the process of subsidiary capability-developments (e.g. Birkinshaw, 2000; Young and Tavares, 2004). It is essential to draw a distinction between these two concepts in the context of our findings. First, we found some decision-making was retained at the parent company to strengthen the local implementation of central decisions and to avoid 're-inventing the wheel', particularly in terms of decision-making on financial, purchasing, and/or partial HR regarding appointing the subsidiary head, etc. However, there are some autonomous decisions taken by this type of subsidiary, as exemplified in the cases of MT and ST, the value of whose roles and/or local developments have been recognised by the parent company. A similar view can be found in the studies of Bartlett and Ghoshal (1986) and Birkinshaw (2000). They focused on subsidiaries with 'assigned roles (autonomy)', based on the strategic importance of the local environment and the competence of the subsidiary that are enforced through a set of coordination and control mechanisms and are granted more autonomy for innovation or pursuing initiatives (Birkinshaw, 2000: 19). More specifically, our finding indicates that this type of subsidiary is granted more autonomy for extending the market scope, for being involved in 'new' product-development decisions and for pursuing innovative activities in association with internal R&D centres. In addition, this kind of subsidiary develops a close collaboration and coordination with the internal MNE network. Second, another finding comes from some high value-added subsidiaries in the context of technological capability-developments, such as RS and PH. The case-study evidence identified that subsidiaries with specific proprietary assets or capabilities build up their own growth or developments by fighting for their initiatives with the parent company, particularly for change in operation process decisions and technology decisions. A similar viewpoint can be found in the work of Birkinshaw and associates (1998, 1999, 2000). They concentrated on subsidiaries with 'assumed roles (autonomy)' based on subsidiaries' strategies and their roles assumed by subsidiary managers. However, this kind of subsidiary not only takes ongoing managerial responsibilities, but also undertakes new innovative activities to respond to new business opportunities when they arise. In particular, our case-study finding shows that this particular type of subsidiary has specific value-added evolved capabilities in terms of marketing-, design-, or production-related capabilities which become an initiative bargaining tool with the parent company, as demonstrated in the local subcontracting decisions made on behalf of RS subsidiary or PH subsidiary's fight for a new design and manufacturing project for a new image sensor.

Our interpretation suggests that previous studies have given consideration to subsidiary initiative, but have not paid adequate attention to subsidiary evolved capability in terms of technological capability-creating and/or exploitation. Our evidence illustrates that subsidiary autonomy and initiative exist in parallel, and indirectly supports the view that initiative takes autonomy to extremes in the context of subsidiary. Therefore, we suggest that it is inadequate to consider assigned and/or assumed autonomy; rather, it is necessary to consider subsidiary autonomy as a multidisciplinary and a cyclical process between the parent company and the subsidiary, due to the fact that the subsidiary is embedded in differentiated networks of the MNE, namely the internal MNE and host country (e.g. Taiwan), which increases its potential skill base, such as employees (i.e. leadership), local linkages with firms competent in technological innovation and/or research institutions. This, in turn, broadens the subsidiary's potential role and scope of responsibility. The more sophisticated subsidiary with significant technological capability or competence tends to strive for its own developments or more technologically innovative initiative, as in the case of PH (present in Chapter 5 and 6). This issue will be formally addressed in the following section.

7.4.2 Subsidiary Autonomy versus Subsidiary Initiative

As earlier discussed, the concept of subsidiary autonomy is allied with assigned autonomy and assumed autonomy. The major difference in granting decision-making between these two types of autonomy pertains to the perception of the subsidiary role and/or development; the former is based on the parent company, while the latter is assumed by the subsidiary (e.g. Birkinshaw, 2000).

The similarity between these two types of autonomy is the high degree of autonomy granted to undertake initiatives for the MNE. In particular, in the context of our findings with regard to these two kinds of subsidiary autonomy, the assigned autonomy pursues initiatives towards internal technology sources. ST subsidiary initiated new product development in association with sister-subsidiaries in Europe and the regional (i.e. AP, Europe) R&D centres for the purpose of market-sharing. In contrast, the assumed autonomy initiated autonomous innovative activities in relation to local technological sources and/or external technological linkage. This is illustrated by RS, which subcontracted out a pivotal technological capability to local firms, resulting in the speeding up of the time to market without the need to expand their own facilities. In these two examples of initiatives, recognition from their parent companies' of their capabilities and/or competences was received. Whilst they have more opportunities to undertake initiatives in a manner consistent with their parent companies' strategic directions, these subsidiaries still take on the scope of managerial responsibilities for MNEs. In this context, our findings accord with Birkinshaw's (1999; 2000) perspective.

Nonetheless, at a higher level of abstraction, our findings suggest that most subsidiaries have a certain degree of autonomy to be enacted through the HQ assignment, and/or undertake ongoing subsidiary managerial responsibilities, although subsidiary initiative takes subsidiary autonomy to the extreme. As Birkinshaw (2000) stated, an initiative is viewed as a discrete, proactive undertaking that advances a new way for the MNE to use or expand its resources. In hindsight, this initiative may not initiate in daily business activities; rather, it requires a subsidiary in-house capability and/or endogenous growth interaction with local or external business environments (e.g. Verbeke and Yuan, 2005). According to our presented findings, subsidiaries using in-house capabilities (i.e. RS or PH) continuously undertook various innovative activities or initiatives which won them recognition by their parent companies, leading to their being granted more autonomy for decision-making. Therefore, we deem that subsidiaries execute initiatives on account of external environments combined with primarily in-house (endogenous) technological capabilities, thereby receiving recognition from parent companies for their competences, which, in turn, leads to the subsidiaries' gaining of increased autonomy. Our findings thus support other studies (e.g. Brooke, 1984; Verbeke and Yuan, 2005) regarding the view that subsidiary autonomy is a cyclical process between the parent company and subsidiary, and that is changed by the development of subsidiary technological capabilities.

7.4.3 Subsidiary Autonomy versus Subsidiary Capability-Development

Having discussed the distinction between different positions of autonomy and subsidiary initiatives, we now understand that

> **PH Subsidiary Evolution Case:**
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> The subsidiary business development roles had changed along with the evolution of Taiwan's industrial environment. During the 1960s, Taiwan was focused on a labour-intensive economy, and the PH subsidiary chose to be an offshore assembly centre. It brought in all the components, manufactured here and then shipped the products abroad. In the 1970s, Taiwan became capital and technology intensive, and the subsidiary turned into an international production centre. The PH subsidiary started to invest more in Taiwan, used local components and machinery, produced components locally, and migrated more R&D and competence into Taiwan. In the 1980s, Taiwan had transformed into an information and knowledge intensive economy, and the role of the PH subsidiary had changed into an Asia Pacific Office for Semiconductors, and the Global Business Centre of Monitors and a (Applied) Research and Development Centre of Semiconductors in association with the production centre. In 2003, the PH subsidiary re-focused on high value-added activities such as design, sales, and product development, departing from its former role as an assembly and production centre. (Abstracted from Chapter 5)

subsidiary innovative activities or initiatives can arise either through the HQ-driven or subsidiary-driven processes, and/or through interaction with local/external environment processes (e.g. Birkinshaw and Hood, 1998b). In each driven innovative activity or initiative, an accumulation of subsidiary capabilities is required over time.[7] A subsidiary technological capability, whether preserved assigned (the HQ) or assumed autonomy (subsidiary- or locally-driven), is accumulated through the organisational routines and collective expertise or skills of specific value-added activity (e.g. Nelson and Winter, 1982; Rugman and Verbeke, 2001; Ernst *et al.*, 1998).

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[7] Birkinshaw and his associates (1998, 2000) model the 'generic subsidiary evolution processes' of subsidiary evolution, which is the result of an accumulation or depletion of capabilities over time. Although this research is confined to capability-creating or enhancement only, we are fully in accord with their work.

Our evidence supports the view that subsidiary capability development in terms of marketing-related, design-related and/or production-related technological capability revolves around the exploiting of internal and/or external technology sources, resulting in creating in-house technological capabilities at the subsidiary level, many of which were discussed earlier. As illustrated by PH subsidiary, a subsidiary capacity evolved to be a high value-added contributor for the MNE following a long evolution process (e.g. Birkinshaw and Hood, 1998b; Birkinshaw, 2000), as the box illustrates. At the initial establishment, PH subsidiary was driven by the parent company-decision. A gradual technological development in country environment (i.e. Taiwan) and subsidiary own interests became viable to enhance PH subsidiary-specific evolution and its in-house technological capabilities and endogenous growth; accordingly, a group of PH senior mangers lobbied hard for their 'initiative' driven by Taiwan high-technological pathway (in Chapter 4) in the corporate level, and followed by a group of elite engineers trained in the parent company in order satisfactorily to deliver on the new scope of subsidiary responsibilities in the 1980s. This, in turn, brought considerable recognition from the MNE, and more autonomy was granted to PH subsidiary. Due to the swift move of global high-technology to AP, PH subsidiary was concerned about its competitiveness and initiated a number of innovative activities, described in Chapters 5, 6 and 7, to strengthen the relevant set of semiconductor capabilities. This process involved expanding the manufacturing plant and design-related facilities, and more innovative activities granted the PH subsidiary access into the external subcontractors and worldwide R&D centres. This long process of capability-creating development led to a higher subsidiary performance in terms of number of patentable cases by an annual average of 7 cases, and a capacity production index (CPI) of 1.67.[8]

There are also a number of subsidiary-specific evolutions, such as MT or ST, driven by the parent company or local environment that were described in Chapters 5, 6 and 7. Our case-study evidence reaffirms that of other studies (e.g.

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[8] The capacity production index (CPI) is an industry standard measure mainly relating to capacity utilisation and overall productivity. In 2002, the semiconductor industry standard was 1.7.

Birkinshaw, 2000; Cantwell and Mudambi, 2005; Rugman and Verbeke, 2001; Verbeke and Yuan, 2005) with regard to the need for a number of combinations of subsidiary in-house capabilities, local or external incentives, and parent company support to facilitate the subsidiary's evolution, rather than the need for the parent company to grant greater autonomy, or for a subsidiary to undertake more initiatives. In other words, a subsidiary's autonomous development is primarily derived from subsidiary endogenous growth exploiting internal and external technology sources, resulting in specific value-adding capability enhancements. The consequence of this is increased autonomous (strategic) decision-making for the subsidiary.

7.5 Communication Systems

Given that the communication system may vary across the different subsidiaries to influence the relationship of the MNE networks in terms of technological innovation (e.g. Gupta and Govindarajan, 1991; Nohria and Ghoshal, 1997; Tushman, 1977; Van de Ven, 1986), the purpose of this section is to seek to understand more about the different intensity of internal and external communication influence on subsidiary capability development or subsidiary autonomy. Table 7.1 reports the relative ranks from cross-subsidiary comparisons of the internal and external CS (discussed in Chapter 6), where relative ranks are of a combined 'score' for the intensity of multidimensional communication systems between the subsidiary and internal and external linkages. This study has conceptualised the intensity of communication with respect to internal and external technology sources (see Section 7.2), some of the findings of which allow us to sketch some interesting patterns of variation across the types and levels of technological capabilities in relation to subsidiary autonomy.

Internal Communication: as expected, the subsidiary predominantly develops vertical links with corporate entities (i.e. central account mangers), and horizontal links with sister-subsidiaries including R&D centres in terms of coordination of decisions and tasks, and exchange of business information through various modes, including formal meetings, informal e-mail, and telephone, etc. In particular, our finding is consistent with other studies (e.g. Ghoshal *et al.*, 1994; Gupta and Govindarajan, 1991) in that the subsidiary with relatively high intensity of internal communication, such as PH and RS, creates higher information-processing capacity. This is shown by RS and PH, who had developed a relatively high intensity of communication with the parent company for shaping the business plan; and with global R&D centres for exchanging knowledge at different phases of collaborative-projects, product and technology developments through face-to-face meetings, personal visits and the intra-net. As opposed to the higher intensity of communication capacity, the lower intense communication, such as MT, was limited to various business activity reports and business-plan meetings, and communication with sister-manufacturing or technology units only involved in technical problem-solving. It is worth pointing out that the different intensity of communication still retained their vertical linkage back to their parent company, however, the type of information-process capacity and the level of horizontal linkages leveraged the subsidiary's TC. Evidence of this internal communication capacity empirically supports the effectiveness in developing subsidiary product and/or process innovation, which is in line with other studies (e.g. Zander and Sölvell, 2000). As stated by one PH senior manager, "*The intranet data-base gives a platform to seek out some resolutions, while we commence the difficulty in the early stage of the pilot product development; in addition, the regular cross-level of R&D engineers' visiting is an alternative way to advance our existing technology capability as the 'new'*[9] *product development stage.*"

External Communication: according to our findings, the subsidiary evolved local and/or international communication profiles. This is exemplified in subsidiary RS, ST and HT, all of which were involved in some exchange of customer-led product or process improvements and technical problem-solving with local customers, local strategic partners, local suppliers and/or local research institutions. In particular, the subsidiary with the higher intensity of external communication, such as RS, developed formal (e.g. personal visits) and informal communication capacity with local customers and strategic partners on joint-initiatives, which related to reciprocal leverage on different levels of technological knowledge regarding technical problem-solving for incremental product design. In addition, there was communication capacity with local universities and research institutions, such as ITRI (detailed in Chapter 5), regarding the applied research development of local initiative projects and exchange of market-driven technology developments. In this context, our finding confirms that subsidiaries build up the specific local network in the host country (e.g. Andersson and Forsgren, 2000; Forst, 2001), in which subsidiaries can assimilate and exploit locally available information to increase subsidiary capability (e.g. Rugman and Verbeke, 2001). In contrast, our finding shows some subsidiaries, such as PH and MT, were distinct

[9] This type of new product or process is defined within the scope of the subsidiary.

primarily in terms of their level of communication with external counterparts. They had greater intensity of communication with regional and/or global customers, suppliers, or strategic partners on product and/or process innovation activities. This is illustrated by PH subsidiary, which had higher intensity of communication with local or global strategic partners and suppliers on engineering process improvements and ongoing collaborative projects. It also intensified its communication capacity with local universities and research institutions in terms of basic and applied chemistry, engineering research and exchange of industrial technology development through regular face-to-face meetings and conferences. This external communication channel and capacity can bring externally specific ideas, knowledge and market opportunities to the subsidiary (e.g. Andersson *et al.*, 2001, 2002). In light of this, we have reason to assume that greater intensity of external communication in which the subsidiary is involved can leverage its breadth and variety of technological resources in the context of subsidiary specific value-added activities.[10]

Taken together, what do these patterns of intensity of CS tell us about subsidiary-capability development and/or the relationship with subsidiary innovative activities or initiatives? In the context of our evidence, the subsidiary that has more intense internal as well as external communication has the breadth and variety of technology sources for acquiring different levels and types of technological knowledge. This, in turn, may increase the subsidiary's capacity to assimilate and exploit available information. By contrast, the subsidiary with less intense internal and external communication has limited communication capacity within the subsidiary's scope of responsibility. Relatively speaking, it has less absorptive capacity (Cohen and Levinthal, 1990) to properly assimilate the knowledge; thus, we assume that this kind of subsidiary involves more capability-exploitation. At a level of abstraction, our finding suggests that subsidiary capability-creating is driven by the intense communication and interactions between internal and external leverages, which broaden the subsidiary

[10] The subsidiary specific value-added activities are related to subsidiary innovative activities and initiatives.

range of technological sources through in-house scope, the assimilation and exploitation of 'new' ideas, knowledge, and technology from the external community. As the capability or resource levels of the subsidiary increase, the independent interests of the subsidiary may lead to a desire for increased autonomy. This is demonstrated by RS subsidiary, which pursued local market interests in a manner consistent with the parent company's strategy directions, resulting in the winning of greater recognition by the parent company.

7.6 Concluding Remarks: A Synthesis of Subsidiary Autonomy, Technological Capability and Communication Systems

Table 7.4 Summary of Technological Capability-creating Interaction with Communication Systems and Subsidiary Autonomy

Technological Capabilities	Communication Systems		Subsidiary Autonomy
	Internal	External	
Marketing-related Capability	Vary: intense vertical linkage with the HQ; horizontal linkage with the R&D centre and product development committees for shaping central marketing strategy.	Vary: intense local or regional communication on customer-led marketing activities.	• Human Resources autonomy for local availability of manpower. • Marketing activity autonomy for undertaking marketing innovation • Product-development autonomy for new product innovation. • Autonomy for expanding the market scope or responsibility
Design-related Capability	High intensity of communication with vertical linkage for core-components with horizontal linkages, R&D centres, for joint-development or knowledge sharing related product and process innovation	High intensity of communication with local knowledge systems including research institutions and universities and global sources of technological subcontractors or cooperative partners.	• Financial autonomy for design-related innovative activities • Purchasing autonomy for core-components and key facilities. • Human Resources autonomy for local availability of manpower. • Product-development autonomy for different degree of product innovation. • Collaboration autonomy for product and process innovation. • Subcontracting autonomy for product and/or process design innovation. • Autonomy for changing in operation process. • Autonomy for technology sources.
Production-related Capability	High intensity of communication with horizontal linkage, R&D centres for joint-development and troubleshooting.	High intensity of communication with local and global suppliers and subcontractors on production process innovation activities.	• Financial autonomy for expanding the plant or production line. • Purchasing autonomy for production inputs or equipments. • Human resources autonomy for local availability of manpower. • Collaboration autonomy for product and process innovation. • Subcontracting autonomy for product and/or engineering process innovation. • Autonomy for changing in operation process • Autonomy for technology sources.

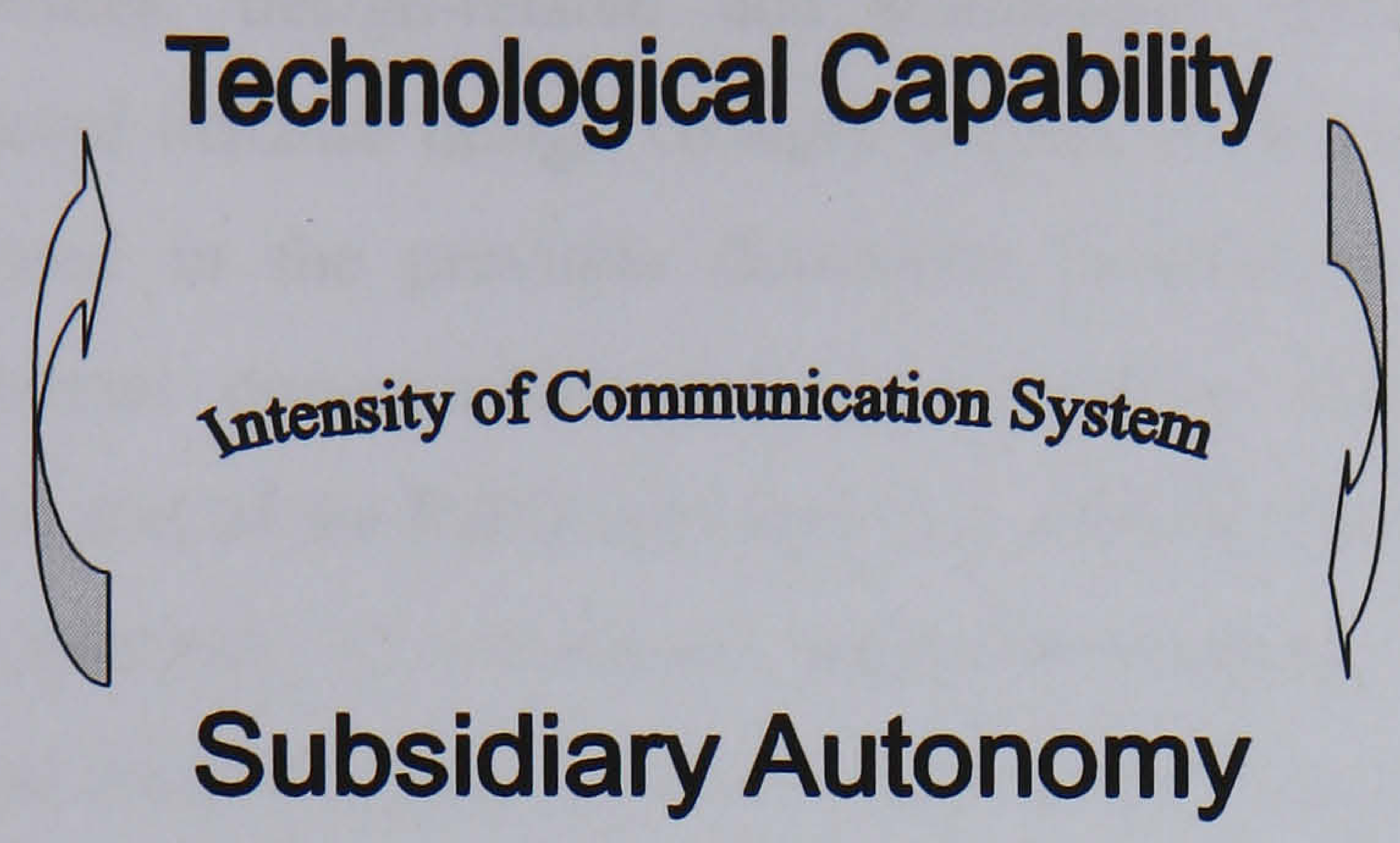

Figure 7.3 A Framework of the Cyclical Process between Subsidiary Capability and Subsidiary Autonomy

This chapter began with the discussion of subsidiary technology sources. As our findings demonstrated, subsidiaries facilitate internal, local and regional/global linkages, evolving different types and degrees of technological innovation activities. In particular, subsidiaries exploit core-technologies from the parent company for product and process innovations, and are involved in technological learning with affiliated R&D centres; in addition, they are involved in relationships with local infrastructures, including research institutions and universities, leading to country-specific technological advantage and access into local technological knowledge organisations. These technological sources - internal and external network linkages - have greater leverage on subsidiary development in terms of technological capability-creating and/or exploiting.

In this study, the value-added function of subsidiaries within the MNE networks is analysed by identifying marketing-, design- and/or production- related technological capability, as tabulated in Table 7.4. Each of the technological capabilities is related to the subsidiary's capacity for a specific value-added activity, network linkages capability and learning capability. These technological capabilities are developed in terms of routine activities (namely, everyday business operation) and innovation-related activities involving different degrees of R&D[11] and technological innovations. Of these three types of technological

[11] R&D, here, refers to basic, applied and advanced technologies.

capabilities, design-related and production related capabilities are innately connected because design changes impact on aspects of the production process. As stated in the previous discussion, marketing-related capability is led by commercial opportunities and market-driven R&D technology, which is an integral part of the R&D activities (e.g. OECD, 2002). The study also highlighted the importance of subsidiary capability-creating linked up with internal and external technological sources, exploiting them to push forward innovation activities or initiatives. Moreover, subsidiary technological capability-creating was shown to require the ability to learn about 'new' technology through joint-developments with internal and external technological linkages. As shown in the RS subsidiary case detailed in Chapter 5, subsidiary technological capability can be built and accumulated based on its in-house experiences and knowledge vis-à-vis internal and external partners over an extended period of time.

In the context of our findings, the heart of subsidiary technological-capability creating lies in exploiting the parent company's core-competitive assets and capabilities and creating its capability development using local knowledge systems, and regional and global cooperative partners. Whilst subsidiary-capability creating is driven by the HQ, subsidiary interest or local environment (e.g. Birkinshaw and Hood, 1998b), subsidiary capability development is continuously evolving in these three respects. In particular, a subsidiary's capability-creating does not simply occur through the subsidiary itself; most capabilities are the products of interaction with the differentiated network. This was shown in the case of PH subsidiary, whose design-related and production-related capabilities interacted and collaborated with, and then were disseminated to, its MNE network. Over an extended period of time, the recognition from the PH parent company of its capability and/or competence was received. The extent to which such subsidiary technological capabilities are dispersed throughout and leveraged on the MNE network, depends on the intensity of internal and external communication systems for assimilating information or knowledge, as presented in Table 7.4.

According to our evidence, the subsidiary is involved in high intensity communication systems in relation to internal and external technology sources, which can broaden and deepen levels and types of technological knowledge and the ability to learn specific functioning resources and/or capabilities. Such intensity of internal and external communication systems provides less legitimate but efficient platforms to exploit the core-competitive, knowledge-related technology from the parent company, and to disseminate complex information or knowledge from local or external environments. In this way, a subsidiary evolves internal and external communications, which in turn, can build up its linkage capabilities in order to enhance its competitiveness (e.g. Porter, 1985). Accordingly, subsidiaries can exercise the bargaining power of their specific capabilities or competences over the parent company through existing internal channels, in order to acquire greater autonomy for innovation activities or initiatives.

As discussed previously, subsidiary autonomy is a multidisciplinary concept and a cyclical process between the HQ and subsidiary, consisting of the granting of, or striving for, technological innovation activities or initiatives. The complexity is derived from identifying subsidiary autonomy, whether a subsidiary is granted more autonomy by the HQ or strives for it. The key to understanding these differences is to ascertain whether the subsidiary undertakes innovation activities to fulfil its scope of responsibilities, or to respond to, and extend, its business opportunities. There are a number of dimensions of subsidiary autonomy that are linked to a subsidiary's specific value-added capabilities, as shown in Table 7.4. The subsidiaries, which have relatively higher autonomy in terms of this type of decision-making, have more incentive to exploit internal resources and/or explore local/external resources, so as to undertake innovation activities/initiatives. In particular, a subsidiary with specific in-house capability, such as RS and PH, as detailed in Chapters 5 and 6, pursues new business opportunities for contributing to the MNE network. Over a period of time, subsidiary capabilities have been built through the accumulation of such experience and knowledge, and as a consequence, they have received more recognition from the parent company for their capabilities and/or competences. This has been seen to result in the granting of greater autonomy for the subsidiary, and an increase in its relative bargaining power to develop their innovations.

Overall, subsidiary autonomy is a cyclical process between the parent company and subsidiary, which is affected by the development of a subsidiary's technological capability. The capability-creating of a subsidiary is driven by the interactions (through intense communication mechanisms) between internal and external leverages which broaden the level and types of technological capabilities (namely, marketing-, design-and production-related) in terms of the scope of responsibility, in-house capability and the capacity for assimilation and creation of 'new' technology, as sketched in Figure 7.3.

CHAPTER EIGHT

CONCLUSIONS

In this study, we have demonstrated that the analysis of the functioning value-added subsidiary activities interaction with internal and external networks greatly benefits from systematic investigation into the development patterns of subsidiary specific capability or competence. Our conceptual framework supports the notion that single subsidiary endogenous development (namely, the maturing of in-house capabilities) is in collaboration with several technological partners embedded in internal (e.g. the HQ, sister-units) and external (e.g. local, regional/global) network linkages. This demonstrates that subsidiary technological capability-enhancement and/or strengthening does not simply rely on the HQ's technology exploitation and exploration, and/or internal affiliated MNE network. This study reveals that the underlying embeddedness between the internal (i.e. HQ-subsidiary) and external linkages (i.e. host country) of the MNE that lead to the development of subsidiary technological capability is more complex. In particular, it involves the dynamic interplay of various aspects of the subsidiary, including autonomy for decision-making, technology sources (i.e. host country's knowledge innovation system), different types and/or levels of technological capabilities, as well as the intensity of internal and external communication systems.

The purpose of this chapter is to provide a summary of the arguments of the study, and to discuss its contributions to the current understanding of the development of subsidiary technological capability and the differentiated internal and external MNE network linkages. Also discussed are the limitations of the study and avenues for further research. Some implications and recommendations for the subsidiary and the MNE are also articulated in this chapter.

8.1 The Argument Summarised

The investigation into the development of technological capabilities for product and process innovations at the subsidiary level undertaken in the previous chapters (See Chapters 5, 6, 7) endorses the modern view of the MNE as a dynamic differentiated network. From the perspective of the subsidiary, the notion of the differentiated network is elaborated by linking distinctive technological capabilities of the subsidiary to local and/or regional/global (external) sources of technological knowledge, to host-country (or location) technological advantage and to internal affiliated units including R&D organisations and the parent company, HQ or RHQ. This reflects internal MNE and external environment embeddedness (e.g. Almeida and Phene, 2004; Cantwell and Mudambi, 2005; Frost, 2001; Manolopoulos *et al.*, 2005). In addition, the case-study subsidiaries indicate that single subsidiaries have different degrees of decision-making autonomy, which influence both the nature of the internal MNE network, and the extent of influence of internal and external network linkages on the development of subsidiary technological capability.

The study began with acknowledgement that subsidiaries are simultaneously connected to the internal technology source including the HQ and affiliated-units, such as R&D centre, and the external technology source comprising of local, regional/global entities, such as local universities. Case-study subsidiaries revealed that the subsidiary is a network exploiter, or nexus, of capability-related linkages, both internal and external. These provide opportunities for a subsidiary not only to take ongoing operational responsibilities, but at the same time, to initiate innovations to respond to business and environmental changes and/or opportunities. Therefore, many subsidiary developments stem from routine activities, and, as expected, from non-routine (innovative) activities. The functioning value-added activities of subsidiaries have been categorised into market-related, design-related and production-related technological capabilities, exemplified in the cases of five-Taiwan based subsidiaries. These three types of technological capability provided the starting point for an analysis of what could account for subsidiary technological-capability development. Through this pattern and process, we identified how subsidiaries evolved as specialists by virtue of their initial HQ mandate, the in-house capabilities they focused on and the unique range of network linkages they formed for both exploiting and co-developing these capabilities. These differences are justified and summarised in Chapters 6 and 7, which present both quantitative and qualitative measures to validate our relative rankings. More specifically, the internal linkage is one of capabilities for subsidiaries to access R&D and production facilities in order to exploit the core-competitive technology from the MNE. The external linkage is another capability for subsidiaries to explore the local, regional or global scope of technology resources, including the technology infrastructure to which they have connections. PH, for example, had evolved relatively advanced design and production-related capabilities, whilst RS was strong in design and marketing, but weaker in high-level R&D capabilities. PH had a wider range of network connections comprised of internal and external (i.e. local, regional and global) innovative actors than the other subsidiaries. It relied on these for very advanced design and production innovation, where most of its in-house capabilities were already more sophisticated than those of the other subsidiaries. It also had strong reliance on internal MNE sources of marketing capabilities, given the relative weakness of its in-house capabilities. RS was more market-oriented and had both more autonomy from its internal hierarchy and a wider range of external links to provide customer-led orientation to its product and process changes. It was, however, highly reliant on internal coordination, particularly on production processes, to respond to customer requirements, as specified in Chapters 5 and 6. These provide partial evidence that internal MNE and external environment origins of technological sources give rise to proprietary in-house capabilities in subsidiaries. These are embedded in the forms of functional activities, and interactions with its internal and external linkages, amounting to distinctive 'subsidiary-specific advantage'.

Crucial importance is given to the development of subsidiary capability over time, building upon its technological capability by linking to the host country's innovative knowledge systems including research institutions (as detailed in Chapter 4), and linking to other innovative firms as learning partnerships to increase in-house technological capabilities. At the same time, the technological capability-creating subsidiaries leverage the parent company's core-competence technology, particularly with regard to linkages with internal hierarchical R&D organisations, as a key source of learning for acquisition of specialist technological capabilities through collaborative learning. These types of subsidiary tend to have more incentives to innovate or initiate through the three main drivers: HQ mandate, internal subsidiary decision-making or host country characteristics (e.g. Birkinshaw and Hood, 1998b; Birkinshaw, 2000), by exploiting internal and external technology linkages, and increasing their potential skill base and in-house capabilities accordingly. PH, for instance, provided unprecedented access to managers at all levels (as detailed in Chapter 3) to generate a picture of how a subsidiary develops its technological capabilities utilising differentiated network linkages, as presented in Chapter 5, a thorough illustration of the process of technological capability development. In the context of our findings, the specific development of technological capability varies markedly by subsidiary, however, and the precise form of capability is specific to an individual set of function value-added activities and the flexible innovation network system of the host country. It is also determined by the changing relationship between HQ mandate and subsidiary-level innovation or initiative as a determinant of capability.

This study has therefore been concerned with the relationship between decision-making autonomy and technological capabilities that have been evolved by all case-study subsidiaries in each subsidiary's value-added 'lifetime' or activities. These subsidiaries share some important and distinctive patterns and processes of decision-making autonomy and development of technological capabilities. First, the relationship between the parent company and subsidiary was a vital determinant of subsidiary autonomy, which had an effect on the levels and types of capability that developed in the subsidiary. In particular, subsidiaries which had less autonomy as regards particular kinds of decision-making were more closely dependent on internal, HQ-linked resources, capabilities and expertise in this aspect of decision-making. Second, as with some specific decision-making dimensions in relation to the contributory mandate or the value of subsidiary role or local development in the parent company's perceptions, subsidiaries were granted significant managerial autonomy, for example, financial, purchasing and human resources decisions, and change in operation process. Third, some subsidiaries, taking autonomy to its extreme, initiated a number of innovations to expand the scope of business responsibilities. These kinds of autonomy were indicated through marketing activity, product development, subcontracting and collaborative strategic decision-making. Altogether, a number of specific dimensions of subsidiary autonomy were related to subsidiary capability development; however, the underlying relationships between subsidiary autonomy and technological capability development were more complex than anticipated.

These characteristics centre upon the distinction between assigned and assumed autonomy at the subsidiary level. The different kinds of autonomy drive different levels and types of subsidiary capability development. Assigned and assumed autonomy have been granted particular kinds of autonomy for pursuing innovative activities. The significant difference in these two types of autonomy is that assigned autonomy fulfils a mandate from the parent company, while assumed autonomy is perceived by the subsidiary managers as a response to the business opportunities that arise (e.g. Birkinshaw, 2000). In the context of our findings, the subsidiary preserved assigned autonomy; for instance, MT and ST enjoyed limited collaboration with the internal MNE network with regard to innovative activities. By contrast, the subsidiary with assumed autonomy, for example, RS and PH, was aware of its specific value-added evolved capabilities in terms of marketing-, design- or production-related capabilities, and undertook new innovative activities to create competitive space for themselves in local, regional markets and/or the internal market (namely, inside the MNE). Viewed in its own terms, the subsidiary recognised the potential of the innovative activities to enhance its proprietary assets or capabilities and to build up its development, for example, by subcontracting out some engineering design jobs to local innovative firms, and by seeking a new operational process for the inside market of the MNE. This particular subsidiary was able to win recognition for its capability from the parent company, and in turn, the subsidiary was able to bargain with the parent company for much greater autonomy to undertake innovative activities or initiatives in a manner consistent with the strategic directions of the parent company. On reflection, many different development-driven subsidiaries are able to undertake innovative activities to complement strategies and technology development of the parent company, on the basis both of the subsidiary in-house capabilities and of their capabilities to leverage resources from the strengths of the differentiated network's internal and external linkages.

Such subsidiary innovative activities, in response to internal and/or external business opportunities, are in alignment with a set of principles that mirrors the model of the five generic processes of subsidiary evolution, developed by Birkinshaw and Hood (1998b: 783). In contrast, our study was confined to technological capability enhancement and exploitation (sharpening and strengthening). In terms of the linkage capability of technology sources, the subsidiaries exploited core-competence technologies from the parent company to strengthen their existing marketing-, design- and/or production-related technology. Some subsidiaries, such as RS or PH, with higher in-house technological capabilities, initiated innovative activities in collaboration with local or global subcontractors or research institutions to respond to business opportunities arising locally or internally (namely, the internal market). This led to technological capability enhancement, i.e. a number of patents or time to market, as discussed in Chapter 6, through collaborative learning and very intense communication mechanisms. Over a period of time, the subsidiary capability was enhanced by these experiences and accumulation of knowledge. As a consequence, they received more recognition from the parent company for their capabilities and/or competences, leading to the granting of greater autonomy. On the other hand, subsidiaries have relatively strong bargaining power, derived through their performance, to strive for much higher autonomy for their innovations. In sum, subsidiary autonomy is a cyclical process between the parent company and the subsidiary, in which change is driven by the development of subsidiary technological capability in collaboration with differentiated network linkages.

8.2 Main Contributions of This Research

This research advances existing literature in bringing together research streams from international business management and technology (innovation) management, in terms of specific measures of subsidiary autonomy and technological capability. These were used to examine the internal governance mechanisms, network linkages and capability-development in five Taiwan-based MNE subsidiaries in the high-tech electronics industry. The findings of the thesis make several theoretical and empirical contributions to these areas. It refines our view of the development of subsidiary technological capability interaction with (not only embeddedness in) the differentiated MNE network linkages, the decision-making autonomy from the parent company in fostering subsidiary autonomous innovation activities, and the way these interact with communication systems affecting the development of subsidiary technological capability. In particular, this study provides rich empirical evidence to show how a subsidiary uses the internal (intra-firm) network, while at the same time, it evolves and explores an external (inter-firm) network to develop different types and levels of technological capability.

The findings provide an important addition to the international business management literature in terms of the details of the development of subsidiary technological capability within internal and external MNE networks. These findings are empirically consistent with the work of Birkinshaw and Hood (1998b), although we confine ourselves to the enhancement and strengthening of subsidiary technological capability. Moreover, we have extended their perception of the subsidiary by highlighting the development of subsidiary technological capability interaction with the differentiated MNE network, as well as by establishing the existence of a cyclical pattern in the relationship between the parent company and the subsidiary in terms of decision-making.

8.2.1 Theoretical Contributions to the Subsidiary Specific Advantage, Subsidiary Evolution and the Differentiated MNE Network Management

Our findings confirm the view that technology in MNEs is no longer derived from one source alone. Traditionally, the view of international business was that firm-specific advantages were developed at the HQ, which dispersed the technology to overseas subsidiaries (e.g. Dunning, 1981). The findings of this study have sought to advance this debate by linking distinctive technological capabilities of the subsidiary to local or regional/global sources of technological knowledge and host-country (or location) technological advantage, as well as to the formal ties of internal affiliated units including R&D organisations and the parent company, HQ or RHQ. In particular, our findings suggest that a subsidiary exploits the core-competence technology of the parent company and explores host-country specific advantages, including research institutions, collaborating with local innovative firms to enhance its technological capabilities. In short, the subsidiary is not only a 'home-base exploiter', but also a 'host-country creator'. The HQ, in contrast, has been transformed to act as a core-competence technology creator as well as a key technology consultant in the MNE's worldwide operations (e.g. Cantwell, 2001; Manolopoulos *et al.*, 2005). Technology resources and knowledge are no longer entirely internally or externally within the MNE. This approach is consistent with the network perspective of Nohria and Ghoshal (1997) and Birkinshaw (2000), but it also takes ideas further by specifying the processes through which types and levels of the development of subsidiary technological capabilities pass. To some extent, this study implicitly reconciles two concepts - exploitation and exploration. The finding of this study accords with the work of Almeida and Phene (2004) and Frost (2001) by highlighting that the development of subsidiary technological capability may be fully understood from the theory of innovation management, and the perspective of the MNE differentiated network, but explicates the HQ-subsidiary relationships to the extent of influencing the development of subsidiary technological capability.

The development of subsidiary technological capabilities in terms of marketing-related, design-related and production-related capabilities within the MNE differentiated network is developed and investigated in this study. Our findings suggest that the subsidiary exploits the parent company's technology and explores host-country specific advantages, including local technology infrastructure, embracing collaborative learning and intense communication throughout the internal and external network linkages. This can lead the subsidiary to strengthen its in-house capability and to enhance its specific technological capability. This research pays attention to the way that technological capability is developed at the subsidiary level, and the way in which it contributes to the parent company by dispersing and disseminating technological knowledge to the MNE networks, rather than just focusing on the corporate level or firm-level capability. At a high level of abstraction, the findings confirm that the dynamic capability perspective provides a platform to understand how a subsidiary, through internal and external collaborative learning and technological dissemination, is able to develop its innovative activities. To some extent, it hints at one concern of the resources-based view of the firm, namely, the lack of consideration of internal and external technological collaborative learning and technology evolution (e.g. Birkinshaw and Hood, 1998b).

The pattern of development of subsidiary technological capability was identified in Chapter 7, implying the multidimensional nature of the subsidiary function in MNE (e.g. Rugman and Verbeke, 2001). This pattern has identified three types of innately interacted technological capabilities and the diffusion process. The patterns of capability strengthening and enhancement with (-in) the differentiated MNE networks have been discussed. We have argued that the development of subsidiary technological capabilities is the process of accumulation of resources and capabilities in the subsidiary over time, involving the concepts of subsidiary-specific advantage and subsidiary evolution. These two perspectives have become of increasing importance in understanding the development of subsidiary technological capabilities, and imply that any attempt to classify subsidiaries according to their specific 'roles' in the MNE is inadequate (e.g. Rugman and Verbeke, 2001). This research theoretically links subsidiary autonomy, subsidiary initiative (subsidiary innovation activities) and subsidiary capability in a sample of multinational firms. In particular, the study has argued that the development of subsidiary technological capabilities interaction with differentiated MNE networks is mediated by the parent company, HQ or RHQ governance and subsidiary autonomous actions. Our findings suggest that the development of subsidiary technological capabilities over time drives the dynamics of subsidiary autonomy; in short, a change in the decision-making in internal governance between the parent company and the subsidiary has occurred (e.g. Verbeke and Yuan, 2005). From the perspectives of subsidiary-specific advantage and subsidiary evolution (e.g. Birkinshaw and Hood, 1998b; Rugman and Verbeke, 2001), changes in internal control mechanisms are based on the development of subsidiary technological capabilities. Subsidiary innovative activities (or initiatives), on the basis of embedded resources and capabilities, as well as specific advantage in understanding local specific technological knowledge and exploration of the host country's technological infrastructure including universities and research institutions, initiate the change in the corporate management context. This implies that 'order' achieved and/or 'recognition for subsidiary competence' received (e.g. Verbeke and Yuan, 2005), in addition to more autonomy for undertaking innovative activities, are granted to the subsidiary accordingly.

8.2.2 Empirical Contributions to the Development of Subsidiary Technological Capability and Subsidiary Autonomy

The main drawback of technology development from the perspective of the HQ is that it does not explain how or why subsidiary technological development occurs. This failing has led to the development of subsidiary technological capability, which endogenises technological progress and/or knowledge accumulation through internal and external networks at the subsidiary level. We have developed a systematic framework to assess patterns of development of subsidiary technological capability, including technological capability-creating and capability-exploiting, as summarised in Chapter 7. Three types of technological capabilities predominated in the context of our study: marketing-related, design-related and production related capabilities. They were individually evaluated through: 1) the capacity for specific value-added activity, 2) linkage capability, and 3) learning capability. Each of the technological capabilities was deconstructed from each value chain function performed by a subsidiary, and the technological knowledge bundles used and/or created (e.g. Rugman and Verbeke, 2001). Explicitly, this research has discussed the empirical innovation processes of the MNE concerning the local, regional and global aspects of innovative activities, which typically exchanged and flowed on empirical grounds. More specifically, the case studies of MNE subsidiaries focused on the internal (intra-firm) and external (inter-firm) routine and non-routine (innovative) activities to understand the development (including exploitation and exploration) of subsidiary technological capabilities, which empirically goes beyond the the enhancement/strengthening of subsidiary capability proposed by Birkinshaw and Hood (1998b). Furthermore, the case studies provided a vehicle through which a set of processes for the development of technological capability in the subsidiary could be identified.

This study is consistent with research that presets the variation, coexistence and dynamism of variegated and differentiated structures of the MNE (e.g. Bartlett, 1983; Doz and Prhalad, 1991; Hedlund and Rolander, 1990). The study identified a set of patterns for the development of subsidiary technological capability in terms of in-house specific capabilities, multi-level linkage capability and learning capability. In particular, it has provided empirical evidence of different types and levels of technological capabilities. On reflection, this research has provided a fuller picture of how a subsidiary can evolve cross-border linkages in terms of technology source connections to both internal and external MNE network counterparts in order to achieve improved/advanced levels of capability and to create the potential for playing a greater strategic role. The context of industrial specialisation provides additional explanation of subsidiary initiatives and the interdependence between subsidiary and the MNE network. In particular, the electronic high-tech industry has been demonstrated to integrate vertical and horizontal supply-chains to convert component products into consumer products, revealing a relatively close relationship in the product development process that reflects the innate connection between product design and production. As a result, this study advances existing research into the management of technology and product innovation across international business operations (e.g. Birkinshaw, 2000; Ghoshal and Bartlett, 1988; Ghoshal and Bartlett, 1990).

Furthermore, such subsidiary innovative activities, in response to internal and/or external business opportunities, are connected to a set of principles that mirrors the model of the five generic processes of subsidiary evolution as developed by Birkinshaw and Hood (1998b: 783). However, our study in this respect was confined to the development of technological capability, including exploration and exploitation. As indicated in the study, the three developments of capabilities and/or the change of scope of responsibilities evolved at the subsidiary level are driven by HQ investment, subsidiary decision or local environment. However, in the analysis of Birkinshaw and Hood (1998b), no distinction is made between subsidiary autonomy and the development of subsidiary technological capabilities whereby technology can be dispersed throughout linkage capability and learning capability. These empirical findings enrich the measures and patterns of subsidiary autonomy, technological capability, and communication systems interaction with differentiated MNE network linkages (e.g. Nohria and Ghoshal, 1997). Our study further indicates a subjective interpretation of data gathered from in-depth interviews with senior managers at the multinational subsidiaries with regard to the degree to which subsidiary autonomy can be devolved downwards to undertake innovation activities from the parent company. A similar interpretation pertains to the way in which a subsidiary is dependent on the parent company in terms of decision-making of strategic and operational managements. On reflection, the concept of subsidiary autonomy is allied with assigned and assumed autonomy; the distinction between the two having been discussed in Section 7.4.2. This reinforces our observation that subsidiary autonomy is a multidisciplinary and cyclical process between the parent company and the subsidiary (e.g. Brooke, 1984). At a higher level of case analysis and discussion (see Section 7.4.3), this study also recognises that subsidiary autonomy can be altered through a change in the development (enhancement) of technological capability. Explicitly, the development of subsidiary technological capabilities is primarily from subsidiary in-house capabilities leveraged with internal and external technology sources and very intense communication for assimilating information and knowledge. This results in the development of subsidiary specific value-added capability, leading to ever greater autonomy being devolved downwards to the subsidiary. While identifying and examining the decision-making process of subsidiary autonomy, showing it to be determined by the relationship with the parent company, this study has reinforced the centrality of the idea of the development of subsidiary capability from the perspective of the differentiated MNE network.

8.3 Limitations of the Research

The issues of credibility, validity and relevance of our findings were central concerns in the within-case analysis and cross-case comparisons of the study, as presented in Chapters 5 and 6. To this end, we utilised the arguments of generalisability, validity and creditability proposed by Eisenthardt (1989) and Yin (1994, 2003). We analysed and discussed in-depth the patterns and processes we undertook to ensure the validity of our study. Throughout the process of this research, we articulated how the findings of our study correspond to, and contrast with, existing literature. We also verified the way in which the empirical evidence is linked to the objective of the research. Nonetheless, a number of limitations of the study may well have influenced the validity and generalisability of our findings, raising questions about the extent to which the account accurately reflects the phenomenon being addressed.

Technological capabilities are difficult to split between the MNE and subsidiary levels. In particular, some technological capabilities are clearly kept in the parent company and dispersed across the internal MNE network, for instance, advanced R&D technology, or core-competitive component/technology. Others are likely to be specific capabilities to the focal subsidiary, such as local marketing-related capability, local technology source or local knowledge systems. difficulty in obtaining subsidiary-level technological innovation quantitative data from a representative sample of MNEs (Kogut and Chang, 1991) was experienced, forcing the researcher to gather some industry-standard measures for technological capabilities from case-study subsidiaries. It was quite difficult to evaluate across subsidiaries by using the data collected from the respondents or internal confidential documents, because each subsidiary was involved in developing slightly different types of products/processes and product/process changes. A perfect match was not possible; however, respondents viewed the measures used as internal benchmarks of gauging (intra-sister) subsidiary capability differences.

Although most technological capabilities are disseminated to reciprocal organisations in the MNE network, specific subsidiary technological capabilities are rooted and cultivated in the subsidiary and the location in which it is situated. In this regard, subsidiaries in host countries perform specific value-added activities, which are fundamentally 'embedded' in these countries' knowledge systems, including research institutions, universities and local innovative firms, etc. This geographic location of the knowledge sources underpins subsidiaries' innovations and increases the subsidaries' potential skill base and local linkage capability (e.g. Cantwell and Mudambi, 2005; Frost, 2001; Rugman and Verbeke, 2001). At the same time, the internal MNE linkage is a technological knowledge source for subsidiaries' innovations (e.g. Frost, 2001; Manolopoulos *et al.*, 2005). While this study is based on a very small sample of Taiwan-based subsidiaries in the electronics industry, and therefore, cannot be regarded in anyway as definitive, it is reasonable to claim that the MNE subsidiaries chosen are representative of the development of subsidiary technological capability interaction with the host country's technological knowledge development systems. The insights generated are suggestive of trends that make it more plausible to argue that the development of subsidiary technological capability is fundamentally embedded in the host country or location in which it is situated (e.g. Cantwell and Mudambi, 2005; Frost, 2001). Its development of technological capability essentially interacts with the internal and external MNE network, leveraging by means of the internal and external technological linkages and collaborative learning. In addition, in view of the obvious limits to generalisability inherent in a study set in a single country and industry, our results must be considered preliminary, due to the combination of small sample size and inherently complex phenomena.

A pattern depicting the development of subsidiary technological capabilities in terms of marketing-related, design-related and production-related capabilities within the MNE differentiated network has been developed and investigated in this study. Our findings propose that the subsidiary exploits the parent company's technology and explores host-country specific advantages including local technology infrastructure, through collaborative learning and very intensive communication throughout the internal (parent company) and external linkages (host country). This dynamic interplay results in the development of subsidiary technological capabilities in terms of capability strengthening and/or enhancement. Whilst the result of the development of subsidiary capability is consistent with Birkinshaw and Hood's (1998b) model, the 'generic subsidiary evolution processes' of subsidiary evolution, which is the result of an accumulation or depletion of capabilities over time, this research is confined to capability-enhancement and strengthening, an obvious limitation of the study. Furthermore, in the context of our findings, the sophisticated technological capability of the subsidiary is, to some extent, related to a function of subsidiary size, so that larger and more important subsidiaries would potentially have greater impact (e.g. Birkinshaw, 1999). Additionally, the literature shows that a debatable association exists amongst subsidiary size, age and subsidiary autonomy (Gates and Egelhoff, 1986; Hedlund, 1981; Young and Tavares, 2004). The researcher was aware of the issues of subsidiary size and age, and therefore efforts were made to carefully select a sample of large multinational Taiwan-based subsidiaries in the same industry (detailed in Chapter 3) in order to avoid this pitfall.

In the context of our finding regarding subsidiary autonomy, a number of generic and technological innovation-related decision-making issues have been identified. The most interesting issue indicated that subsidiary technological capability-development seems to be an initiative to change subsidiary autonomy, as illustrated in PH and RS subsidiaries. This appears to provide limited evidence for the 'cause-effect' relationship between the development of subsidiary technological capability and subsidiary autonomy, representing the usual constraints of a small-sample process study. Nonetheless, this study reinforces the view that subsidiary autonomy is a multidisciplinary and cyclical process between the parent company and the subsidiary, which can be bargained or altered through a change in the development of technological capability over a period of operational time. Here, the dimension of time arises. Whilst the interview was conducted over a long period of data-collection time (see Chapter 3), the issues with regard to the change in subsidiary autonomy and the development of subsidiary capability at a given period of time, for instance, in the last 5 years, were also acquired from the interviewee. The difficulties associated with interpreting personal recollections are well known (e.g. Schwenk, 1988) and were understood in advance. Thus the researcher endeavoured to reduce the problems in this respect by gathering information from multiple respondents and analysing archival and secondary data (e.g. Birkinshaw, 1999). With regard to one of the conventional paradigmatic limitations of the particular period of the data-collection time, a longitudinal study is recommended for future research.

8.4 Further Research Agenda

This research advances existing literature in bringing together research streams from MNE management and technology management. In particular, the emphasis is placed on a set of patterns and processes of the development of technological capability evolved in the subsidiary. More specifically, this study delivers the multi-faceted relationships of the development of subsidiary capability that is embedded both in the internal affiliated HQ or sister-units and in the external host country's technological knowledge systems. This research adopted an exclusively subsidiary perspective, which was necessary and appropriate as a means of studying the development of subsidiary technological capability and understanding subsidiary autonomy in depth. However, a priority for future work would be to gain a balanced perspective from the parent company, HQ or RHQ and/or any affiliated counterparts and the subsidiary on the same processes. The findings of this study will provide a basis for future research in the field.

There is already wide acknowledgement that subsidiaries evolve over time the process of accumulation or depletion of resources and the development or depletion of specialised capabilities and charters (Hedlund, 1986; Prahalad and Doz, 1981; Birkinshaw and Hood, 1998b). However, there is not usually enough evidence to assess the status of subsidiaries in accumulating different types or levels of capabilities and/or charters. Whilst this study provides a set pattern for the development of subsidiary technological capabilities, the process of the depletion of subsidiary technological capability remains unanswered with respect to how and why the subsidiary depletes its capabilities and/or its scope of responsibilities, an area which needs to be addressed further. The question of how to evaluate the technological capability accumulation or depletion of subsidiaries when they are exploiting, creating and exploring different types and levels of technology remains unexplored, and should also be addressed in future studies. Another issue with regard to subsidiary evolution (e.g., Birkinshaw and Hood, 1998b), namely, the development of subsidiary technological capability, was implicitly implied in this study. It is worthwhile to empirically explore this issue in detail, considering how and why the subsidiary accumulates existing technological capability, and subsequently, to move on to other technological capability which is accumulated later. Future research could develop a more in-depth study of the accumulation of subsidiary technological capability, leading into the area of subsidiary technology path-dependency. For this type of study, longitudinal research is recommended.

The concept of learning capability is examined in this study with regard to the pattern in which technological capability from internal and external network linkages is acquired, as well as the type of mechanisms used by a subsidiary to acquire different types and levels of technology. However, it does not specifically discuss the process of subsidiary learning (e.g. Nonaka and Takeuchi, 1995) or the diffusion of subsidiary innovation (e.g. Rogers, 1995), and so these are areas recommended for further research. One of the key contributions of this study is to underscore the intertwined nature of the learning capability and the development of technological capability. The evidence of this study provides some insight into the conditions necessary for a subsidiary to use different types of learning mechanisms to obtain different types and/or levels of technological capability through its internal and external network linkages. Some unexplored questions of what combinations of learning mechanisms contribute more to the different types and/or levels of subsidiary technological capability via the differentiated MNE network are worthy of consideration in future studies.

This study breaks new ground empirically. The key contribution of this study is the illumination of a systematic pattern linking the development of subsidiary technological capabilities in the differentiated internal and external MNE network. The findings of this research suggest that the development of subsidiary technological capability is involved in three drivers of subsidiary evolutions, the interplay between subsidiary in-house capabilities and its internal and external network linkages, as well as learning capability. Exploring the dynamics of these relationships as they evolve over an extended period of time represents a future research direction. To some extent, the result of this research, particularly in the case of PH, confirms the idea of a 'centre of excellence' (e.g. Frost *et al.*, 2002) that has gradually evolved particular types of technological capabilities into a manufacturing centre for the MNE. These capabilities are leveraged by, and/or disseminated to, other parts of the internal and external MNE network. Future research should focus on exploring in greater depth under what conditions, and through what specific advantages, the subsidiary evolves into a 'centre of excellence'.

In addition, this research provides empirical support for the viewpoint that the subsidiary acts as a significant 'host-country technological capability-creator' as regards subsidiary-specific advantage. In this research, established was a pattern for understanding the development of subsidiary technological capability from three main angles: types and levels of technological capabilities, degrees and characteristics of subsidiary autonomy, and communication systems. This implies the multidimensional nature of subsidiary vale-added activities in the differentiated internal and external MNE network, although this study is limited with respect to the diversity of the development of subsidiary capability and examination of subsidiary-specific advantage. It would perhaps be interesting for future research to investigate the relationships between the developments of subsidiary capability, for instance, technological capabilities, and subsidiary-specific advantages. An additional focus might be the extent to which subsidiary-specific advantages change whilst the subsidiary is in the process of evolution (e.g. Birkinshaw and Hood, 1998b).

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Appendix

A. The Top Ten Countries of the Global Competitiveness from the year of 2002 to 2005

Country	2005 Rank	2004 Rank	2003 Rank	2002 Rank
Finland	1	1	1	2
United States	2	2	2	1
Sweden	3	3	3	5
Denmark	4	5	4	10
Taiwan	5	4	5	3
Singapore	6	7	6	4
Iceland	7	10	8	12
Switzerland	8	8	7	6
Norway	9	6	9	9
Australia	10	14	10	7

Source: World Economic Forum (2003-2006)

B. Gaining Access: Brief Introduction Letter

WARWICK
BUSINESS SCHOOL

Dear Sir/Madam,

I am a doctoral researcher at Warwick Business School under the supervision of Dr. Simon Collinson writing to appreciate your participation in this PhD research. The research will analyze co-operation between subsidiaries and their parent companies in the high-tech electronic industry and how subsidiaries develop innovative capability. Ideally, it will involve in-depth interviews with senior managers based in *Taiwan*.

The focus of this research is at the subsidiary level of Multinational Enterprises (MNEs), it will discuss *why and what relationships determine the degree of subsidiary autonomy, and how the subsidiary develops innovative capability through the parent, sister subsidiary and local linkages.* A summary of the research is enclosed.

Naturally, I will be willing to share the findings of this research by providing a case study report and/or presentation, and also sign a confidential agreement. Furthermore, the value of this research will be in developing a greater insight of how subsidiaries vis-à-vis headquarters can be better managed to develop and increase their innovative capability through internal and external linkages. This in turn will provide an indication of the development of innovative capability at the subsidiary level and also strengthen the core competences of the MNE.

As I am sure you are aware research access to leading companies is essential to develop a greater understanding of the effective and efficient management of subsidiaries. I very much appreciate that you are willing to assist me with my PhD research and look forward to meeting you soon.

Yours Sincerely,

Jung-Li Wang

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C. Research Summary

PhD Research Summary

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Title: The Relation between Subsidiary Autonomy and Innovation Capability

Research Objective and Questions:
The objective of this research is to consider co-operation between subsidiaries and their parent companies and how subsidiaries develop innovative capabilities. It will discuss: (1) *why and what relationships determine the degree of subsidiary autonomy*, (2) *how a subsidiary develops its innovative capability through the linkages between the internal (headquarters-subsidiary-sister subsidiaries) and external (subsidiary-suppliers-local entities) linkages*. In particular, this study will evaluate cross-firm comparisons of subsidiary autonomy (vis-à-vis Headquarters) and how autonomy subsequently relates to innovative capability at the subsidiary level.

Research Scope:
A subsidiary's autonomy is defined by the degree of dependence on the parent company and characterized by formal and informal mechanisms including (1) resource allocation such as HRM, investment, financial and procurement control; (2) coordination and decision-making control; (3) communication, and interaction, and; (4) technological autonomy. These characteristics will be used to measure the extent that the operations of overseas subsidiaries depend on linkages with their parent company, sister subsidiaries and other external parties.
Innovative capability accumulates as a result of various internal and external linkages. Internal linkage includes: (a) the dependence on the headquarters and/or the regional headquarters, and (b) the coordination with sister-subsidiaries. External linkage includes: (a) the intensity of coordination/cooperation with suppliers, (b) host government support, and (c) other affiliations. When measuring innovative capability, this research focuses on product and/or process developments. Its initial aim is to show whether or not the subsidiary has developed at least one major product on its own and/or in a joint-development in the past 3 years. 'Major' in this context is

defined as an activity that is of strategic importance for the corporation as a whole. The second aim is to measure the level of product and process developments and the extent to which these developments require specialized technological expertise. Product development is classified as radical, incremental and basic product changes at the subsidiary and/or the corporation. Subsequently, this study will discuss whether product development has co-developed with any other internal and/or external affiliations, and whether product development requires any process developments in terms of technological/technical, engineering and manufacturing improvements and/or developments. Furthermore, this study will explore internal measures of innovative capability that are adopted by subsidiaries to evaluate outcomes/performance.

Research Design:
This research will be applied to the high-tech electronic industry. The empirical study will be confined to an in-depth look at Taiwan-based subsidiaries that are wholly owned by USA, European, and Japanese parent companies. Semi-structured interviews will be conducted with the CEOs/directors and senior managers of the manufacturing, human resources, procurement, financial & accounting, engineering and/or R&D departments. Each interview will last approximately an hour. Initially, this research will be carried at Taiwan-based subsidiaries in the first three months of 2004.

Research Contributions:
This contribution will stem from the subsidiary autonomy and the development of innovation capability; and the integration of the relationship of MNCs networks. Not only will this research provide an academic understanding of the development of innovation capability and collaboration/governance with the MNC, but it will also help the manager to coordinate and collaborate with the subsidiary, headquarters and/or external partners. The value of this research will be in developing a greater insight of how subsidiary vis-à-vis headquarters relationships can be managed effectively and efficiently while a subsidiary develops and increases its innovative capability through internal and external linkages. This in turn will provide an academic research of the development of innovative capability at the subsidiary level and also strengthen the core competences of the MNE.

D. Checklist for Interview

A. Characteristics of a subsidiary[1]

1. The role of respondent (manager, director…)/Job title, Designation
2. Industry/Sector
3. Age: Date of establishment
4. Location
5. Creation of the firm: background
6. Current responsibilities for the MNC
7. Scop[2]e of operations
8. Size: number of employment, turnover, revenue and production of this subsidiary
9. The ratio of the subsidiary's exports to total sales/revenue
10. The ratio of the subsidiary's total sales to its parent's total sales/revenue
11. The percentage/amount of R&D expenditure/investment
12. The percentage of corporate profit/revenue (as a whole MNC) 'earned' by a subsidiary
13. Product life cycle time
14. Are there any influences from local government? (Extent to E)

B. Subsidiary Autonomy

1. Please describe how <u>your company</u> operates within <u>the MNE</u> between global HQ, regional HQ, and sister subsidiary and your suppliers? Specifically, I am interested to be told how these units influence <u>your company</u>?

2. I would like to know about the dependence on the parent company, in particular, how <u>your firm</u> depends on the parent company in management (control) mechanisms, strategy decision-making, structure setting, behavioral context and other characteristics (subsidiary leadership, subsidiary experience).

2.1 Do you produce reports on your organisation? What type and how often do you produce? And whom do you need to submit to? Do you deliver the report to your inter-units and/or external entities? Such as for the HQ produced a financial and/or technical report, and/or for the suppliers produced manufacturing report.

2.2 I am keen to know of the style and the frequency of communication between the subsidiary, and the parent company and major suppliers. How often do you have formal routine communication, such as senior manager visited <u>your organisation</u> once a year; and /or how often do you have informal communication? For example, internet, intranet, telephone, fax, or other style of communication between the subsidiary and the HQ/sister subsidiaries, and/or the major suppliers?

2.3 Related to accounting and financial management system, specifically how degree of budgeting /investment/financial power does your firm have? How many amounts would your firm allow to use from the parent company?

2.4 Can you tell me about the purchase process? Does your firm purchase from your sister-subsidiary or from the regional HQ or the global HQ? How much number/ratio of material/product does your firm purchase from internal/external linkages? Do you have the regular source or suppliers to provide the material?

2.5 Can you tell me about how your firm manages/operates products? Do you sell products to the HQ, sister subsidiary, local market, and/or global market? Does your firm make an initial marketing/production-decision?

2.6 How do you manage the human resource recruitment and training process? Do you recruit employees from the HQ or other units? Do you train your employees in the subsidiary or in the HQ and/or cooperate with other organisation? I'm also interested in training activities in terms of formal and/or informal training process between the subsidiary, the parent company and the supplier.

2.7 How many involvements of the subsidiary can involve into the strategy making? To what extent does your firm have particular international responsibilities to the MNC?

2.8 Does your firm make a decision to collaborate with the other business units and/or the supplier and/or other local organizations? How is this collaboration to be processed?

2.9 Does your firm make a major/minor change in product development? How is the development undertaken? Does the regional HQ and/or global HQ intervene this development?

2.10 Does your firm make a decision to switch a new/improved manufacturing/engineering/operational process? How is the development done? Does the regional HQ and/or global HQ intervene this development?

2.11 Does your firm make a decision to subcontract out some portions of the manufacturing instead of expanding subsidiary's own facilities? Does the HQ intervene the decision? How is the business job undertaken?

2.12 How much freedom does the subsidiary have to develop its R&D /manufacturing technology? Specifically, whether your manufacturing/production/engineering/R&D technologies depend on your parent company.

2.13 What level of strategic dependence on the parent company does your firm have? To what extent does your firm have a track record of success getting project approved and do your firm conduct this project on your own?

C. Innovative Capability

Product development

Development Process	Create For	Adopt From	Diffuse to
Level of Development	The Corporation-(HQ/regional HQ)	The Corporation-(HQ/regional HQ)	The Corporation-(HQ/regional HQ)
	Sister subsidiaries	Sister subsidiaries	Sister subsidiaries
	Global market/Regional market/Local market		
Degree of Development	Radical	Radical	Radical
	Incremental	Incremental	Incremental
	Basic	Basic	Basic
Cooperation	Internal : The corporation (HQ/regional HQ), sister subsidiaries, R&D center		
	External: suppliers, Taiwan government, research institutions…..		
Measures	Standardization	Product Quality	
	Product Cycle time	Quantitative Measurements	
	Patent		

1. Does your firm create new products, adopt products from <u>your MNC's</u> network and/or diffuse products to your <u>MNC's</u> network, local market in the past 3 years? Where do your products sell to, for example, global/local/regional market?
2. Can you tell me how <u>your firm</u> develops your products, in particular, whether <u>your firm</u> co-operates with internal linkages (sister subsidiaries, parent company), external linkages (major supplier and/or host country entities) to produce products/service?
3. Does <u>your organization</u> apply any measures to product development? Could you provide the details of the measures? For example, standardization of product development to the MNC network (parent company, sister subsidiary), customers' benefits for their products/service, product cycle time, product life cycle, patent.

Process development

Process Learning	Internal learning: the corporation (HQ/regional HQ), sister subsidiaries, R&D center	
	External learning: suppliers, Taiwan entities (government institutions/research institutions/universities)	
Measures	Time to market for new products and/or service	Quantity and depth of standardized process
	Quality of new product development	Quality of manufacturing process
	Project management processes	Quality initiative processes

1. How is your organization conducting your production/manufacturing/operation?
2. How efficient are the internal processes in producing your firm's products/services?
3. How is your process learning? Does your firm learn from the HQ, sister subsidiaries and/or from suppliers, and/or from Taiwan (institutions)?
4. Does your organization evaluate process development? How do you measure it? Such as, time to market for new products and service, quality of new product development and project management processes, quantity and depth of standardized process, quality of manufacturing process and quality initiative processes.

D. Suppliers relationships

1. Please describe how your company relies on local resources, particularly on local technological expertise, the relationships with local suppliers for example, the co-ordination and/or co-innovation with the local suppliers/global suppliers?

E. Host Country Issue

1. Are there particular/significant benefits and problems with operating in Taiwan?
2. Is Taiwan actively looking to support investment and industrial growth? Can you provide some examples? Such as government regulations, public institutions...and so on.

E. Interview Questions

Doctoral Research: Jungli Wang

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WARWICK BUSINESS SCHOOL

PhD Research Interview Questions:

1. What is your role in IBM Taiwan?
2. What is the role/function of IBM integrated Supply Chain in the IBM Taiwan and IBM Corporation?
3. How many employees and how many sales, turnover/revenue, revenue growth rate, profit, production and product life cycle are there IBM Taiwan? (Please would you provide IBM Taiwan chart/annual report, and/or IBM Corporation annul report?)
4. Can you describe how your organisation operates within the IBM Corporation between global HQ, regional HQ, and sister subsidiaries, and main suppliers? Specifically, I'm interested in how these units influence your organisation.
5. I would like to know about the relationships between the parent company (IBM Corporation) and IBM Taiwan, in particular, I am interested in the degree of how independent/freedom of the parent company in your organisation, specifically in control mechanisms, strategic decision-making (such as, technological innovation), structure setting and other characteristics.
6. Do you produce reports on your organisation? What types and how often do you produce? Whom do you need to submit to? Do you deliver the report to your internal linkages (such as, the parent company) and/or external linkages (such as, main suppliers)?
7. I am keen to know of the style and the frequency of communication between your organisation and the parent company, sister subsidiaries, major suppliers and Taiwan entities.
8. I am very keen to know how your firm create/adopt/diffuse the product and process developments. In particular, whether your organisation co-operate with the MNC/the corporation network (HQ-subsidiary-sister subsidiary) and/or external linkages (suppliers) to develop product and/or process.
9. I'm also very interested in how your organisation evaluates or benchmarks your innovative capability in terms of product and process development.
10. Please describe how your organisation relies on local resources, particularly on local technological expertise, the relationships with local suppliers for example, the co-ordination and/or co-innovation with the local suppliers?
11. Are there significant/particular benefits and/or problems with operating in Taiwan? Is Taiwan actively looking to support investment and industrial growth? Can you provide some examples?

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