In search for a silver lining:

The evolution of the E&E industry of Batam

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PREFACE

We, Mathijs van Campenhout (25) and Jasper de Graaf (24), are students at the University of Utrecht and this report is the thesis and finalization of our master's program Economic Geography. The subject for this thesis was proposed by our professor Leo van Grunsven. We were enthusiastic about doing research in Asia. The research subject is the evolution of the electrical and electronics industry of Batam and is part of a larger research project about the evolution of the E&E industry in Southeast Asia and the role that multinational corporations play regarding industrial upgrading. The evolution of subsidiaries of multinational corporations and their relation with the local environment of the host region fits well with subjects covered during the bachelor Human Geography and Planning, but especially during the master Economic Geography.

Conducting this research was very interesting and created new insights. Our understanding of the research subject has strongly improved. During the fieldwork we learned to deal with unforeseen difficulties. The data collection on both industry- and firm-level was sometimes hard. Data was not always fully available or unambiguous, while interviews were due to some cultural and linguistic differences difficult to arrange. Although we encountered several difficulties, we never had the feeling of getting into unsolvable problems. We really enjoyed the months we spend in Southeast-Asia. We definitely hope to do research in Asia once again.

We would like to thank our teacher, professor Leo van Grunsven, for his professional and social commentary, advice and guidance during the research and for visiting us in Asia. Also thanks to our local supervisor, professor Francis Hutchinson, for his advice during the fieldwork. Together with our fellow students Stan van Oerle, Raphael Rietema, Daan van der Velden and Catherine Visch we were able to deliver good teamwork, besides they were very pleasant company during the fieldwork. Tuty Sirait and her colleagues Batami Lily Marlina and Jaka Prasetya of BIFZA were also very helpful with arranging of and accompanying us to the interviews. Finally, we would like to thank the managers and other employees of the subsidiaries who were so kind of granting us an interview and almost always a factory tour.

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1. INTRODUCTION

1.1 THEME

The industrialization of Southeast Asian countries is strongly determined by foreign direct investment (FDI) through multinational corporations (MNCs). Within the SIJORI Growth Triangle, Singapore and Batam have a strong economic relationship especially with regard to the electrical and electronics (E&E) industry. The E&E industry of Batam is characterized by subsidiaries of foreign Singapore-based MNCs. These subsidiaries are mainly involved in low value-adding activities such as manufacturing and assembly, while the Singaporean facilities most of the time function as headquarters (HQ) or regional headquarters (RHQ) and/or are involved in high value-adding activities such as research and development (R&D), finance, sales and marketing, and logistics. The regional production network (RPN) of MNCs consists of multiple subsidiaries with their own functions. Evolution and upgrading of single subsidiaries in the host region determine evolution and upgrading of the E&E industry of the host region.

1.2 RESEARCH AIM, QUESTIONS AND RELEVANCE

1.2.1 RESEARCH AIM

The aim of this research is to understand and explain the long-term evolution of the E&E industry of Batam. Long-term evolution of the E&E industry can result in industrial upgrading; development to higher value-adding, more knowledge-intensive activities in a specific region. This process can occur on both industry- and firm-level. The Southeast Asian industrialization pattern is predominantly characterized by FDI and governments trying to attract MNCs. This is the reason that MNCs and their subsidiaries play an important role in this research. Within MNCs (R)HQs and subsidiaries interact in a regional production network (RPN). These networks also determine the geographical dispersion of economic activities and the evolution of this dispersion through time. The chosen time period in this research is from 1990 to 2012. In order to understand and explain long-term evolution of the E&E industry of Batam it is necessary to study the evolution of single subsidiaries of MNCs that participate in the E&E industry of Batam.

1.2.2 RESEARCH QUESTIONS

Main question

How has the E&E industry of Batam evolved from 1990 to 2012 and which factors are of influence on this evolution?

Sub questions

1. How can the evolution of the E&E industry of Batam from 1990 to 2012 be characterized?
2. How can the evolution of the subsidiaries of MNCs in the E&E industry of Batam from 1990 to 2012 be characterized?
3. Do RPNs influence the evolution of subsidiaries of MNCs in the E&E industry of Batam and to what extent?
4. Does the local environment influence the evolution of subsidiaries of MNCs in the E&E industry of Batam and to what extent?
5. Can the evolution of the E&E industry of Batam from 1990 to 2012 be characterized as industrial upgrading?

1.2.3 RELEVANCE

This research has a two folded contribution. On the one hand, it gives new theoretical insights in the long-term evolution and upgrading of the E&E industry of Batam (as part of the Growth Triangle) and individual subsidiaries of MNCs in the E&E industry. Although the path of endogenous development is favored by some scholars (Frenken & Boschma, 2009), Van Grunsven & Witte (2012) argue that for late-industrializing countries the impact of exogenous implantation (FDI) requires more attention. According to Boschma et al. (2011) there has been little systematic study of how regions diversify over time and how new growth paths develop. Many studies have explored the formation stage of regional economies, while there is still a lot to be learned about development issues from examining the long-term sustainability of economies (Edgington & Hayter, 2013a). As Kuchiki and Tsuji (2011) indicate, because of the relative 'newness' of MNCs there has been little systematic research of the long-term trajectories of MNCs. This is also the case for Batam, where during the formation stage many studies were conducted, however after this phase these studies stopped. Since then, only occasionally studies on Batam and the Growth Triangle were conducted.

The focus on the evolution of charters and roles of subsidiaries in an RPN together with the local environment as drivers of in situ upgrading is relatively new. Traditionally, relations between firms and their environment play a central role in economic geography (Atzema et al., 2009). Due to globalization and internationalization value chains are more and more geographically dispersed. MNCs are through their RPNs able to exploit comparative advantages by slicing up production processes and allocating parts of the production process to different world-wide destinations (Thorbecke et al., 2010). FDI is one of the drivers of economic evolution in Southeast Asia and increases knowledge transfers and innovation. To understand the economic evolution of regions it is therefore necessary to focus not only on the firm in its local environment, but also on the firm in its wider RPN.

Finally, the E&E industry is important for the regions in Southeast Asia. For example, the E&E industry in ASEAN accounted in 2007 for about 35 percent of the total export. Besides, the E&E industry is a technology-creating industry what means that it provides new technologies that are also applicable in other industries. This may lead to the revival of up- and downstream industries related to the E&E (Rasiah, 2010; Henderson, 1994).

On the other hand, the research also has a societal contribution: for ASEAN countries to reap the full benefits of the internationalization and globalization of RPNs. It is necessary for their economies to move up the value chain instead of only remain engaged in labor-intensive activities. Technology transfer and upgrading are essential elements of this process. Upgrading contributes to the increase of local skills, wages and welfare (Thorbecke et al., 2010).

1.4 METHODOLOGICAL APPROACH

The research starts with a theoretical framing. All relevant concepts are examined for a better understanding of the theme. An important characteristic of the research is the subdivision into two different levels: (macro- or) industry-level and (micro- or) firm-level. At the highest geographical scale, the focus is on the sum of all MNCs in the E&E industry of Batam, while at the lowest scale, individual subsidiaries of MNCs are subject of analysis. Since the main goal of the research was to analyze the evolution and upgrading of the E&E industry data of several years was analyzed. The chosen time frame is from 1990 to 2012, because the first industrial estate on Batam was established in 1990. Since the research covers two scales the data collection is divided into two parts. At the industry-level, data on the presence of (subsidiaries of) MNCs per year and where possible their line of business (function/activity or product) was analyzed. At the firm-level, data on the evolution of the subsidiary (functions, products, processes, capabilities), local environment (characteristics) and the RPN was collected through interviews with representatives of subsidiaries of MNCs by means of a questionnaire and analyzed.

1.5 STRUCTURE

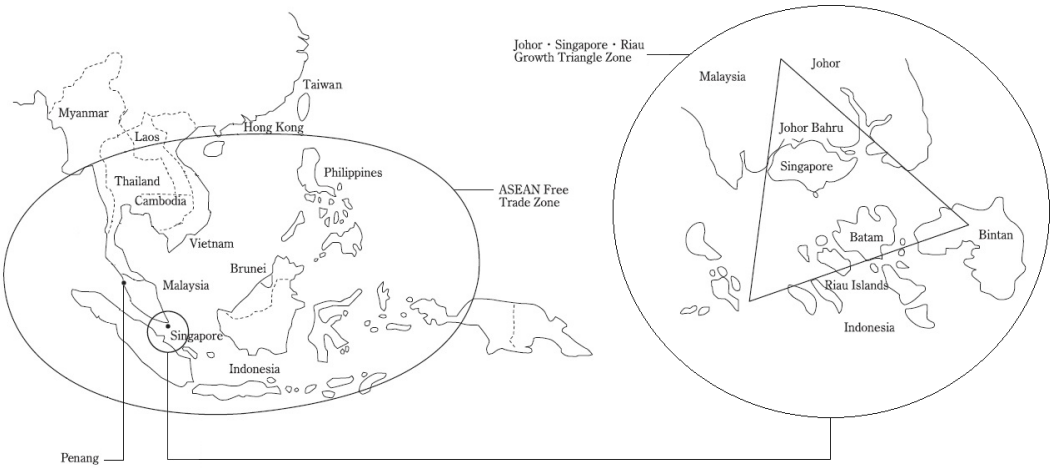
In the following chapter, an elaboration on the context of the E&E industry in Southeast Asia including industrialization through FDI, evolution and upgrading, is given. The third chapter explains the most important theoretical concepts regarding evolution and upgrading, including branching, industrial- and in situ upgrading, subsidiary charter development and RPNs culminating in conceptual frameworks on industry- and firm-level. The fourth chapter elaborates on the regional context of Batam. It describes the industrialization of the island and the influence of Singapore on this development. Further, social-economic characteristics as workforce, location, infrastructure, connectivity, institutions and incentives are discussed. Finally, this results in expectations regarding the evolution of the E&E industry of Batam. The fifth chapter presents the research design and describes and explains the methodological decisions were taken during the research, the operationalization of concepts and methodological limitations. The sixth and seventh chapters present the results of the analysis on both industry- and firm-level covering all parts and questions of the questionnaire. The eighth and final chapter draws a conclusion from all the above and formulates a future perspective for Batam.

2. E&E INDUSTRY IN ASIA

2.1 ASIAN INDUSTRIALIZATION

Southeast Asia is well-known for its rapid industrialization over the past fifty to sixty years. Forerunner in this industrialization was Japan, which economy, in terms of GDP, is currently the third largest of the world. Besides this global economic giant, Asia gave birth to other fast growing economies, the so-called 'Asian Tigers'. The first cohort of these Asian Tigers consisted of Singapore, Hong-Kong, South Korea and Taiwan (figure 2.1). They owe their nickname to a period of rapid industrialization since the mid-1950s, which led to becoming the advanced high-income economies they are nowadays. The economic growth in these countries relied heavily on increased export demand and FDI, both mainly from the USA, and higher domestic savings. Furthermore, they adopted a somewhat similar economic policy as Japan used to have, which includes giving support to potential leading sectors with fiscal and trade incentives and the provision of capital on favorable terms. At the same time, the domestic savings were used to invest in the physical infrastructure and to expand the available human capital. This human capital expansion was meant to create an educated workforce that was able to master and adapt technological change. These developments led to growth rates of nine percent per year (Yusuf & Nabeshima, 2009). Following the success stories of the Asian Tigers, more Asian countries tried to implement similar policies. A second cohort of Tigers emerged, sometimes called 'Asian Cub Tiger Economies': Indonesia, Malaysia, Philippines and Thailand (figure 2.1). These second Tigers adopted similar economic models and made adjustments according to their specific regional conditions, strengths and needs. By now, all these Southeast Asian countries have shifted away from natural resources as their main source of income, to manufacturing activities as the driver of economic and employment growth. Relocation of electronics manufacturing from Japan, Taiwan, Korea and Singapore to the four second cohort Tigers stimulated further economic growth. However, there is an important distinction between the earlier and later cohort of Asian Tigers. In Japan, Korea and Taiwan, there is a focus on the development of local firms, while in Indonesia, Malaysia, Philippines and Thailand, there is a focus on the attraction of MNCs (Hobday, 1995; Yusuf & Nabeshima, 2009).

Figure 2.1: ASEAN and an enlargement of the Growth Triangle



Source: own editing of Miyamoto, 2011

2.1.1 ASIAN FOREIGN DIRECT INVESTMENT

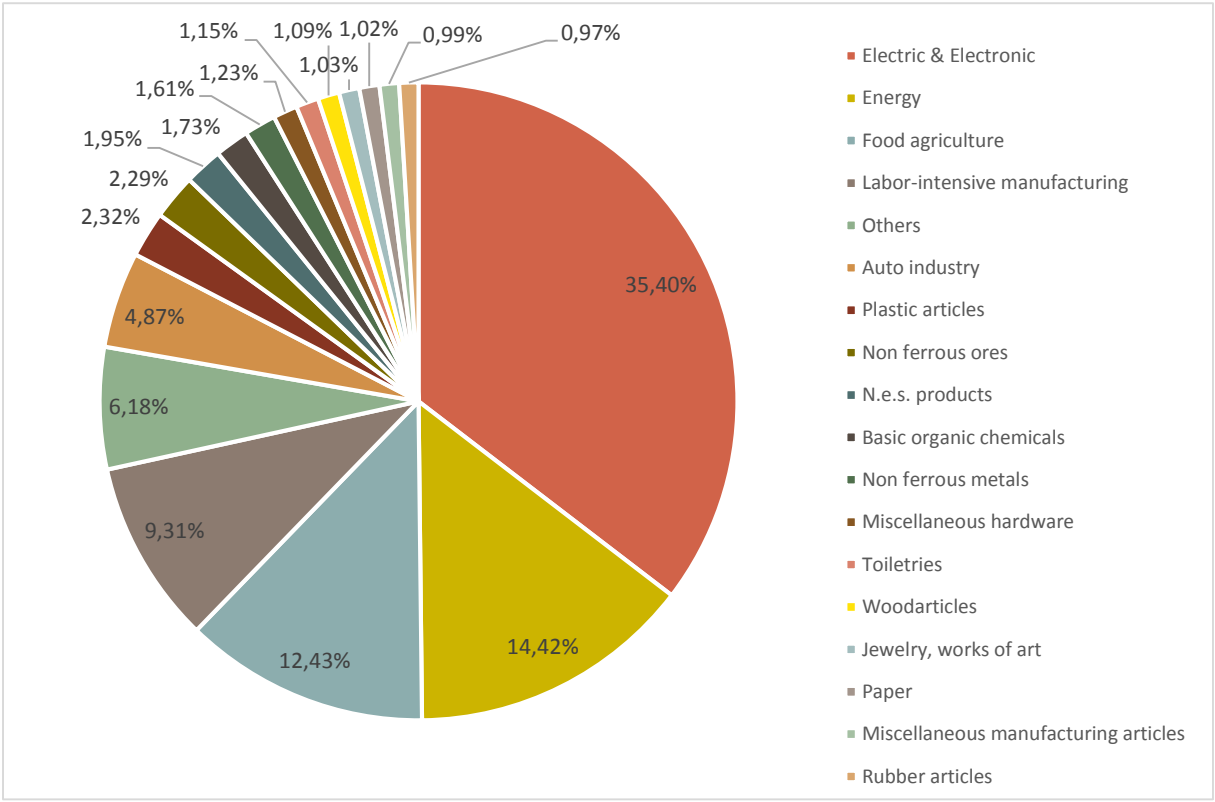
Thorbecke and Salike (2013) provide a theoretical overview for understanding the developments of Asian FDI. They indicate that after the appreciation of the Yen in 1985, Japan was the first Asian country from where MNCs shifted production facilities to other Asian countries. Based on differences in regional characteristics Japanese MNCs dispersed parts of the production process across Asia. Korea and Taiwan were the first major destinations of this outward FDI. Already before the Asian

Crisis (1997-1998) increasing labor costs and exchange rates in both countries resulted in a relocation of Japanese production facilities to other Asian countries. Due to these rising labor costs in their home countries Korean and Taiwanese MNCs started investing in other Asian countries as well. Taiwanese MNCs mostly invested in the Chinese computer-related market, while Korean MNCs mostly invested in small and medium enterprises (SMEs) focused on higher value-adding activities in technology-intensive industries. After the Asian crisis the focus of Japanese MNCs shifted to Eastern China. This time, however, without withdrawing their investments from the other Asian countries. Japanese MNCs continued to export large quantities of intermediate goods to affiliates in ASEAN (Thorbecke & Salike, 2013). Chinese subsidiaries were mainly involved in final assembly with imported components and parts from other Asian countries and exportation of the final products. However, this pattern is subject to change, since increasing labor costs in Eastern China urge MNCs to relocate their investments to inland China or other rising Asian economies. Recently, also China has increased its FDI in less-developed Asian countries aiming at low-end production.

2.2 E&E INDUSTRY IN ASEAN AND SOUTHEAST ASIA

The E&E industry is ASEAN's biggest export industry (figure 2.2). Other important export product categories in ASEAN are energy, food and agriculture, and labor-intensive manufacturing.

Figure 2.2: Exports by ASEAN countries by product category in 2007

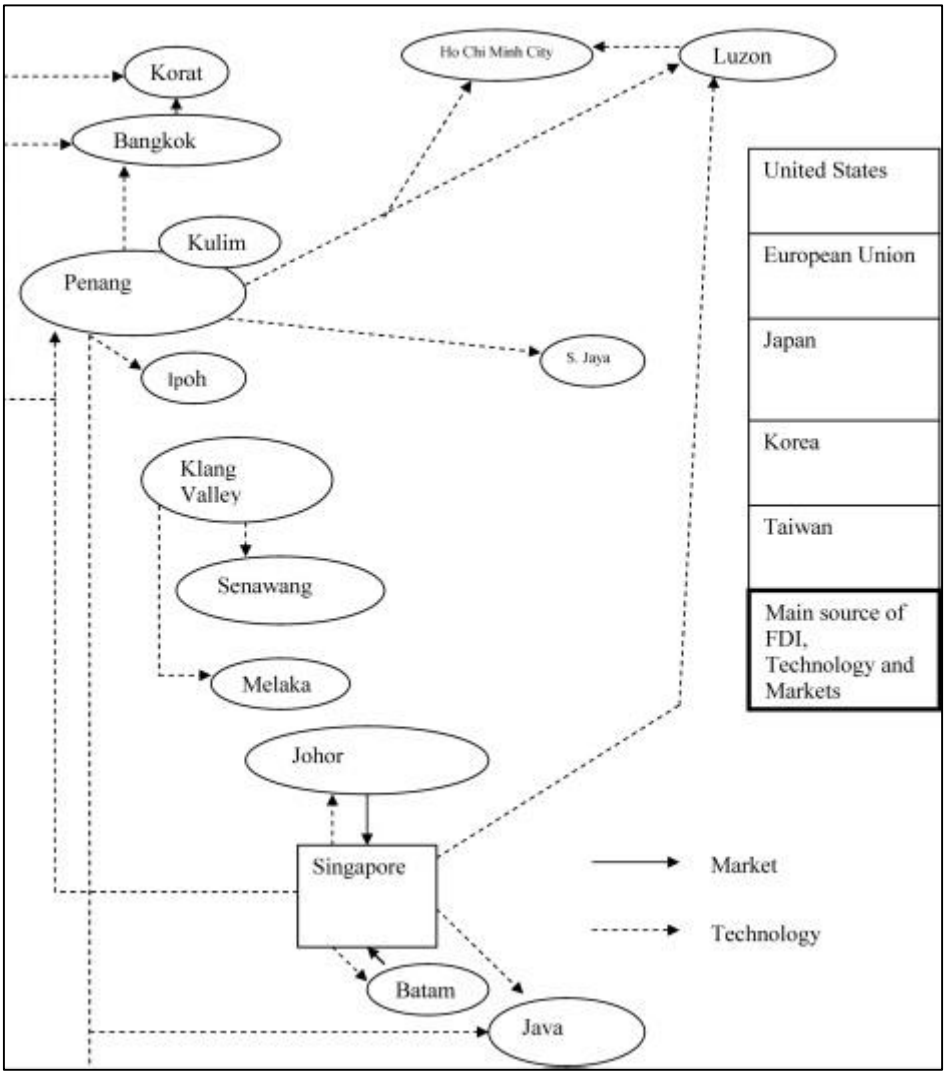


Note: Labor-intensive manufactures includes carpets, clothing, fabrics, furniture, knitwear, leather goods, and yarns. N.e.s. refers to product categories that are not specified elsewhere.
Source: own editing of Thorbecke et al., 2010

When considering concentrations of E&E industries in Southeast Asia, different regions come to attention (figure 2.3). The E&E industry of Singapore is most sophisticated in Southeast Asia and is characterized by high-end activities as design and development (D&D) with strong specialization in regional customization (Rasiah, 2009). The E&E industry is important for the Singaporean economy accounting for 33 percent of the total value-added in manufacturing sector, 45 percent of the fixed asset investments and 19 percent of all manufacturing jobs (EDB, 2013). At the same time, Singapore

is the main source of FDI and technology for different regions in Malaysia, Thailand, Indonesia and Philippines (Rasiah, 2009). The E&E industry of Penang in Northern Malaysia is the second most advanced and sophisticated in Southeast Asia. Just like Singapore, it provides technological support to surrounding regions. Furthermore, knowledge and skills flow from Penang to surrounding regions through training and support (Rasiah, 2009). Since the first semiconductor plant was established, Malaysia has become an important manufacturing hub for the Southeast Asian E&E industry.

Figure 2.3: geographic overview of the electronics and electrical industries in Southeast Asia



Source: Rasiah (2009)

Regions with a strong focus on Singapore are Batam (Riau, Indonesia) and Johor (Malaysia)(figure 2.3). Together, these three regions form the SIJORI Growth Triangle. On the Indonesian Riau-islands, especially Batam, the E&E industry became of more importance over the last two decades. The E&E industry is nowadays the largest operating industry of Batam. Mostly, computer components and parts, audio and video equipment, automotive parts, printed circuit boards are produced on Batam. According to the Batam Industrial Free Zone Authority (BIFZA), these kinds of industries are most suitable for the island because of the unlimited labor supply and simple labor-intensive activities (BIFZA, 2013a).

2.3 EVOLUTION AND UPGRADING OF JAPANESE FIRMS IN SOUTHEAST ASIA

Studies about the evolution and upgrading of subsidiaries in Southeast Asia mainly concerns Japanese MNCs (Lim, 1994; Song, 2002; MIDA, 2009; Edgington & Hayter 2013a, 2013b). Japanese MNCs have made important changes in the functions of their subsidiaries in Southeast Asia. Although the strategy and structure of subsidiary operations are still strongly determined by the headquarter's global strategy there is a shift from a centralized, top-down management philosophy to a more localized approach. The changed role of Southeast Asian countries from merely low-cost production locations to regions with increased welfare and increased local demand for customized products is the main reason for this shift (Edgington & Hayter, 2013b). In Malaysia, the Japanese subsidiaries shifted from mainly low labor-cost production to the production of more sophisticated products, design activities and factory development. The subsidiaries mainly produced cathode ray tubes, flat-screen televisions, video players and recorders, audio sets for cars, digital cameras, mobile phones, and hard disk and DVD drives. However, they were not chartered for manufacturing personal or notebook computers (Edgington & Hayter, 2013a).

From Indonesia, Malaysia, Philippines and Thailand especially Malaysia and Thailand have experienced strong growth of the E&E industry. Although the E&E industry has strongly expanded in these two economies, data shows that the four economies in terms of institutional support and firm-level technological capabilities in skill and R&D intensities are still significantly lagging behind Korea and Taiwan (Rasiah, 2009).

When it comes to firms in the E&E industry of Malaysia, according to Rasiah (2010), their technological capabilities improved significantly over the period from 2000 to 2007. Firms in the semiconductor branch improved significantly over the period from 1974 to 2007 and are able to participate in the higher levels of knowledge-intensive activities. However, the upgrading process is not fast enough to help stimulate catching-up by progressing to higher value-adding activities such as R&D and D&D that make the industry more competitive (Rasiah, 2010). In the semiconductor branch Korean and Taiwanese firms operate at the global technology frontier. These firms have relocated much of their assembly and test activities to China and Southeast Asia, wherein Chinese and Malaysian firms are still largely specialized (Rasiah et al, 2008).

3. THEORETICAL FRAMEWORK

This chapter presents an overview of the relevant theoretical concepts regarding industrial- and subsidiary evolution. On both geographical scales (subsidiaries of) MNCs in the E&E industry are the main objects of analysis. The first paragraph elaborates on evolution by explaining the industry-level concept of branching and the firm-level concept of subsidiary charter development. A possible result of evolution is upgrading. The second paragraph explains industrial and in situ upgrading. To understand the underlying mechanisms of evolution, the third paragraph elaborates on the factors of influence on evolution and upgrading: regional characteristics of the host region, RPNs, subsidiary embeddedness and locational commitment, and characteristics of the global E&E industry.

3.1 EVOLUTION

3.1.1 BRANCHING

An industry consists of related branches and a branch consists of related firms. For example, firms in Light-Emitting Diodes (LED) branch produce LED-devices or -applications. An industry develops by the emergence of new branches and the disappearance of existing branches. The evolution of an industry can be explained by the concept of *branching*. Originally, this concept is used by Boschma & Frenken (2009, 2012) to explain the evolution of regional economies. They (Boschma et al. 2012, p. 10) describe the concept as:

> *"[…] a process of regional diversification, by which new industries arise from technologically related industries in regions in which existing competences are recombined in new economic activities."*

Regional economies consist of several industries. The composition of a regional economy changes slowly from year to year (Boschma, 2011; Neffke et al, 2011). The concept of branching is a method to obtain insight in the development of a regional economy by analyzing entries of new industries and exits of existing industries. Boschma & Frenken (2009) distinguish two ways in which new industries can emerge: a new industry emerges out of an old industry or a new industry emerges through the recombination of different competences of several industries. Thus the emergence of a new industry is influenced by the current composition of a regional economy (Neffke, Henning & Boschma, 2011). Industries that are technologically related to established industries are more likely to emerge than industries that are not related, Boschma (2005) refers to this concept as *related variety*. Related branches with a high degree of variety exhibit more learning opportunities and local knowledge spillovers than related branches with a low degree of variety (Frenken et al., 2007; Boschma et al., 2012) and thus create new business opportunities. An example of technologically related industries leading to new combinations or innovations is found in Germany where the development of the car industry was boosted by highly skilled aeronautic engineers who lost their jobs in the airplane industry but found work in the car industry. In the car industry they could use their skills to lift the car industry to a higher level (Neffke & Henning, 2012).

However, the concept of branching originally tries to explain the evolution of a regional economy, while this research aims at explaining the evolution of a specific industry. In this case, a new branch emerges out of an old branch or a new branch emerges through the recombination of different competences of several branches. The current industrial composition determines whether or not a new branch successfully enters the industry. Branches that are technologically related to the established branches are more likely to enter than branches that are not related.

While the industrial composition changes through the emergence of new and disappearance of existing branches, the composition of a branch changes through the entrance and exit of firms. Klepper (2001, 2002) distinguish three ways in which new branches emerge and evolve. First, existing firms diversify their scope of products and/or activities. Second, existing entrepreneurs establish new

firms in the same or related branch or industry. Third, former employees start a new firm in the same or related branch or industry and are called *de novo spin-offs*. MNCs and their subsidiaries can follow the same trajectories, for example an existing subsidiary is able to diversify its product scope or an MNC establishes a new subsidiary in a related branch. Van Grunsven & Witte (2012) make a distinction between endogenous development and exogenous implantation. *Endogenous development* refers to the entrance of firms from the region, while *exogenous implantation* refers to the allocation or relocation of activities of MNCs to a particular region.

The current composition of an industry or branch is determined by decisions made and obtained capabilities and routines in the past, defined as *path dependency* (Boschma et al., 2002). The probability that something occurs in a specific region is affected by the events that have already taken place in the past (Boschma & Frenken, 2007). Path dependency can be used as an explanation for the unequal distribution of economic activity across regions. The moment of entering an industry influences the economic performance of a firm. Firms that enter early in a new industry will face better growth opportunities than firms that enter later.

3.1.2 SUBSIDIARY CHARTER DEVELOPMENT

The role of a subsidiary in the MNC is interrelated with its HQ's or RHQ's strategies and is subject to change. According to Birkinshaw & Hood (1998), change or development of a subsidiary's role can express itself through its capabilities and its charter which are inescapably intertwined. The subsidiary's capabilities are shaped by its capacities and routines. These capacities and routines combined with its resources determine a subsidiary's output potential. The subsidiary's charter encompasses all its activities from production to sales and marketing allocated by (R)HQ. Drawing on previous research by White & Poynter (1984), Dörrenbächer & Gammelgaard (2006) distinguish three dimensions of subsidiary charter development. First, change of its market scope by entering new geographic markets. Second, new product creation by expanding its current production or creating a completely new product. Third, development of the production process whereby more value-adding activities as marketing, logistics or R&D are carried out. To what extent these processes take place, depends on the subsidiary's capabilities, the (R)HQ's intended strategy and localization advantages (Birkinshaw & Hood, 1998; Dörrenbächer & Gammelgaard, 2010; Dörrenbächer & Gammelgaard, 2006; Rodrigues, 1995; Paterson & Brock, 2002). The extent to which a subsidiary has unique, scarce and irreplaceable value-adding resources as a high-skilled workforce, organizational routines or learning processes determines the competitiveness and therefore the subsidiary's position in the local environment (*external embeddedness*) and relative to other subsidiaries in the MNC (*internal embeddedness*)(Dörrenbächer & Gammelgaard, 2006). Also the (R)HQ's intended strategy plays an important role in the development of a subsidiary's charter. The performance and capabilities of a subsidiary are frequently evaluated by the (R)HQ in order to assign a new charter, in other words allocate new functions or activities. However, this intended strategy is not final, especially when this strategy has an unsatisfying result for the subsidiary's charter. Subsequent negotiations between the (R)HQ and the subsidiary can result in a change of the (R)HQ's intended strategy into a more satisfying outcome for the subsidiary: the (R)HQ's realized strategy. The extent to which the (R)HQ is dependent on the subsidiary is determined by the quality of the capabilities of the subsidiary. The better the capabilities of the subsidiary, the stronger the dependence of the (R)HQ and the stronger the subsidiary's position during the negotiations regarding its charter (Dörrenbächer & Gammelgaard, 2006; Dörrenbächer & Gammelgaard, 2010).

Another way of understanding the decision making process of a (R)HQ regarding a subsidiary's charter concerns the concept of centrality (Dörrenbacher & Gammelgaard, 2010). According to literature of Ghoshal & Bartlett (2005) centrality in a network can be defined as:

> "*[…] the degree, that is, the number of other actors within the MNC network with which it has direct exchange relations* (Dörrenbacher & Gammelgaard, 2010 p. 209)."

Another way of measuring centrality is the extent to which an actor is an essential link in the whole network: the number of peripheral actors that will be disconnected when a central actor is removed the network. In an RPN centrality would mean the extent to which other subsidiaries and the (R)HQ are dependent on a single subsidiary. A subsidiary with a central position in the RPN has a better position during negotiation regarding its charter. Still, the (R)HQ often have multiple subsidiaries. This means a (R)HQ can decide which subsidiary in the RPN is eligible for upgrading its charter and which is not (Ernst & Kim, 2002; Ernst, 2004). In addition, other factors as bureaucracy, rivalry, conflicting interests, lack of recognition or just personal preferences can influence this process, so that creative ideas or initiatives proposed by the subsidiary don't have any chance of approval.

3.2 INDUSTRIAL AND IN SITU UPGRADING

The evolution of an industry can result in industrial upgrading. Industrial upgrading can be an increase of overall productivity, expansion of functions or moving to adjacent more technologically sophisticated branches (UNCTAD, 2013). If an industry has developed in such a way that the overall composition of the industry has become more sophisticated compared to a previous stage in development, the industry has upgraded. Ernst (2003) defines the concept of industrial upgrading and the required conditions:

> *"[...] a shift to higher value-added products, services and production stages through increasing specialization and efficient domestic and international linkages, industrial upgrading necessitates a strong domestic knowledge base."*

Industry-level evolution (or industrial upgrading) is influenced by the evolution of single establishments. The evolution of single establishment can manifest itself in a change of functions or activities, product portfolio and/or production process. Functions of firms may change over time, for instance from manufacturing activities to development activities. Apart from changes between functions, changes within a function can also occur, for instance from low-end to high-end manufacturing. Rasiah (2010) has developed a taxonomy with six levels of functions and activities related to knowledge depth and a firm's technological capabilities (table 3.1). The development of firms' technological capabilities can be analyzed on three areas: human resources, processes and products. In the first three levels, the workforce is characterized by in-house training and is prepared for low-end activities like assembling, components processing, precision engineering and quality controlling using simple machinery. In the last three levels, the workforce consist of hired and well-educated engineers and scientists concerned with innovation activities as adapting and developing existing and new products using sophisticated machinery, equipment, materials and techniques (Rasiah, 2010). In this taxonomy, in situ upgrading represents the shift to higher levels of knowledge depth. However, firms can cover different levels at the same time. Firms are only able to participate in the development of new products and technologies on level five and six, but firms aren't necessarily able to reach the highest levels of the taxonomy. Subsidiaries need to experience upgrading in order for industrial upgrading to occur.

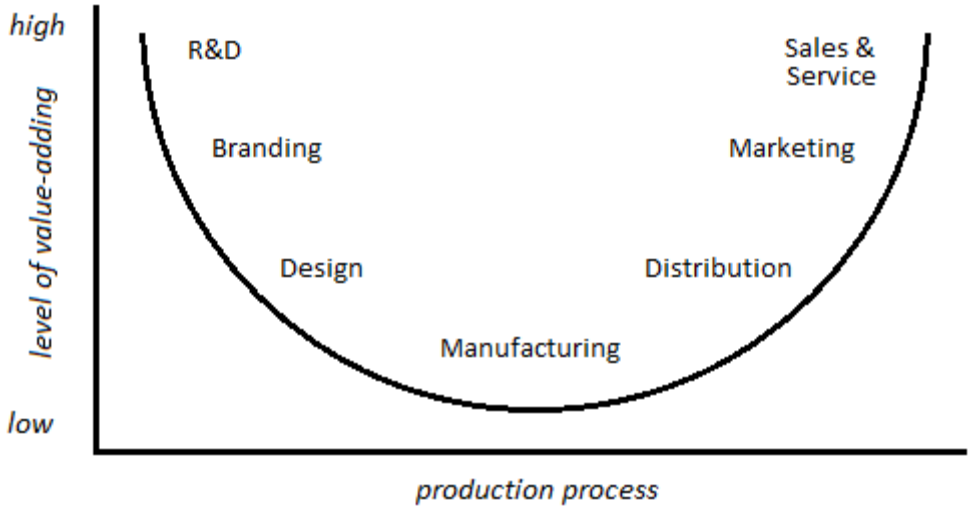
Considering Ernst's (2003) above mentioned definition of industrial, value-added means the profit that is made by the execution of a function or activity. In the 'Smile curve' functions and activities are linked to the amount of value added, as shown in figure 3.1 (Economic Planning Unit & The World Bank, 2011). At both the start, R&D, and the end, sales & services, of the production process the activities add the most value. Manufacturing add the least value to the product. Following this conceptualization, in situ upgrading can mean a shift from low to high value-adding activities or expansion activities. For example, from manufacturing to manufacturing and marketing.

Table 3.1: Taxonomy of firms' technological capabilities

Knowledge depth	Human Resource	Process	Product
1.Simple activities	On the job and in-house training	Dated machinery with simple inventory control techniques	Assembly or processing of components, CKD and CBU using foreign technology
2.Minor improvements	In-house training and performance rewards	Advanced machinery, layouts and problem solving	Precision engineering
3.Major improvements	Extensive focus on training and retraining staff with training responsibility	Cutting-edge inventory control techniques, SPC, TQM, TPM	Cutting-edge quality control systems (QCC and TQS) with OEM capability
4.Engineering	Hiring engineers for adaptation activities; separate training department	Process adaptation: layouts, equipment and techniques	Product adaptation
5.Early R&D	Hiring engineers for product development activities; separate specialized training activities	Process development: layouts, machinery and equipment, materials and processes	Product development capability. Some firms take on ODM capability
6.Mature R&D	Hiring specialized R&D scientists and engineers wholly engaged in new product research	Process R&D to devise new layouts, machinery and equipment, prototypes, materials and processes.	New product development capability, with some taking on OBM capability

Note: CKD, complete knock-down; CBU, complete built-up unit; SPC, statistical process control; TQM, total quality management; TPM, total preventive maintenance; QCC, quality control circles; TQC; total quality control; OEM, original equipment manufacturing; ODM, original design manufacturing; OBM, original brand manufacturing. Source: Rasiah (2010)

Figure 3.1: The smile curve; value-adding functions and activities

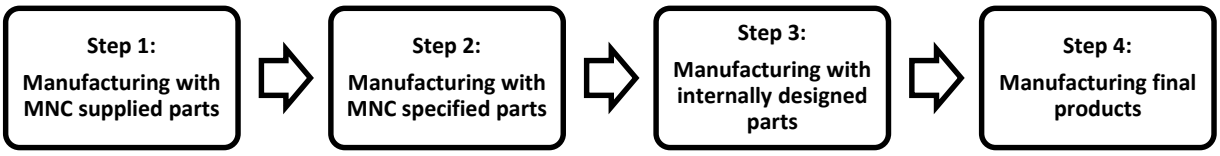


Source: Redraw of Economic Planning Unit & The World Bank (2011)

Azadegan & Wagner (2011) give an example of the development from simple to more complicated activities. They make a distinction between four progressive steps a firm (or subsidiary) can take in the upgrading process. With each step extra value-adding activities are added to the firm's operations (figure 3.2). Azadegan & Wagner (2011) use in their concept the relationship between a late entrant manufacturing firm and an existing (foreign) firm to describe this process. However, this concept is also applicable to the relationship between an MNC and its manufacturing subsidiary. In the first step, the subsidiary starts to perform activities as manufacturing of low value-added parts and assembles parts supplied by the MNC. In the second step, the subsidiary is also allowed to do procurement of parts specified by the MNC. In the third step, the subsidiary initiates the

manufacturing of parts that are internally designed as well. In the fourth and final step, the subsidiary is allowed to manufacture complete products for the MNC.

Figure 3.2: Industrial upgrading steps according to Azadegan & Wagner (2011)



Source: own draft

Another example of the development of a firm's activities is done by Chu (2009) and is described by the OEM-ODM-OBM development path (Chu, 2009). A leader firm contracts a smaller firm (subcontractor) to outsource an activity of the production process. This development path can also be applied to a subsidiary's charter development (figure 3.3). During this process the subsidiary's number of activities in the production process can be expanded. Starting as an *original equipment manufacturer* (OEM) the subsidiary's main activities are manufacturing of components and parts and the assembly of final products. When the subsidiary evolves into an *original design manufacturer* (ODM) it also starts to perform some design and development activities. Finally, when the subsidiary becomes an *original brand manufacturer* (OBM) it conducts full manufacturing as well as marketing and R&D (Chu, 2009). In conclusion, it has become evident that in situ upgrading has everything to do with the amount of value-adding of a certain activity.

Figure 3.3: OEM-ODM-OBM development path

Source: own draft

3.3 UNDERSTANDING EVOLUTION AND UPGRADING

3.3.1 REGIONAL CHARACTERISTICS

The performance and evolution of a subsidiary is influenced by the locational characteristics of the host region. Favorable locational characteristics are often the main reason why an MNC establishes a subsidiary in a specific region. Locational characteristics are more important for vertically integrated value chains than for horizontally integrated value chains. Since MNCs often geographically disperse their activities, only few activities are situated in one location and only specific locational characteristics are of relevance for profitably executing these activities. When an MNC wants to locate more activities in one place more locational characteristics will be of relevance (UNCTAD, 2013). According to Meyer et al. (2011) local environments particularly differ on two dimensions: the institutional dimension and the resource dimension. The institutional dimension ranges from all formal (legal, political, administrative, governmental) to all informal (relationships and social norms) institutions. These institutions are, in contrast to MNCs, immobile and bound to a specific region. To create a conducive environment for evolution and upgrading the participation of both national and regional governments, for example in the establishment of R&D parks and links between firms, research centers and universities, is crucial (Rasiah et al, 2008). Resources range from natural resources to human capital and local knowledge. According to Edgington & Hayter (2013a), a shortage of skilled labor in Malaysia hindered upgrading of subsidiaries. Therefore, resources of the host region are important for the evolution and upgrading of single subsidiaries.

Another distinction can be made between 'soft' and 'hard' infrastructure. To make the horizontally integrated value chain profitably, good connectivity through soft and hard infrastructure is crucial. Soft infrastructure entails all institutional conditions, i.e. good governance and sound legal

structures. This is, for instance, important to facilitate the possibility of people (human capital) to cross borders and switch between jobs. Hard infrastructure involves harbors, airports, railroad systems, roads, ICT systems and all other physical infrastructure in the region. This is also important for MNCs to connect 'all pieces of the value chain puzzle' in order to finalize the product. Just-in-time approaches are greatly facilitated by good physical infrastructure as well. Another, important locational characteristic is the local supplier base. The best suitable local supplier as well as alternatives when expectations are not met are most easily found in a broad supplier base (OECD, 2013). However, for example, disappointing technological development of local suppliers in Malaysia hindered upgrading of subsidiaries (Edgington & Hayter, 2013a).

Edgington & Hayter (2013a) distinguish three different types of FDI-dominated clusters within regional economies: assembly clusters, embedded clusters or technology clusters. Regions characterized as *assembly clusters*, as well as Martin's regions of export specialization, have low labor costs and multiple investment incentives like export subsidies, free trade zones and attractive tax regimes. Competition between this kind of regions is primarily based on costs. For MNCs these regions provide an attractive location for low-cost production. Increasing footlooseness enables MNCs to easily shift activities from one region to the other depending on the price level. This could both create opportunities for easily attracting new MNCs as well as threats for easily losing MNCs. Regions characterized as *embedded clusters* have low taxes, good infrastructure, a skilled workforce and the capacity of local suppliers to easily absorb new technology and knowledge. Local suppliers have the capacity to easily adopt technological changes. Therefore, subsidiaries in these regions have changes in the production process implemented faster, easier and at lower costs. Strong linkages and cooperation between subsidiaries, local suppliers and local knowledge institutions lead to an increase in external embeddedness of the subsidiaries and locational commitment of the MNCs. In regions characterized as *technology clusters*, according to Martin (2005) regions of knowledge hubs, MNCs collaborate intensively with local sources of knowledge and technology such as research institutes and universities, acquire technology from local suppliers and recruit high-skilled experienced technicians and engineers. Competition is based on the sophistication of production and the capabilities of subsidiaries. Subsidiaries depend heavily on local external information and expertise that leads to a higher external embeddedness. Technology clusters are characterized by science parks, high-standard educational institutions and a fast and easy transfer of knowledge and technology.

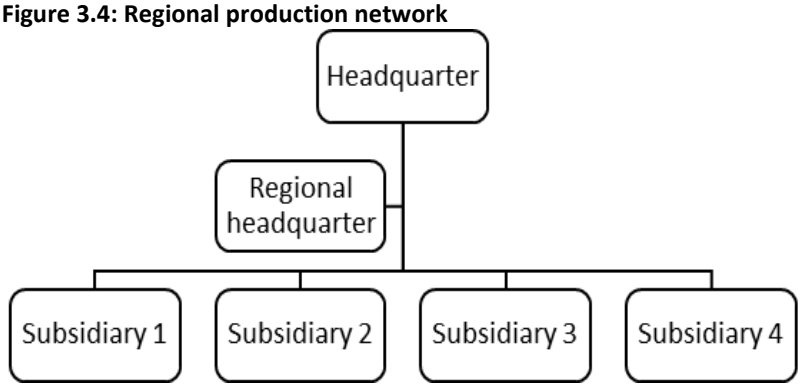
3.3.2 REGIONAL PRODUCTION NETWORKS

Subsidiary evolution is also influenced by the internal embeddedness in the production network of the MNC. The headquarter of the MNC follows a locational strategy in which it makes decisions about the allocation of functions and activities within the value-chain. The contemporary global economy is characterized by value-chains to a large extent coordinated by MNCs (UNCTAD, 2013). In a global value-chain (GVC), the different intermediate goods and services are no longer concentrated in one country, but geographically dispersed and integrated in an international production network (Ernst & Kim, 2002; OECD, 2013). In this research the focus is on the production network of an MNC within Southeast Asia: *regional production network* (RPN). The activities within an RPN occur at multiple geographical scales which are interrelated (from local and regional to national and global and vice versa)(Henderson, 2002). The rise of GVCs and/or RPNs is stimulated by several trends: increased liberalization (trade policy reforms), development and diffusion of information and communication technologies (technological development), increased competition (Ernst & Kim, 2002), increased cost-efficiency strategies and increased access to resources and markets (OECD, 2013).

The MNC with its foreign subsidiaries form the RPN (figure 3.4). While the decision-making process within the RPN takes place at the MNC's (R)HQ, the MNC's subsidiaries carry out production functions such as assembly, manufacturing, design or a combination of different activities. The past decades, MNCs have also increasingly relocated and assigned R&D activities to established subsidiaries (Diez & Bergero, 2005). Based on the roles and corresponding activities of a subsidiary,

Dörrenbacher & Gammelgaard (2006), distinguish five different types. First, a subsidiary can act as a *marketing satellite*. They market a single or a range of products in the host country and can provide only limited services. Second, a subsidiary can be a *miniature replica*. Besides marketing, they are engaged in manufacturing several products for the parent company. Third, *rationalized manufacturers* produce for other markets as well. Fourth, *product specialists* are responsible for product development, manufacturing and world-wide marketing. Fifth, so-called *strategic independent units* are free to set up new markets for products that they develop and manufacture. Apart from intra-firm transactions, inter-firm transactions can be covered in a RPN as well. RPNs are coordinated by MNCs through linkages between local suppliers, service providers and other partners carrying out activities for the MNC (Ernst & Kim, 2002; Ernst, 2004). An RPN of an MNC can express itself in various modes from direct ownership of subsidiaries to contractual relationships (UNCTAD, 2013).

Figure 3.4: Regional production network



Source: own draft

3.3.3 SUBSIDIARY EMBEDDEDNESS AND LOCATIONAL COMMITMENT

Subsidiaries are not only embedded in the production network of the MNC (internal embeddedness), but they also participate and engage in the local network of the host region's economy (external embeddedness)(Meyer et al., 2011). Also this external embeddedness has a strong influence on the evolution of a subsidiary. Andersson & Forsgren (2000) have found a positive relationship between the (R)HQ's strategy and the embeddedness of a subsidiary in the host region. The local relationships of a subsidiary with specific clients and suppliers are an important determinant for the position of a subsidiary in the production network of the MNC and the (R)HQ's strategy. Through these local relationships embedded subsidiaries are able to provide access to a wide variety of competencies (Andersson et al., 2007) and subsidiaries can enhance their abilities to absorb new knowledge and skills from the local environment. Andersson et al. (2005) argue that innovations originate as much from the behavior of a single firm as from relations between firms. Thus, the stronger the relationship between a subsidiary and its clients and suppliers in terms of interaction and mutual trust, the more likely a subsidiary will perform well. While a subsidiary is embedded in the host region, an MNC can be committed to the host region through the subsidiary. The (R)HQ of an MNC evaluates the performance and capabilities of the subsidiary and decide whether to allocate functions an activities to the subsidiary. Good performance of the subsidiary (induced by its embeddedness in the host region) and positive experiences with the host region can intensify the locational commitment of an MNC.

3.3.4 GLOBAL E&E INDUSTRY CHARACTERISTICS

A final factor of influence on the evolution of subsidiaries in the E&E industry are the characteristics of the global E&E industry and its natural development. The E&E industry shows a strong fragmentation of the production process, because intermediate products in the industry are relatively easy to ship between different subsidiaries in the production process and to assemble into final products (Thorbecke and Salike, 2013). Furtermore, the E&E industry is a fast-changing industry

wherein technological advancement is continuously occurring. For example, the evolution from VCRs to DVD players is a consequence of the 'natural' global technological evolution. In this way the E&E industry differs significantly from other industries. The invention and wide application of integrated circuits (ICs) in the mid-1960s was a major cause for the rapid evolution of the E&E industry. The controlling and governing properties of ICs make the E&E a technology-creating industry (Rasiah, 2010). Technological developments are of big influence on the pace of entrance and exit of firms and thus of the pace of the emergence of branches in an industry (Boschma & Frenken, 2009). The use of ICs enables synergies in a wide variety of industries and especially in related branches within the E&E industry. Meanwhile, the capacity of ICs has increased rapidly. The number of transistors on ICs has doubled approximately every two years (Moore, 1965). As a result of this trend IC development has been miniaturization by scaling down transistors (IRC, 2012). The semiconductor industry managed to dramatically decrease costs per elementary function within the ICs and enabled the emergence of entirely new markets.

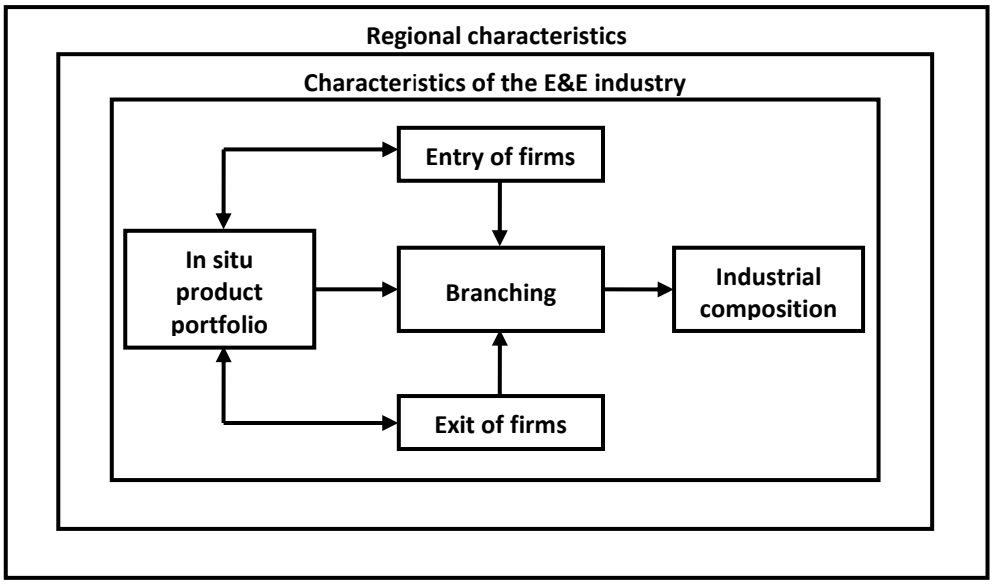
The improvements in ICs are characterized by developments on six fields (IRC, 2012): integration level (more transistors on one chip), costs (lower costs per function), speed (increased microprocessor performance), power consumption (longer battery life), compactness (downscaling) and functionality (wide application). As ICs are practically used in all final products in the E&E industry, these developments have also fueled related branches. As a result, many improvements have taken in place in diverse branches, (i.e telecommunications, hard-disk drives and medical devices). Nowadays, products and devices in the E&E industry are cheaper, faster and at the same more complex and compact.

The rapid developments within the E&E industry puts branching in another perspective compared to other industries. On the one hand, new technologies arise and consequently new branches arise. On the other hand, new technologies also make branches in a short time period outdated. From this perspective, the fast changing characteristic of the E&E industry accelerates the branching process compared to more conventional industries. In situ upgrading, especially in the E&E industry, should therefore be hold critically and carefully in the light of the developments in the global E&E industry.

3.4 INDUSTRY-LEVEL FRAMEWORK

Since this research uses a clear separation between micro and macro level evolution of industries/firms, this distinction is also made for the conceptual framework. The macro level conceptual framework has as ultimate dependent variable 'industrial composition'. Overarching factors that are of an influence on this composition are the general regional characteristics and the specific characteristics of the E&E industry. Since some industries evolve in a different fashion than others, this is an important factor for the cycle that ultimately leads to a particular industrial composition. The iterative cycle that (within the framework of the characteristics of region and industry) leads to the evolution of the industrial composition consists of four factors. The product portfolio of firms, the entry of exit of firms with those product portfolios and (through the concept of branching) the composition of the industry.

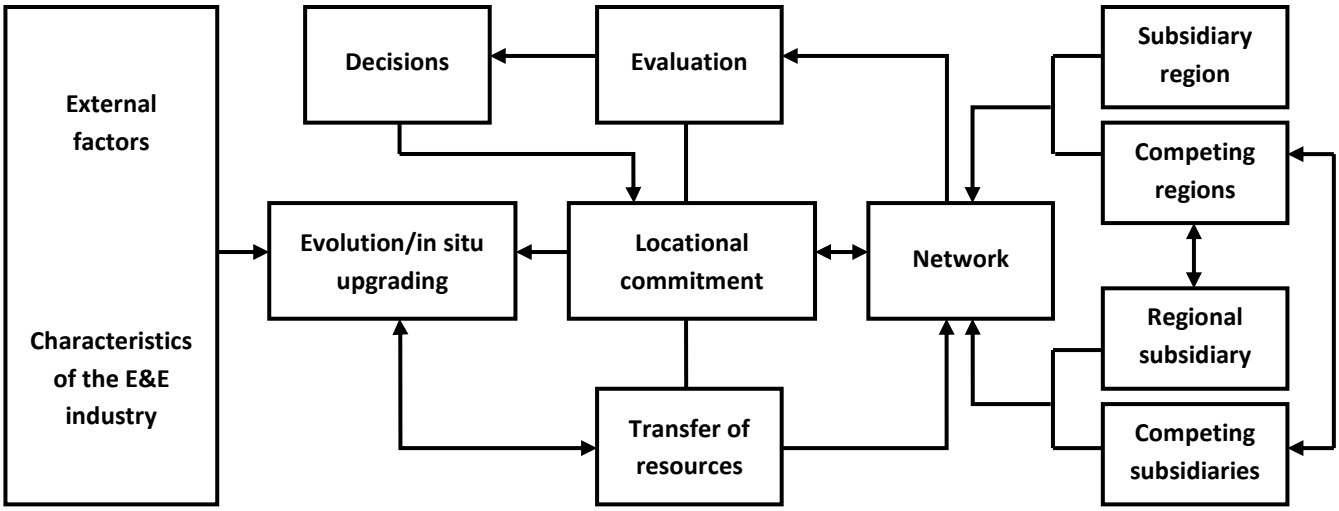
Figure 3.1: conceptualization of the relevant theoretical aspects of macro level industry evolution



3.5 FIRM-LEVEL FRAMEWORK

The conceptualization of micro (firm) level evolution can be seen as an elaboration of the 'in situ product portfolio' factor in the macro level conceptual framework. As well as in the macro model, this model also has clear iterative cycle of causalities in the center, influenced by six external factors (characteristics of the industry, characteristics of both the subsidiary's as competing regions and capabilities/charter of both the subsidiary as competing subsidiaries). In the top half of the cycle, subsidiary role development is being made visual. In the center, position within RPN as well as locational commitment/external embeddedness is clearly distinguishable. Regional characteristics are to be found as the four 'external' factors that are on the right hand side and the characteristics of the E&E industry as well as all other factors of importance (i.e. world economy, natural disasters etc.) are being placed.

Figure 3.2: conceptualization of the relevant theoretical aspects of micro level firm evolution



4. BATAM ISLAND: INDUSTRIALIZATION AND CURRENT CONDITIONS

The history of economic development and industrialization of Batam cannot be seen in separation of the economic development of the neighboring state of Singapore. Yeoh et al. (2004) used the name 'Singapore-Riau alliance', however it's mainly a relationship between the neighboring regions of Singapore and the island of Batam (figure 4.1). Regional economic plans also often include the Malaysian state of Johor, most well-known is the 'SIJORI Growth Triangle'. For understanding the contemporary economic situation on Batam, an overview of the industrial development of Batam and the influence of Singapore is useful.

Figure 4.1: Location of the Batam and Singapore

Source: redraw after Sparke et al. (2004)

4.2 ECONOMIC DEVELOPMENT OF BATAM

4.2.1 BEFORE THE INDUSTRIALIZATION

With president Suharto, as the successor of Sukarno, Indonesia initially, during the 1960s, adopted a more open economic strategy with regulatory mechanisms as preferred by foreign investors (Field, 2009). But when oil prices in the mid-1970s began to rise, the previous inward-looking strategy returned. The export of high-priced oil made national revenues increase. These revenues were used to invest in import-substitution industrialization (ISI). Goods and services that were originally imported should rather be replaced by domestic production. The goal was to decrease Indonesia's dependence on external actors and to make the country self-sufficient through investments in education, agriculture, communication, transportation and more. When oil prices in the early 1980s

began to decline, the revenues followed at the same time. This decline in revenues could be compensated by increasing revenues from export of gas and manufactured products. From that moment onwards the Indonesian government supported an export-oriented industrialization policy, instead of production primarily for the domestic market. Growing manufacturing activities had to be retained through the attraction of foreign investments. Therefore, regulations were relaxed and tariffs and duties were lowered (Field, 2009).

Initially, before the industrialization period, agriculture was the most important sector for whole Indonesia. It was not before 1994 that less than 50 percent of the total workforce was employed in this industry (Royle, 1997). On the island of Batam the most important economic activity was, besides agriculture, fishery. Batam didn't take part in the early export industrialization of Indonesia and during the early 1970s it became clear that the earlier idea of competing with Singapore was impossible. Instead, it was thought that Batam could be better developed into a supporting location for the booming oil and gas industry in Indonesia as well as the whole ASEAN region (Field, 2009). Especially the Indonesian state-owned oil company Pertamina wanted to develop Batam into a location where it could execute its oil and gas (supporting) activities (Yeoh et al., 1992). The establishment of the Batam Industrial Development Authority (BIDA) in 1973 had to facilitate the development of the oil and gas industry on the island (Wong, 2009), but this goal was never really achieved (Field, 2009). By the late 1970s the plans were broadened. Batam should in the future better exploit its favorable geographical position near Singapore by developing into an industrial, commercial and tourist center (Field, 2009, Yeoh et al., 1992), especially due to Singapore's rapid economic development and outward-looking economic policy.

4.2.2 INFLUENCE OF SINGAPORE

Lim described Singapore in 1983 as the ‘world’s most successful economy’ (Huff, 1995). The small city-state obtained this position in less than twenty years. After Singapore had achieved full independence in 1965 it was suffering from a high unemployment rate. An export-oriented industrialization (EOI) approach almost fully based on inward foreign direct investments (FDI) had to solve this problem. Through this new economic policy Singapore would attract multinational corporations (MNCs), firms who already established several (geographical) markets, had access to large amounts of capital and up-to-date technologies. The attraction of MNCs was assisted by the creation of government-linked corporations (GLCs) who had to coordinate financial, infrastructural and transport improvements. Together with the GLCs, the Singaporean government created a situation with relatively low wages, a reliable infrastructure and a non-corrupt, trustful government (Huff, 1995; Field, 2006). This policy in combination with the exploitation of Singapore’s unique geographical location, alongside the east-west shipping route and bridging the time-zone gap between the financial markets of New York/London and Hong Kong/Tokyo, resulted in advanced economic growth. All these factors stimulated the development of Singapore’s financial and business services and manufacturing industries, in particular the electrical and electronics (semiconductor) and biochemical industries (Huff, 1995).

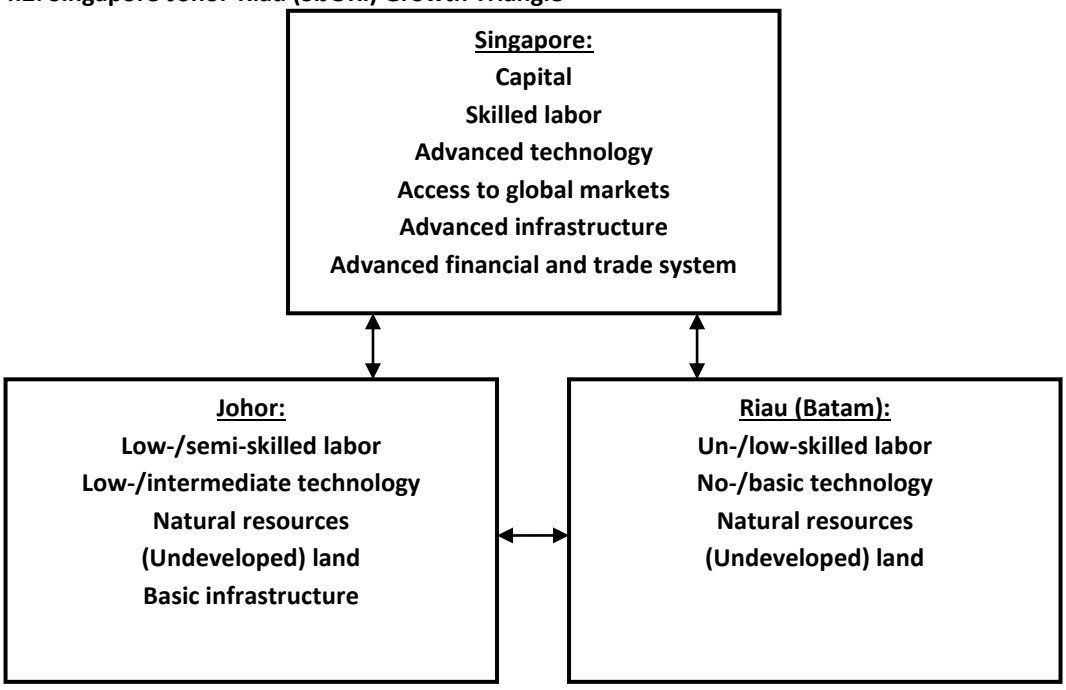
However, in the 1980s Singapore faced new competitors: a quartet of surrounding countries, also known as the Asian Cub Tigers, had adopted a comparable economic strategy focusing on the attraction of FDI. These countries found themselves in an earlier stage of industrial development accompanying lower wages and therefore lower production costs. This situation resulted in the relocation of MNCs from Singapore to these surrounding countries. The Singaporean government reacted by presenting its ‘Second Industrial Revolution’ plan. This plan aimed at retaining, stimulating and attracting high value-adding activities in semiconductor technologies, biochemical production, business services and general R&D. Despite different tax and other financial incentives, only a few MNCs started to upgrade their activities quickly (Pereira, 2004). However, the Singaporean government stuck to its vision of upgrading to a knowledge-based economy.

4.2.3 INDUSTRIALIZATION OF BATAM

The establishment of Batam as a 'free trade zone' (1974) and later a 'bonded zone' (1978) had to make the island attractive for labor-intensive manufacturing activities of Singapore-based MNCs (Field, 2009). Batam had to move away from traditional industries in order to profit from Singapore's rapid economic growth. The 'Master Development Plan' for Batam in 1979 had to support industrialization by developing transshipment facilities, industrial estates, marshalling areas, tourist facilities etc. (Yeoh, et. al., 1992). Especially export-oriented industries were supported. For protection of the Indonesian economy and firms, penetrating the domestic market was forbidden. Everything that was manufactured on the island had to be exported to other countries (Royle, 1997).

Although the potential of Batam for attracting labor-intensive activities linked to Singapore-based activities of Singaporean and overseas MNCs was early recognized by Singapore, during the 1980s this potential remained unexploited and the island of Batam remained sparsely populated and developed (Grundy-Warr et al., 1999). When, in the late 1980s, the Singaporean economy started to experience the limits of its growth, the concept of the SIJORI Growth Triangle, covering Singapore, the Malaysian state of Johor and the Indonesian Riau islands (Phelps, 2006), emerged. The philosophy behind this concept was to utilize the economic complementarity between the regions (figure 4.2). In this way, a triple-win situation could be created. For Singapore the Growth Triangle was a possibility to exploit the potentials of surrounding regions such as Batam, which had to be developed, in cooperation with the Indonesian government, into a production enclave for Singaporean and overseas MNCs.

Figure 4.2: Singapore-Johor-Riau (SIJORI) Growth Triangle



Source: Redrawn after Sparke et. al. (2004) and Chen (2009)

The Singaporean government unveiled additional plans, the 'Strategic Economic Plan' and the 'Regional Industrial Parks Programme.' Not only did the Singaporean government with this plan continue to encourage upgrading to higher value-adding activities in Singapore, it also stimulated the relocation of low value-adding labor-intensive activities out of Singapore (Perry, 1995). The program recognized and aspired the utilization of the opportunities in surrounding Tigers. Singaporean GLCs together with the foreign governments and private companies fully developed foreign industrial estates in that were directly prepared for business after completion. These foreign industrial estates, also known as 'Second Wings', were located in China, India, Indonesia, Korea, the Philippines, Thailand and Vietnam (Blomqvist, 2002). Batamindo Industrial Park (BIP) on Batam, completed in

1990, was Singapore's first overseas industrial estate (Shaw & Yeoh, 2000). BIP is located in the center of Batam. Most of its tenants are specialized in light and medium industries, especially the electrical and electronics industry, plastic moulds and precision parts (Gallant Venture, 2013). Since the establishment of BIP the foreign investments of Singapore-based MNCs in Batam rapidly increased and Batam experienced an extension of its industrial parks to a total of 22 (table 4.1).

Table 4.1: Overview of Industrial Parks on Batam in 2012

Industrial Park	Start	Size (Ha)	Industrial Park	Start	Size (Ha)
Batamindo Industrial Park	1990	320	Latrade Industrial Park	2000	60
Bintang Industrial Park	2001	64,4	Lytech Industrial Park	N.A.	N.A.
Cammo Industrial Park	1995	18	Malindo Cipta Perkasa	1995	23
Citra Buana Centre Park I	1994	10	Mega Cipta Industrial Park	N.A.	44
Citra Buana Centre Park II	2000	8	Panbil Industrial Estate	2001	103
Citra Buana Centre Park III	2002	20	Puri Industrial Park 2000	N.A.	30
Executive Industrial Park	2004	30	Sarana Industrial Point	N.A.	12
Hijrah industrial estate	2002	6,4	Sekupang Makmur Abadi	N.A.	19
Indah Instrustial Park	2000	16	Taiwan International Park	1990	54
Kabil Industrial Estate	1991	410	Tunas International Estate	2001	38
Kara Industrial Park	1996	19	Union Industrial Park	2003	25

Source: Miyamoto (2011) & BIFZA (2012)

Besides the development of industrial estates the Singaporean government invested in infrastructure that connected the industrial estates to key economic centers. Convinced by the non-corrupt Singaporean government, Singapore's former success and strategic investment plans, host governments were willing to collaborate because the local economy was likely to benefit from Singaporean development efforts. Investing in foreign industrial estates was interesting because Singapore offered a less expensive but equally reliable environment outside of Singapore for low value-adding activities, while Singapore became more attractive for MNCs' high value-adding activities. The low-cost estates also offered a potential location for expansion of Singaporean SMEs (Blomqvist, 2002; Pereira 2004; Miyamoto, 2011).

4.3 CHARACTERISTICS OF THE INDUSTRIALIZATION

Since the beginning of the industrialization 15,7 million US dollars (11,6 billion euro) has been invested (up to December 2012) in Batam from which 43 percent (6,8 billion US dollars, 5,0 billion euro) are foreign private investments (BIFZA, 2013). In recent years the foreign investments continue to show a gradual growth pace (table 4.2). Especially due to these foreign investments Batam still experience rapid economic growth (figure 4.3)(BIFZA, 2012).

Table 4.2: Foreign cumulative investment on Batam

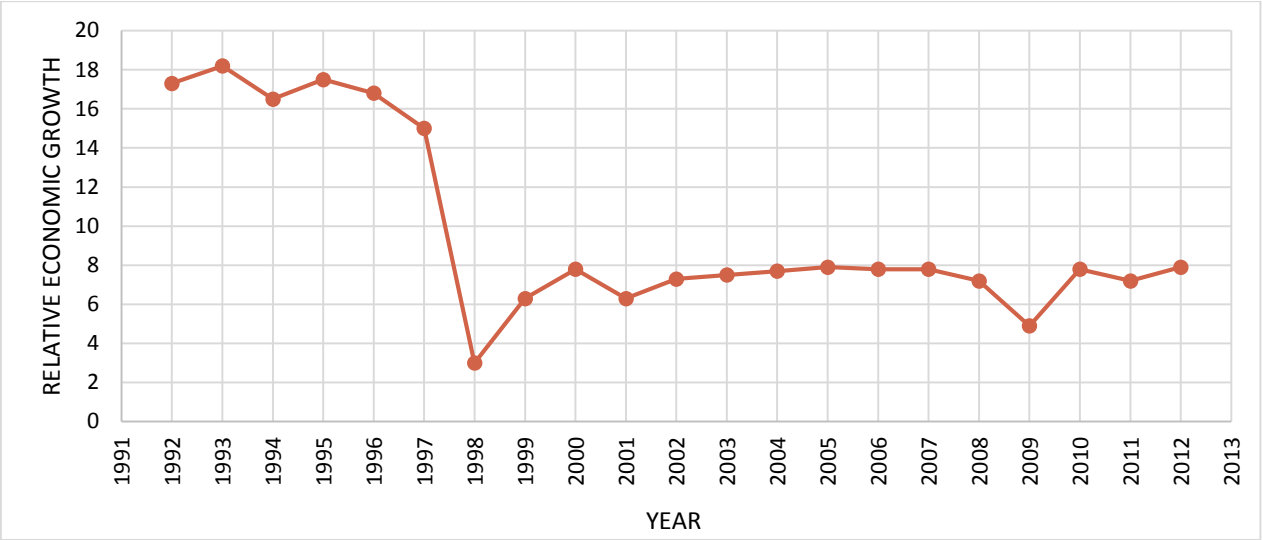
Year	2008	2009	2010	2011	2012
Foreign cumulative investment (in billion US dollars)	5.18	5.60	5.94	6.16	6.78

Source: BIFZA, 2013

However, Batam as well as whole Indonesia suffered from the East Asian Crisis from 1997 and 1998. This crisis slowed down growth in Southeast Asia during the first decade of the 21th century (Nabeshima & Yusuf, 2009; Wong & Ng, 2009). Before the actual crisis East Asian and Southeast Asian countries like Korea, Malaysia, Thailand and Indonesia experienced an investment boom. These investment came from local savings, but especially foreign capital inflow (Corden, 2007). These countries were attractive locations for investments, for example, because of Indonesia's fully liberalisation of capital movements. But this long-lasting investment period was followed by a 'hard landing' (Corden, 2007). A sharp decline in investments caused a exchange rate or financial crisis. Especially Indonesia suffered from this crisis with the biggest currency depreciation, the biggest growth decline and the slowest recovery. The consequences of the crisis in Indonesia was reinforced

by political factors. The lack of accurate intervention by the Soeharto government led to a strong decline in confidence in this government. The result was a further currency depreciation and deepening of the crisis (Corden, 2007). The economic growth rate of Batam was never able to reach levels from before the crisis (figure 4.3). However, Batam still had high growth rates of 8 percent, in comparison to whole Indonesia with growth rates of 4 to 6 percent. After that Batam and Indonesia would suffer from another drop in economic growth in 2008 and 2009 (Nabeshima & Yusuf, 2009).

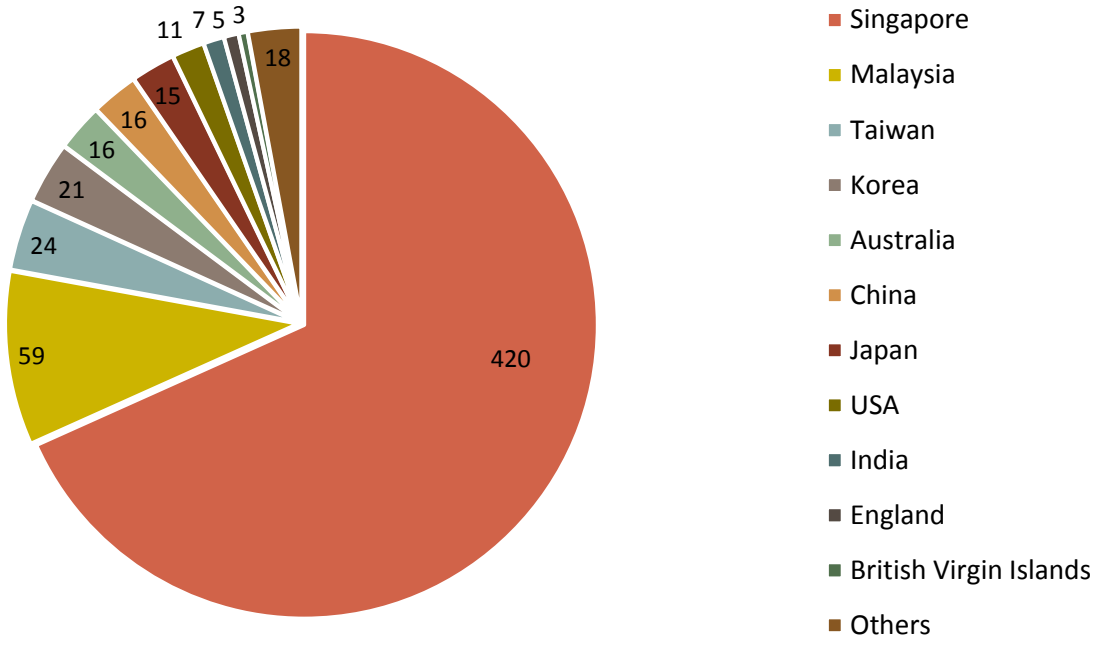
Figure 4.3: Economic Growth of Batam from 1992 to 2012



Source: BIFZA (2012)

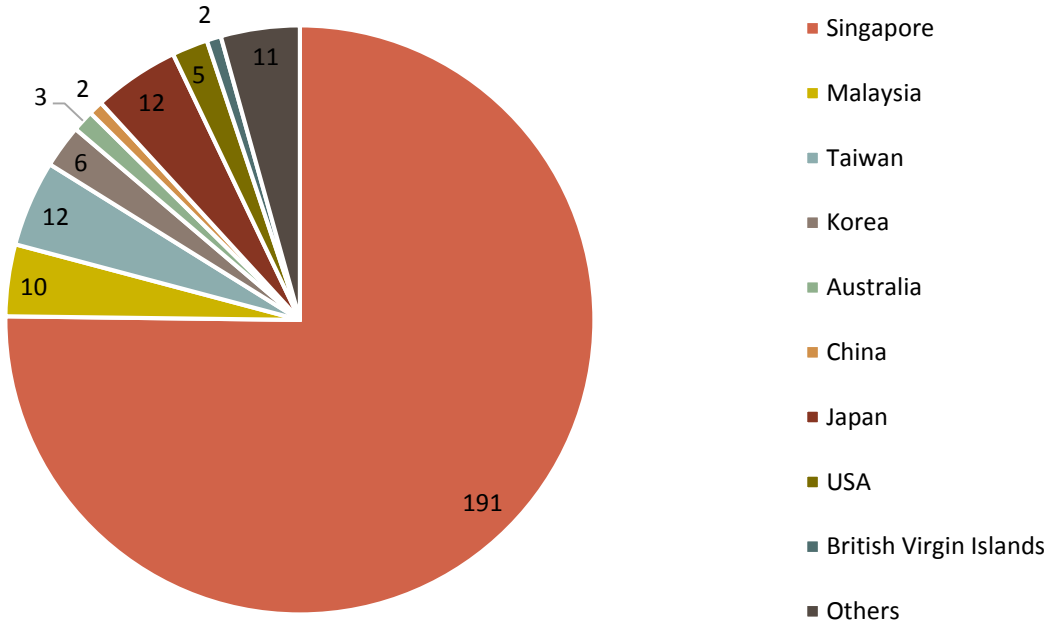
In 2012 a total of 615 foreign MNCs are located on Batam. The importance of Singapore is very clear (figure 4.4). The majority of MNCs is from Singaporean origin (68,3%). The second most MNCs are from Malaysia (9,6%). Originally big investors like the USA or Japan only have respectively 11 and 15 companies (respectively 2,4% and 1,8%) and the upcoming investor China also have no more than 16 companies (2,6%) on Batam (BIFZA, 2012). However, this pattern can be a little misleading since many MNCs invest in Batam through their regional headquarter in Singapore whereby investments seem to come from Singapore while they actually come from elsewhere. The involvement of Singapore in the development of Batam is though obvious. In comparison with 2001 however, it's clear that the number of MNCs with Singaporean origin has decreased (figure 4.5). MNCs from other countries seem to have discovered Batam as an attractive location for the outsourcing of economic activities.

Figure 4.4: Total number of MNCs to country of origin in 2012



Source: BIFZA (2012)

Figure 4.5: Total number of MNCs to country of origin in 2001



Source: BIDA (2001)

Industry is the most important sector on Batam with 35,5 percent of all firms operational in this sector (table 4.3). It employs more than 54 percent of the total workforce. Other large sectors are trade, hotel and restaurants (23% of all firms, 11% of all workforce) and construction (15,4% of all firms, 10% of all workforce). Public service provides a relatively large amount of employment. The historically important sector of agriculture is nowadays very small. MNCs are active in electronic sub assembly, shipbuilding industry, oil and gas supporting industry, export-import trading, garment, accommodation services and others industries (BIFZA, 2013).

Table 4.3: Total companies and total workforce per business sector

Business sector	Total companies		Total workforce	
	Absolute	Relative	Absolute	Relative
Industry	1.884	35,5 %	182.212	54,1 %
Trading, hotels	1.214	22,9 %	37.703	11,2 %
Construction	817	15,4 %	33.915	10,1 %
Public service	646	12,2 %	48.507	14,4 %
Finance, insurance	480	9,1 %	26.270	7,8 %
Transportation, communication	173	3,3 %	3.919	1,2 %
Agriculture	44	0,8 %	2.552	0,8 %
Mining	26	0,5 %	557	0,2 %
Electricity, gas, water	16	0,3 %	927	0,3 %
Total	**5.300**	**35,5 %**	**336.562**	**100 %**

Source: BIFZA (2012)

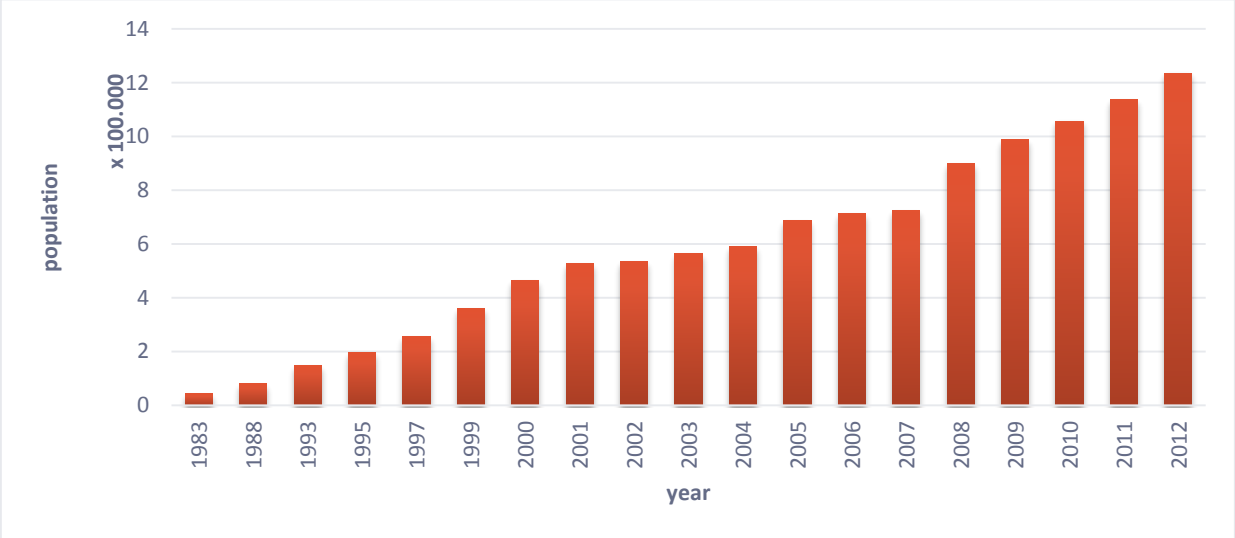
4.4 REGIONAL CHARACTERISTICS

4.4.1 POPULATION AND WORKFORCE

Indonesian economic policy accommodated Singaporean MNCs by stimulating the migration of people with low prospects for employment from overpopulated regions like Java to Batam (Yeoh et al., 1992). Since this policy, Batam has seen its population rapidly increasing and its population is still growing. Currently, Batam has a population of over 1.2 million, one million more than before the industrialization period (figure 4.6)(BIFZA, 2012).

Along with the increasing population and the increasing economic activity, the workforce has also increased in the last two decades (figure 4.7). Although the island attracts a lot of investments from foreign countries, it attracts only a relatively small number of foreign workers (5,970 in 2012), compared to the number of Indonesian workers (330,892 in 2012). The same distribution between Indonesian and foreign workers applies to all business sectors (table 4.4)(BIFZA, 2012).

Figure 4.6: Development of the population of Batam from 1983 to 2012



Source: Wong (2009): data: 1983-2007 & BIFZA (2013): data: 2008-2012

Figure 4.7: The evolution of the Indonesian and foreign workforce from 1990 to 2012

Source: Wong (2009): data: 1990-2007 & BIFZA (2013): data: 2008-2012

Table 4.4: Workforce based on business sectors in Batam in 2012

Workforce/Business sector	Indonesian workforce absolute	Indonesian workforce relative	Foreign workforce absolute	Foreign workforce relative	Total	Relative sectors
Industry	179.286	98,4%	2.926	1,6%	182.212	54,1%
Trading, hotels	36.802	97,6%	901	2,4%	37.703	11,2%
Construction	33.349	98,3%	566	1,7%	33.915	10,1%
Public service	48.258	99,5%	249	0,5%	48.507	14,4%
Finance, insurance	26.114	99,4%	156	0,6%	26.270	7,8%
Transportation, communication	3.892	99,3%	27	0,7%	3.919	1,2%
Agriculture	1.446	56,7%	1.106	43,3%	2.552	0,8%
Mining	527	94,6%	30	5,4%	557	0,2%
Electricity, gas, water	918	99%	9	1%	927	0,3%
Total	**330.592**	**98,2%**	**5.970**	**1,8%**	**336.562**	**100%**

Source: BIFZA (2012)

The wages on Batam are relatively low (table 4.5). Whether labor is skilled or unskilled the wages are below 196 USD (150 EUR). Only with manager functions people are able to earn more money starting at 796 USD (607 EUR), but still not more than 2208 USD (1684 EUR). The minimum wages on Batam are clearly higher than on the other islands of the Riau archipelago as well as the whole of Indonesia (table 4.6).

Table 4.5: Minimum and average wage per month and per classification in 2012

Classification/Wage per month	In IDR (Rp)	In USD ($)	In EUR (€)
Unskilled labor	1.110.000 - 1.175.000	112 - 118	85 - 90
Skilled labor	1.265.650 - 1.947.000	127 - 196	97 - 150
Factory supervisor	2.012.000 - 4.743.000	203 - 479	155 - 365
Factory manager, senior accountant, marketing manager, financial controller	7.888.000 - 21.868.000	796 - 2208	607 - 1684
Personnel manager or production	11.882.000 - 15.876.000	1200 - 1603	915 - 1222

Source: BIFZA (2012) and Batam Manpower Office (2012)

Problems like shortage of semi-skilled and skilled labor, rising labor costs, shortage of R&D personnel and low labor productivity were rising problems for companies on Batam (Yeoh et al., 2004). The current workforce still seems to be too inexperienced and unqualified for the activities that companies want to execute.

Table 4.6: Minimum and average wage per month

Region/Wage per month	2009		2010		2011		2012	
	Minimum	Average	Minimum	Average	Minimum	Average	Minimum	Average
Batam	1.045.000	N.A.	1.110.000	N.A.	1.180.000	N.A.	1.402.000	N.A.
Bintan	895.000	N.A.	925.000	N.A.	975.000	N.A.	1.225.000	N.A.
Karimun	899.000	N.A.	935.000	N.A.	981.000	N.A.	1,057,000	N.A.
Riau Province	892.000	N.A.	925.000	1.938.174	975.000	2.178.240	1.015.000	2.277.302
Indonesia	892.000	N.A.	908.800	1.510.568	988.829	1.529.161	1.121.460	1.580.882
	Minimum	**Average**	**Minimum**	**Average**	**Minimum**	**Average**		
Batam	1.402.000	N.A.	142	N.A.	109	N.A.		
Riau Province	1.015.000	2.277.302	103	230	79	178		
Indonesia	1.121.460	1.580.882	113	160	87	123		

Source: BPS Provinsi Kepulauan Riau (2013)

4.4.2 LOCATION, INFRASTRUCTURE AND CONNECTIVITY

Batam is located just 20 kilometers from Singapore and therefore, just like Singapore, near international shipping routes. This location makes the island attractive for manufacturing and distribution. Despite the island's small land area of 415 square kilometers compared to Singapore's 674 square kilometers, the availability of relatively cheap land for expansion of industrial activities was (Yeoh et al., 1992) and still is one of Batam's main comparative advantages.

Figure 4.8: International ports and ferry terminals on Batam

Source: BIDA (2005)

The island of Batam is connected to Singapore and other surrounding regions by ferry (figure 4.8). Ferries take off from in total six terminals to national (Bintan) and international (Singapore, Johor) destinations. A ferry trip from Batam to Singapore is only 40 to 60 minutes (Batamcenter.com, 2013) depending on the specific terminal of departure. Besides ferry transport service the harbors of Batu Ampar and Sekupang also provide larger seaport functions for passenger, container and bulk movement. Batu Ampar is the main seaport with a capacity of about 70,000 containers (TEUs) and 3 million cargo per year (BIDA, 2005). Kabil is the smallest seaport and also provides seaport facilities, but lacks a ferry terminal. In expansion plans Kabil should develop into a container port with a capacity of 5 million containers (TEUs). In recent years, passenger movements (domestic and foreign, arrivals and departures) within all the ferry terminals as well as the harbors are increasing (BIFZA, 2013).

On the island are more than 500 kilometers of paved roads. However, the quality of the roads is not always that good. Batam is connected to other small islands of the Riau Archipel, Tonton, Nipah, Setoko, Rempang, Galang, and Galang Baru, by six bridges. The industrial development is however limited to Batam. Batam has one airport, Hang Nadim International Airport. The airport is located in the eastern part of the island and is used for passenger movement as well as cargo. Currently, the airport have a capacity for about 3,3 million passengers per year. But plans for expansion should increase this capacity to 8,3 million passengers. This expansion is necessary because passenger numbers are increasing, from 2,7 million in 2008 to 3,8 million in 2012 (BIFZA, 2013). Also cargo is growing. Batam's largest industrial estate, BIP, is easy accessible by road and well connected to the airport and the seaports (Gallant Venture, 2013).

4.4.3 QUALITY AND RELIABILITY

Singapore has influenced the past industrial development and will influence the future development of Batam (Wong, 2009). Not least because the Singapore-Batam partnership is definitely a complementary one. Singapore needs the economic resources of the Indonesian islands: cheap labor (table 4.5) and abundant land, while Batam and Bintan lack the economic resources of Singapore; capital and expertise (figure 4.2) (Yeoh et al. 1992). Due to these low labor costs and abundant land Batam offers Singapore a contrasting environment just around the corner (Yeoh et al, 2004). The strong economic linkages between Batam and Singapore can be found in the presence of economic activities on Batam. The proximity to Singapore is the main reason for the presence of these activities. While manufacturing is mainly based on Batam, other key value chain activities are based in Singapore. Singapore provides a wide array of financial services (Gallant Venture, 2013). Singapore is also the main source of purchase. The strong business linkages with Singapore-based companies and institutions provide resources to Batam (Wong, 2009).

These linkages are especially apparent with foreign-owned manufacturing companies (MNCs). Foreign companies who are based on Batam as well as in Singapore have relationships in the field of regional headquarters, business networks, contacts and finance, while the companies who are only based on Batam have relationships in the field of transport and logistics (Wong, 2009). Overall business networks and contacts seem to be more important relationships than physical linkages. Not only business linkages exist between Batam and Singapore, but also linkages with professional institutions, however these are weaker. Ties with Singapore seem to determine future plans. Companies who have strong ties with Singapore seem to have more plans for expansion than companies who have less strong ties with Singapore (Wong, 2009).

The strong linkages with Singapore can influence the business environment on Batam. This is the case with Batamindo Industrial Park (BIP)(Yeoh et al., 2004), developed by Singaporean government-linked companies. BIP (530,000 m^2) is self-contained area with facilities according to Singaporean conditions and little to no commitment to the rest of the island. With facilities like its own power supply, water treatment, sewerage and communication facilities, but also supermarkets, shops, restaurants and medical center, BIP can act relatively independent (Yeoh et al., 2004). Furthermore, its communication and business linkages are almost all linked to Singapore instead of Indonesia. Important factors for MNCs to base their manufacturing activities on this industrial park are the excellent infrastructure, political commitment from the Singaporean government (and corruption-free administration) and investment incentives.

4.4.4 INSTITUTIONS

Many actors were involved in the development of Batam. For example, the creation of several industrial parks on the island involved the governments of Singapore and Indonesia, BIDA (nowadays BIFZA), MNCs and local Indonesian companies (Field, 2009). The Batam Industrial Development Authority (BIDA), nowadays Batam Industrial Free Zone Authority (BIFZA), was established in 1973. The main purpose of the establishment of the organization was the coordination of the industrial development of the island. With offices in Jakarta, Singapore and even Osaka, Japan, BIFZA tries to represent the interests of Batam abroad and to promote the island as an interesting investment

destination in Southeast Asia (BIFZA, 2013). The attraction of foreign investments is one important task of BIFZA. Another important task is the maintenance and improvement of Batam's infrastructure and other facilities. Currently, BIFZA is also involved in social development. It searches for solutions to several social problems brought by the industrial development in the last decades.

Two other institutions with a strong influence on the development of Batam are Sembcorp and Gallant Venture. Both companies are involved in the development of industrial estates, including Batamindo Industrial Park. Semborp Industries is a large (over nine thousand employees) Singaporean company established in 1998 and primarily involved in energy and water supply and related services like marine and offshore engineering, construction services (building, repair and conversion of ships and rigs) and urban development. Sembcorp Industries is a leading Asian urban developer, active in China, Indonesia and Vietnam and the main investor in Batamindo Industrial Park (Sembcorp, 2013). It is responsible for the initial (master) planning, land preparation, the development of infrastructure and even management of industrial estates and other business and commercial space. Most important for Batam is Sembcorp's ability to transform raw land into large scale urban developments. These urban developments attract local and international investments and therefore facilitate economic development and creating employment opportunities. Sembcorp Industries is, together with the Salim Group, the key shareholder of the investment holding group Gallant Venture, established in 2003 (Gallant Venture, 2013). Gallant Venture is primarily involved in the development and management of industrial parks (and resorts) on Batam and Bintan and the developer of Batamindo Industrial Park and the supplier of power, water, telecommunication and other utilities to the companies located on the estate. Further, they provide ready-built factories, logistics services, residential, recreational and medical amenities for the companies and the employees, infrastructure, security and commercial centers. Both Sembcorp and Gallant Venture utilize the strategic proximity of Batam to Singapore and the economic cooperation between the governments of both countries (Economic Cooperation in the Framework of the Development of the Riau Province, 1990)(Gallant Venture, 2013).

4.4.5 INCENTIVES

The local government of Batam as well as the national government of Indonesia try to make Batam an attractive investment environment to support the development of Batam (Batam Center, 2013). Batam offers potential investors attractive conditions. First, Batam has a streamlined procedure for foreign investment application. To guarantee this accuracy, all necessary permits and licenses are processed by BIFZA according to a one-stop policy. Getting approval won't take more than twenty working days. When an approval is given the company has a license to operate for thirty years. To keep total control over foreign establishments companies are allowed to have hundred percent foreign ownership (Batam Center, 2013).

Second, Batam offers simple immigration procedures for expatriates. It's easy for foreigners to obtain a staying permit through the local Immigration Office. Foreign visitors with most nationalities can get a Visa On Arrival (VOA). Once through the immigration process foreigners are allowed to buy and own houses, regardless of whether they work on Batam (Batam Center, 2013).

Third, to stimulate the profitability of operating on Batam there are easy import and export procedures. Batam is, together with the islands of Rempang and Galang, a bonded and free trade zone. This means that companies don't have to pay import or export duties for goods related to production, such as machines, equipment, parts and raw materials (Batam Center, 2013). Batam neither collects value-added tax (VAT) for all processing industries for export purposes and has a Generalized System of Preferences (GSP). Investment Allowance makes investing in Batam attractive by letting companies deduct a percentage of their capital investments from their taxable income. When companies do have to pay tax the Double Taxation Avoidance Agreement with 51 countries prevent companies from paying double (Batam Center, 2013).

4.5 EXPECTATIONS

Due to the expanding nature of the E&E industry since the early 1990s and the proximity to Singapore the evolution of the E&E industry of Batam is expected to be characterized by an early increase of firms. Because of increasing competition from other Second Asian Tigers and other rising economies in Asia (China, India, Myanmar), rising labor costs and the relatively footlooseness of MNCs, the E&E industry of Batam is expected to be characterized by a later decrease in the total number of firms (expectation 1). The solution for rising labor costs and the lack of abundant land in Singapore was to be found on Batam where labor costs are relatively low, compared to Singapore, but also compared to Malaysia. The Singaporean government started to invest abroad in the form of the 'Singaporean Parks Programme.' In the case of Batam, this resulted in the development of BIP. Therefore, the E&E industry of Batam is characterized by a constant overrepresentation of Singaporean firms (expectation 2).

1. The industry is characterized by an early increase and a later decrease of the total number of subsidiaries.

2. The industry is characterized by a constant overrepresentation of Singaporean subsidiaries.

Almost all MNCs on Batam also have establishments in Singapore. This complementarity between Singapore and Batam and within the Growth Triangle can become problematic for upgrading of subsidiaries on Batam. In this kind of cooperation every region has its own characteristics with which they complement other regions and which determines their competitiveness (Sparke et al., 2004). Because of the presence of knowledge-intensive activities in Singapore there is little reason for the MNCs' (R)HQ to allocate high value-adding knowledge-intensive activities to industrial estates on Batam, since Singapore provides a more conducive business environment for these kind of activities and very proximate to Batam. As a result, Batam only attracts and maintain the low value-adding labor-intensive and knowledge-extensive manufacturing activities. This relatively weak position in the RPN hinders subsidiary-level evolution (expectation 3). Due to Batam's weak position in relation to Singapore and within the Growth Triangle, its low land and labor costs, and the lack of knowledge and technology the subsidiaries are expected to be characterized by low value-adding, high labor-intensive functions (production) and activities (manufacturing and assembly)(expectation 4).

3. The subsidiary's weak position in the RPN hinders subsidiary-level evolution.

4. The lack of knowledge, technology and high-skilled labor hinders the development of subsidiary's capabilities.

Batam lacks knowledge, technology, a medium- or high-skilled workforce and an insufficient institutional system (especially in comparison to Singapore). Since Singapore is the regional hub for high value-adding, knowledge-intensive activities learning processes only seldom occur on Batam. The regional knowledge and technology base of Batam has not really developed over time. The lack of knowledge, technology and medium-/high-skilled labor is expected to hinder in-situ development of capabilities and evolution. Instead, the strength of Batam lies mostly in its cost advantages.

5. Subsidiaries have experienced little to no industrial upgrading.

5. METHODOLOGY

This chapter presents an overview of the methodological research decisions regarding the data collection and analysis. As mentioned before, the aim of this research is to map the evolution of the E&E industry on Batam from 1990 to 2012. During this period, new MNCs enter and existing MNCs remain in or exit the E&E industry, causing changes in the industrial composition. The first paragraph explains the research design and definitions of the most important theoretical concepts. The second and third paragraph describe the methods on respectively the industry- and firm-level. The fourth and last paragraph discusses problems that occurred during the research and shortcomings.

5.1 RESEARCH DESIGN AND DEFINITION

The theoretical framework provides different concepts that try to explain changes in the E&E industry. These changes (industry-level) as well as the mechanisms behind these changes (firm-level) are interesting. In order to accurately analyze changes in the E&E industry between 1990 and 2012 data of several years is required. At the industry-level, data of all (subsidiaries of) MNCs in the E&E industry located on Batam in the specific time period could provide an overview of the evolution of the whole industry. At the firm-level, data of individual subsidiaries of MNCs in the E&E industry located on Batam could provide insight in the causes behind this evolution.

Table 5.1: Operationalization E&E industry (Indonesian Standard Industrial Classification (KBLI))

Code	Branch:	Code	Manufacture of:
31	Electrical equipment and parts	311	Electric motors, generators and transformers
		312	Electricity distribution and control apparatus
		313	Insulated wire and cable
		314	Accumulators, primary cells and batteries
		315	Lighting equipment and electric lamps
		319	Other electrical equipment
32	Radio, Television, and Communication Equipment and Parts	321	Electronic valves, tubes etc.
		322	Television/radio transmitters; line communication apparatus
		323	Radio and television receivers and associated products
33	Medical Equipment, Measuring Tools, Navigation tools, Optical Equipment, Watches and Clocks	331	Medical, measuring, testing appliances, etc.
		332	Optical instruments and photographic equipment
		333	Watches and clocks

Source: KBLI (2013)

First, it is necessary to define the E&E industry. Since the industry-level data collection is based on the annual books published by BIFZA their classification of the E&E industry is used. However, with the use of the International Standard Industrial Classification of all Economic Activities (ISIC) and the Indonesian Standard Industrial Classification of Economic Activities (Klasifikasi Baku Lapangan Usaha Indonesia (KBLI)) the classification of BIFZA is verified and extended with specific products and activities related to the E&E. Therefore, in this research the E&E industry is defined as the industry that entails the production of all products mentioned in table 5.1.

5.2 INDUSTRY-LEVEL METHODOLOGY

The E&E industry consists of several branches, wherein companies with related products/activities form a branch. The composition of all these branches within the E&E industry is subject to change (Neffke, Henning & Boschma, 2011). Due to technological developments new branches emerge while old branches disappear. This process is known as branching (Boschma & Frenken, 2009). When because of branching the new composition of the industry is more sophisticated than the old

composition then the E&E industry experienced industrial upgrading. The evolution of branches within the E&E industry and the E&E industry as a whole is determined by the behavior more specifically the entry and exit of individual firms. These entries and exits influence the branches within the industry which in turn influence the composition of the whole E&E industry. In order to analyze the evolution of the E&E industry between 1990 and 2012 an overview of the compositions at different times is necessary. This requires an inventory of all subsidiaries of MNCs in the E&E industry preferably per year with their relevant characteristics. All subsidiaries of MNCs that are or have been operating in the E&E industry (or related supplying activities as plastic and metal molding) on Batam from 1990 to 2012 are part of the total population. An MNC is defined as a company that has subsidiaries in at least two countries (Business dictionary, 2013). All foreign-owned companies as well as Indonesian companies with subsidiaries outside Indonesia are included. The presence and products/activities of the subsidiaries can give insight in the branches that form the E&E industry. So in order to map the process of branching and to determine whether the E&E industry experienced industrial upgrading data about the presence, products/activities and some other company information (table 5.2) of all subsidiaries in the E&E industry on Batam from 1990 to 2012 has to be monitored and analyzed.

Table 5.2: Industry level indicators per subsidiary

Indicator	Description
Company name and former names	Subsidiary's current name and Subsidiary's former name(s)
Country of origin	Country of origin of the parent company (MNC)
Address/location	Industrial estate where the subsidiary is located
Telephone	Telephone number of the subsidiary
Website	Website of the subsidiary or parent company (MNC)
Presence on t(+1)	Presence on Batam since start (t) and so on (t+1, t+2)
Business activity on t(+1)	Business activity since start (t) and so on (t+1, t+2)
Additional notes	Interesting information (i.e. linkages with Singapore)

The marketing division of BIFZA and the library of BP Batam were able to provide industry-level data of the following years: 1990 to 1994, 1996, 1999 to 2001, 2003, 2009 and 2012. For these years, annual books published by BIFZA provided lists of (subsidiaries of) MNCs per industrial estate. Besides the name of the MNC, these books gave information about the exact location (industrial estate) and sometimes the sector (i.e. electronics industry), product (i.e. electronic components) and/or activity (i.e. assembly). Unfortunately, books of the following years were missing: 1995, 1997, 1998, 2002, 2004 to 2008, 2010 and 2011. For 2009, there was an second source available which provided information for all present MNCs in 2009, but also their year of license (year of establishment). In this way, it was able to recover some information about the missing time gap from 2004 to 2008. For MNCs that were in operation on Batam in 2009, but were not present in earlier books, it was possible to identify their year of start. Finally, BIFZA also provided a digital database with all the MNCs present in 2012. This database had information about the year of establishment as well, in order to recover information about the missing years 2010 and 2011. The collected data is combined to construct a database which provides an overview of the evolution of the E&E industry on Batam from 1990 to 2012.

5.3 FIRM-LEVEL METHODOLOGY

In order to understand the mechanisms behind branching and industrial upgrading more specific analysis of the behavior and the evolution of individual subsidiaries is necessary. The best way to collect data about subsidiary behavior and the underlying reasons for this behavior is through interviewing. It must be taken into account with this method that the collected data is based on the perception of the respondent. The interviews are to be taken with representatives of the subsidiaries that are currently present on Batam, preferably someone with sufficient knowledge of and experience within the subsidiary (i.e. managers and senior workers). The database provided a list

with currently present subsidiaries in the E&E industry on Batam which were to be invited for an interview. A semi-structured questionnaire consisting of open and closed (multiple choice) questions is used. Based on the theoretical framework the questionnaire consists of five main subjects (table 5.3).

Table 5.3: Five subjects of the questionnaire

Subjects
1. General information
2. Evolution of the subsidiary
3. Local environment
4. Regional production network (RPN)
5. Future prospects

5.3.1 OPERATIONALIZATION

Concepts as in situ (firm-level) upgrading, RPNs and regional characteristics need to be operationalized in order to construct a questionnaire. In situ upgrading can be divided into functional upgrading, product upgrading and process upgrading. Changes occur at all three areas. The nature of this change determines whether this change is actually is upgrading. For example, when considering functional change, a shift from a relative simple activity as assembly to a relative advanced activity as research and development can be considered functional upgrading. Besides a situation where an old function is replaced by a new function, the acquisition of additional functions can also be considered functional upgrading. For example, an expansion from only manufacturing activities to manufacturing and sales activities. An overview of the functions at the start of operating and the current functions should make it possible to indicate functional change and upgrading.

To examine whether there has been in situ product upgrading it is necessary to analyze the evolution of the product portfolio from the start of operating to the current situation (table 5.4). Therefore, the difference between the current products and former products manufactured in the subsidiary has to be analyzed. Factors that could indicate whether there has been in situ product upgrading are a shift from lower- to higher-end products, but also an increase in complexity and/or specialization of the product portfolio. However, the reasons behind the change of the product portfolio are also important in order to accurately indicate upgrading. Companies can be at the frontier of technological development or just simply try to follow competitors in order to survive. In the first case, it could well be that the main product was new for the parent company and/or the market, while in the latter case the main product was probably not new. An overview of the product portfolio at the start of operating and the current product portfolio should make it possible to indicate product upgrading.

The indication of in situ process upgrading is a bit more difficult. A factor that can indicate a more efficient production process and thus in situ upgrading is an increase in the production volume. Other factors that can indicate the efficiency of the production process and in situ upgrading can be the type and quantity of machinery (in relation to the number of employees) and the dominant trends regarding the use of machinery. Subsidiaries with high levels of sophistication of the machinery and high automation of the production process (and a low number of employees) probably have an efficient production process. Another factor is the ability to absorb and create new product and process technology which can determine the extent to which both in situ product and process upgrading can occur. The ability to be flexible enables to quickly adapt to changing circumstances and to seize possible (innovative) opportunities. Finally, the composition of the employment (number of technicians, assembly workers, engineers, foreign employees and the ratio between low- and high-skilled employees) can give insight in the way the subsidiary operates, the in-house knowledge and upgrading abilities. For example, the more high-skilled the workforce, the more likely the subsidiary will be able to realize upgrading.

Table 5.4: Indicators for in situ upgrading

Subject	Indicators
Functional upgrading	Past and current functions: shift to more value-adding functions
Product upgrading	Past and current product portfolio: shift to higher-end products, increase of complexity, increase of specialization
Process upgrading	Increase of the production volume, trends in the use of machinery (type and quantity), number of employees
General	Ability to absorb and create new knowledge/technology, flexibility, composition of the employment

Subsidiary evolution and upgrading is also influenced by the position of the subsidiary in the RPN. The mapping of the whole RPN is important to examine the exact position of a single subsidiary. The RPN, consisting of a (R)HQ and one or more subsidiaries, has a specific division of activities in which every unit has its own function. The position of a single subsidiary in the RPN is determined by its functions, capabilities, its competitors or collaborative partners, and the HQ's strategy (table 5.5). The more subsidiaries in the RPN, the less important a single subsidiary probably is. Other factors that can indicate the position of a subsidiary within the RPN are the responsibilities and autonomy of a subsidiary, and the locations in the RPN where decisions are made. Competition and collaboration within the MNC with other subsidiaries In order to construct a clear image of the RPN additional corporate data is collected from company websites. Most websites provide an overview of the (R)HQ and the subsidiaries and sometimes even the functions and/or activities per establishment.

Table 5.5: Indicators for the position of a subsidiary in the RPN

Subject	Indicators
Regional production network	Responsibilities of the subsidiary, decision making process (where are decisions taken), autonomy of the subsidiary, amount of competition between subsidiaries, amount of collaboration between subsidiaries

Table 5.6: Indicators for the local environment

Subject	Indicators
Labor	Availability (volume), costs, skills, training institutions
Technology base	(From) other companies, research institutions, educational institutions, government programs
Infrastructure	Physical, ICT, knowledge
Connectivity	International, national, local
Local supplier base	Quality, diversity
National and local government	Efficiency, policies and incentives, pro-activeness, stability, interaction potential
Living environment	Pollution, congestion, crime, cultural amenities, housing, health facilities, schooling

The local environment and other local drivers can influence the functionality of an establishment and can be important for upgrading. Based on the theory and previous research, eight subjects (labor, technology base, infrastructure, connectivity, local supply base, (national and local) government and living environment) with 33 indicators are composed (table 5.6). With these indicators a chart is constructed. In this chart the respondent can rate every indicator from 1 (very unimportant) to 5 (very important). Herewith the perception of the MNC towards the importance of each indicator for the functioning of the establishment and for possible upgrading is measured. Besides the importance, the respondent evaluates from 1 (very bad) to 5 (very good) the current situation of these indicators in the region. To figure out if the overall environment has changed, a question on the development of the overall environment since 5 years is added in the questionnaire.

Subsequently it is important to figure out if any of the indicators played a major role in the (lack of) upgrading of the subsidiary. Therefore a question on this matter is included in the questionnaire.

5.3.2 INTERVIEWING

First, companies in the E&E industry currently located on Batam were contacted by phone and/or e-mail. The availability of a phone number and e-mail address on the company website was a requirement. Unfortunately, this first approach remained without any result due to cultural and linguistic barriers: little knowledge of the English language led to misunderstanding during telephone conversations and e-mails remaining unanswered. Our contact person at the marketing department of BIFZA, Mrs. Tuty Sirait, advised and proposed to fax companies through BIFZA with the request for an interview with a (assistant) manager or someone with sufficient knowledge about and experience within the company. So companies were faxed according to a priority list which was to contain a good representation of the MNCs in the E&E industry of Batam according to several characteristics as country of origin and product/branch. This strategy worked and finally led to interviews with thirteen companies which give a good representation of the E&E industry of Batam (MNCs from Singapore, Japan and Europe producing components, parts, and full products for consumer and industrial markets). All interviews were conducted at the company's location.

5.4 METHODOLOGICAL LIMITATIONS

At the industry-level data of eleven years is missing. Therefore, companies entered and exited Batam during a missing time gap remain unknown. But, as stated earlier, with an additional data source it was able to recover most of these unknown companies. Furthermore, sometimes the nature of the data differs per year. Some data sources only provide the name and location of the subsidiary of an MNC, while a few other data sources also provide the sector or branch, product and activity of the subsidiary. Therefore not for all subsidiaries the product information is known. Whenever available this additional information is used in order to form a better image of the E&E industry of Batam. However, sometimes the use of extra data sources in order to verify the data of BIFZA caused some confusion. For example, the tenants lists of BIP mismatched with the data of BIFZA making the analysis a little more complicated. Due to insufficient data the analysis of branching in relation to the technological composition and the shift from less to more value-adding functions is restricted to a limited number of MNCs. These firms are selected according to their relative importance for the global E&E industry. Therefore, it is difficult to determine whether upgrading of the whole E&E industry of Batam has occurred.

Due to time pressure the questionnaire is not extensively tested. Therefore, interviews sometimes took a little too long and some questions were not always equally applicable. Some concepts such as low- and high-end could be a bit better operationalized. Despite these small imperfections, it was still able to measure evolution and upgrading. But extensive testing of the questionnaire would have helped preventing these little problems. During the interviews some respondents experienced troubles with the English language causing some misunderstanding of questions. Fortunately, an employee of BIFZA who accompanied us during the interviews was very helpful with some translation when necessary. Finally, the number of interviews (13) is relatively low, but it still provides a good representation of the industrial composition of the E&E industry of Batam according to country of origin, size, branch, products etc. Besides, not for all variables the evolution is measured in the questionnaire (capabilities, processes: composition of labor, technology, markets).

6. EVOLUTION AND UPGRADING OF THE E&E INDUSTRY OF BATAM

This chapter presents the results of the industry-level analysis of the E&E industry of Batam. The first paragraph elaborates on the evolution of Singapore and its influence on the development of Batam. The second paragraph describes the evolution of the E&E industry of Batam. The third paragraph provides an overview of the current industrial composition according to country of origin and division in branches. The fourth paragraph describes the evolution of the technological composition. The fifth and last paragraph attempts to draw a conclusion and formulates an answer to sub question 1.

6.2 EVOLUTION OF THE E&E INDUSTRY OF BATAM

Since the start of cooperation with Singapore, the government of Batam aimed at a wide range of investments. From light to heavy export-oriented industries. Preferable non-pollutive and low in water consumption. With these criteria it specifically targeted the electric & electronics, garments, textiles, wood-based and food processing industries (Yeoh et al., 1992). Especially American, European and Japanese MNCs who were often already operating in Singapore invested in Batam through the establishment of subsidiaries. So it is likely that also MNCs in the E&E industry of Singapore are located on Batam as well. Therefore, an overview of the composition and evolution of the Singaporean E&E industry could provide insights in the characteristics and evolution of the E&E industry of Batam.

6.2.1 EVOLUTION OF THE E&E INDUSTRY OF SINGAPORE

Van Grunsven (2013) mentions that the E&E industry of Singapore origins from the late 1960s and plays up to now an important role in Singapore's economy. The evolution of the E&E industry of Singapore can be marked by four phases. Phase one, during the 1970s, can be described by the allocation of production functions by MNCs in the consumer electronics to Singapore. Singapore's attractiveness was determined by its low labor costs, reliable infrastructure and central position. The second phase took from the late 1970s to the late 1980s and can be characterized by a diversification of the E&E industry, but also with an attempt to upgrade the industry. Besides consumer electronics, industrial electronics was added to the E&E industry. Specifically, this meant production of disk drives and other computer peripherals, computer systems and integrated circuits, but also supporting industries such as printed circuit board assembly and precision engineering were established in Singapore. At the same time, Singapore endeavored to trigger industrial upgrading and industrial restructuring towards higher value-adding, more technology-intensive business activities. In the third phase (1990s) new attempts for product and process upgrading were made. Low value-adding, labor-intensive operations regarding relatively mature products were stimulated to relocate out of the city-state. During this phase the composition of the Singaporean E&E industry was still characterized by assembly of consumer electronics, integrated circuits and data drives, but also assembly of semiconductors. The fourth phase started in the early 2000s with the Singapore Industry 21 Master plan. This plan aimed for high value-added and high-precision production and processes, with increasing input from computer science, engineering and artificial intelligence research. This plan identified electronics as a key cluster of Singapore's manufacturing sector (Van Grunsven, 2013).

Table 6.1 E&E industry as share of the total manufacturing sector

Share of total manufacturing	1991/1995	1996/2000	2001/2005	2006/2010
Output	45.1	50.1	40.0	31.5
Value-added	35.0	40.4	33.2	29.6
Employment	33.8	32.3	26.1	21.3
Fixed asset	-	43.5	52.8	37.7
Domestic export	60.3	54.7	36.3	26.1

Source: Van Grunsven, 2013

Looking at the evolution of the Singaporean E&E industry, the absolute output in million Singapore dollar for the whole industry grew steadily from 1991 to 2010 (table 6.1). In this time period also the absolute amount of value-added and productivity per worker increased. The latter, partly due to a decrease in employment in the E&E industry. For the absolute investment in fixed assets there is only data available since 1996. Since this year the absolute investment in fixed assets increased. The absolute domestic export increased from 1991 to 2005, but decreased in the period from 2006 to 2010. Despite of these positive developments the relative importance of the E&E industry in the manufacturing sector actually decreased. While the absolute total amount of output of the E&E industry increased, its share in output in the manufacturing sector dropped since then from 45.1 percent in the period 1991 to 1995 to 31.5 percent in period 2006 to 2010. The same applied to the share of value-added (35%-29.6%), domestic export (60.3%-26.1%), the employment (33.8%-21.3) and investment in fixed assets (43.5%(1996-2000)-37.7%) in the manufacturing sector.

The composition of the E&E industry of Singapore's manufacturing sector consists of five different branches: computer peripherals, consumer electronics, data storage, semiconductors and other electronics components. When looking at the composition of the E&E industry in the period 1991 to 1995 based on total output in Singapore dollar the consumer electronics is the largest branch and accounted for 38.9 percent of the E&E industry (table. 6.2). The second largest branch was the data storage branch with 24.1 percent. The third largest branch was the semiconductors branch with 15.7 percent. Fourth, the computer peripherals branch accounted for 14.2 percent. The smallest branch is that of electronics components with 7.1 percent. The importance of these branches changed through the years. In the period from 2006 to 2010 the consumer electronics was not the most important branch anymore and accounted only for 15.2 percent. The only growing branch is the semiconductors branch and accounts for more than half of the total E&E industry (53.5%) in 2010. The data storage branch was with 15.2 percent of the same importance as the consumer electronics branch. The fourth most important branch was that of computer peripherals and accounted 12,9 percent. Lastly, the branch electronics components had a negative grow and accounted for only 3.1 percent of the E&E industry.

Table 6.2 Evolution of branches in the E&E industry of Singapore (as share of the total output)

Total output	**1991/1995**	**1996/2000**	**2001/2005**	**2006/2010**
Semiconductors	15.7	22.0	34.7	53.5
Computer peripherals	14.2	17.0	17.9	12.9
Data storage	24.1	27.8	23.7	15.2
Consumer electronics	38.9	28.0	19.1	15.2
Other electronic components	7.1	5.3	4.7	3.1
Total	100	100	100	100

Source: Van Grunsven, 2013

When looking at the evolution of the industrial composition based on value-added there is a comparable situation. In the period from 1991 to 1995 the consumer electronics had the biggest share in value-added (33%), but decreased sharply and in the period from 2006 to 2010 accounted for only 10 percent of the total value-added for the E&E industry (table 6.3). The semiconductors branch is once again the only growing branch (19%-59.3%). The computer peripherals branch experienced the least decrease in importance; from 17.3 percent to 14.7 percent. Also for the data storage branch the share in value-added decreased (19.3%-11%). Finally, the branch of other electronics components declined from 11.4 percent to 5 percent.

Table 6.3 Evolution of branches in the E&E industry of Singapore (as share of the total value added)

Value-added	1991/1995	1996/2000	2001/2005	2006/2010
Semiconductors	19.0	28.5	43.0	59.3
Computer peripherals	17.3	13.5	18.5	14.7
Data storage	19.3	23.6	13.7	11.0
Consumer electronics	33.0	25.0	16.3	10.0
Other electronic components	11.4	9.4	8.6	5.0
Total	100	100	100	100

Source: Van Grunsven, 2013

These developments are almost equal when looking at total employment (table 6.4). The semiconductors branch have grown (13.2%-46.5%), but the other branches have declined; consumer electronics (31.9%-11.4%), data storage (24.3%-17.0%), computer peripherals (17.8%-15.3%) and other electronics components (12,7%-9.9%).

Table 6.4 Evolution of branches in the E&E industry of Singapore (as share of the total employment)

Total Employment	1991/1995	1996/2000	2001/2005	2006/2010
Semiconductors	13.2	20.9	34.9	46.5
Computer peripherals	17.8	17.5	16.1	15.3
Data storage	24.3	27.8	23.0	17.0
Consumer electronics	31.9	20.5	13.9	11.4
Other electronic components	12.7	13.3	12.1	9.9
Total	100	100	100	100

Source: Van Grunsven, 2013

Despite of an absolute growth, the E&E industry, compared to other industries in the manufacturing sector, lost importance. The composition of Singapore's E&E industry strongly changed. Within the E&E industry the branches of computer peripherals, consumer electronics, data storage and other electronics components lost importance, while the branch semiconductors still grew in importance. The outsourcing and decrease of low-value adding production activities in Singapore can probably result in an increase of these activities on Batam. While the emergence of more high-value adding production as semiconductors in Singapore can possibly result in the development of supporting industries on Batam.

6.2.2 EVOLUTION OF THE E&E INDUSTRY OF BATAM

The E&E industry is the largest industry of Batam, manufacturing and assembly are its niche activities (Yeoh et al., 2004). Firms in the E&E industry on Batam primarily focus on manufacturing and assembly of audio and video equipment, automotive parts, printed circuit boards (PCB) and other computer-related components and parts. The E&E industry of Batam follows a similar development path as Singapore. In absolute terms, the E&E industry in output in Rupiah and number of firms grew gradually from 1998 to 2007. However, the number of firms in the E&E industry of Batam as share of the manufacturing sector declined from 45 percent in 1998 to 30 percent in 2007 as well as the output in Rupiah declined from 78 percent in 1998 to 53 percent in 2007. The number of employees of the E&E industry of Batam as share of the manufacturing sector declined from 73 percent in 1998 to 55 percent in 2007 (Wong & Ng, 2009).

As described in the fourth chapter, the rapid economic development of Batam started in 1990 when BIP was finalized. According to our data, in 1990 four MNCs in the E&E industry decided to allocate economic activities to Batam (table 6.5). Three of these MNCs are, after more than twenty years, still present on Batam. These companies are Leo Industries Batam, PCI Electronics International and Sumitomo Wiring Systems Batam. The fourth company, Prima Circuitama Indonesia, left Batam in the years after 2009. In the years after 1990 the E&E industry on Batam increased sharply. In 1991, the E&E industry already counted twenty companies. Some newcomers are Epson, Foster, Schneider Electric, Varta Batteries and Thompson. Seven of the sixteen new

companies are still present in 2012. Due to seven newcomers in 1992, the E&E industry further increased to a total of 27 companies. Of this group Fujitec, Polestar Plastics, Sanyo Energy and TEC Indonesia are nowadays still in operation. In the next two years, the E&E industry almost doubled (in comparison to 1992). In total 24 companies started operating on Batam (1993: fourteen new companies, 1994: ten new companies), including NIDEC Servo Batam, Sanwa Engineering, TEAC Electronics, Matsushita Batteries (Panasonic), Rubycon and Alps Electronic. Only seven of the 24 newcomers are still in operation in 2012: NIDEC Servo Batam, KEMET Electronics Indonesia, Sanwa Engineering, Singamip Coil Winding, TEAC Electronics, Excelitas Technologies and Rubycon. According to our data, in the period from 1994 to 1996 for the first time companies in the E&E industry started to leave Batam. Of course, meanwhile Batam still attracted a lot of new companies in the E&E industry. In these years Batam had to see three companies leaving, but still could welcome 33 new companies, a further increase of thirty companies. Newly settled companies during these years were Infineon Technologies, Siemens Hearing Instruments, Yokogawa Manufacturing and Western Digital. Remarkable is that only three companies of this large group of 33 are still in operation in 2012. During the next three years, from 1997 to 1999, the E&E industry on Batam continued to grow: 26 companies started operating, while eight companies stopped. Compared to 1996 the E&E industry experienced a growth of 24 percent to a total of 99 companies. Starting from scratch, in less than ten years, the E&E industry on Batam experienced a rapid development to almost hundred companies. The next decade, however, would not be so successful.

During the first years of the second decade the E&E industry of Batam experienced the same steady growth pace as during the previous decade. In 2000 24 companies started doing business, while eight companies left. Among others, SIIX Electronics, Global Rising Technologies, Copia, Sun Creation and Takamori located on Batam and were still in operation in 2012. In 2001 only nine new companies entered the E&E industry, while at the same time only two companies left. During 2002 and 2003 the E&E industry showed the same developments. In these two years seventeen companies opened their doors on Batam of which Asiatech Electronics, Atech Electronics, Hitech Displays, Sanmina-SCI and Acropolis Electroindo are still in operation in 2012, while only three companies closed down their business. In 2003 the E&E industry reached its highest point with as many as 134 companies (table 6.5). During the six year period from 2004 to 2009 the number of companies for the first time decreased to a total of 109. This period is characterized by as many as 46 companies closing down their businesses, while only 21 companies started operating. Among the newcomers were Panasonic, Epcos, Flextronics, Awatronics, Jovan Technologies and Xenon Technologies. From 2010 to 2012 the E&E industry experienced an even stronger decline. Only four new companies opened their doors in this period, while 51 companies left, a decline of more than 40 percent compared to 2009.

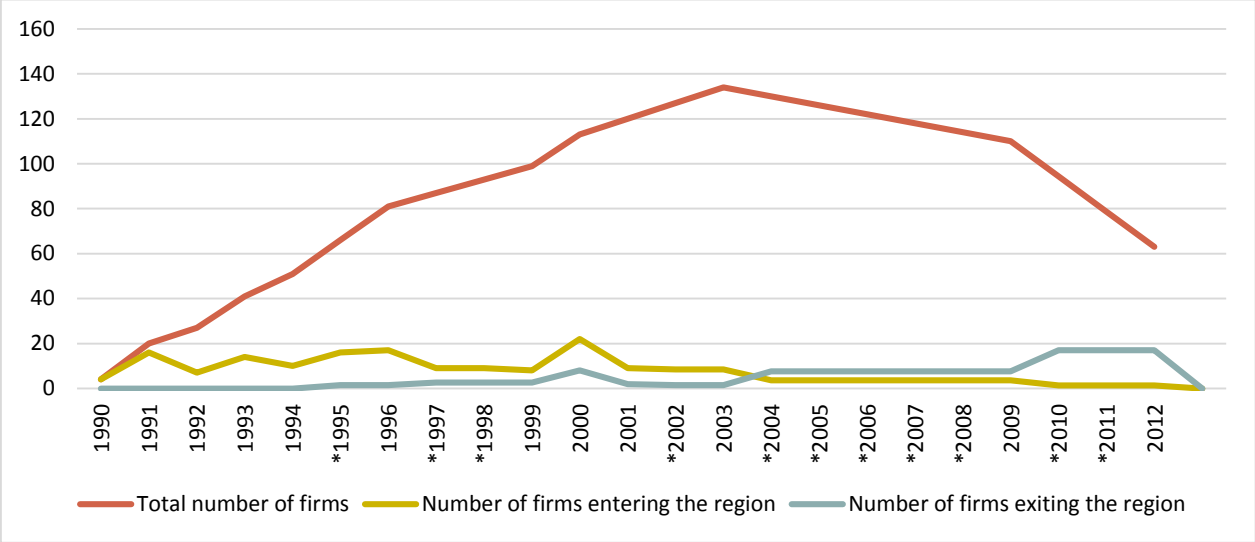
During these two decades, in total 196 MNCs were in operation on Batam. With a current total of 62 companies, this means that 134 companies entered and left the region within 23 years. According to our data, the E&E industry grew steadily to 134 companies in 2003, but fifteen years after the first companies entered, the E&E industry already starts to decline with the strongest decline in recent years (2010 to 2012)(figure 6.1).

Table 6.5: Annual evolution of the E&E industry on Batam between 1990 and 2012

Year	1990	1991	1992	1993	1994	1996	1999	2000	2001	2003	2009	2012
Total firms	4	20	27	41	51	81	99	113	120	134	109	62
Annual growth	N.A.	400%	35%	52%	24%	59%	22%	14%	6%	12%	-19%	-43%
Entries	4	16	7	14	10	33	26	22	9	17	21	4
Exits	0	0	0	0	0	3	8	8	2	3	46	51
Balance	4	16	7	14	10	30	18	14	7	14	-25	-47

Source: own data

Figure 6.1: total number of firms in the E&E industry on Batam from 1990-2012



*Source: own data *data not available*

6.3 CURRENT INDUSTRIAL COMPOSITION

According our data, the current E&E industry of Batam consists of 62 operational MNCs (table 6.5) of which forty companies are already in operation for at least ten years and seventeen companies already for at least twenty years. Of all MNCs 92 percent is involved in manufacturing and/or (sub)assembly activities. Besides manufacturing and/or (sub)assembly activities, some companies are also involved in testing, plastic injection, packaging and trading activities. Frequently manufactured and assembled products are printed circuit boards (PCB), cables, wires, wire harnesses, batteries, domestic (household), medical, and audio and video equipment. For the remaining eight percent the business activities are unknown. According to our data, BIFZA (2013) and Wong & Ng (2009) the E&E industry of Batam can thus broadly be divided in five branches (table 6.6).

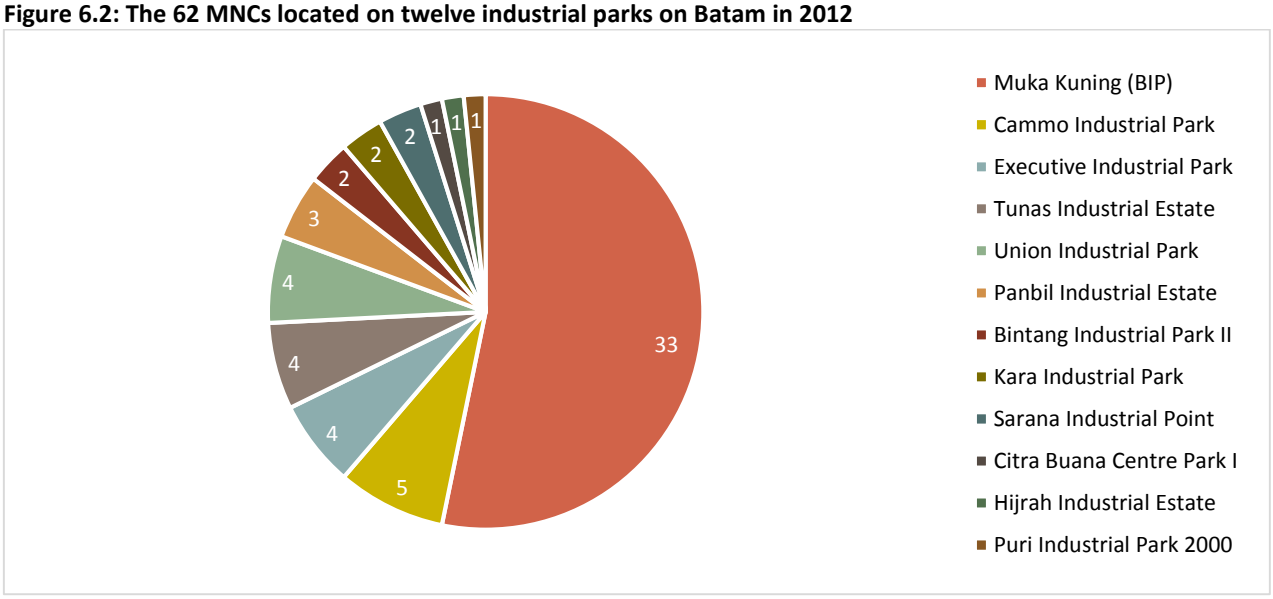
Table 6.6: Division of the E&E industry in branches

Branches:
1. Consumer electronics
2. Audio and video equipment
3. Automotive parts
4. Printed circuit board (PCB)
5. Other components and (electric and plastic) parts

Source: BIFZA, 2013

As described in chapter 4 Batam has 22 industrial parks. The firms in the E&E industry can only be found on twelve industrial parks (figure 6.2). The majority can be found on Batam's biggest industrial park: Batamindo Industrial Park (BIP), also known as Muka Kuning. 58 Percent of the companies in the E&E industry is located on BIP, for example Cicor ESG Panatec, Epson, Foster Electric, Fujitec, Infineon Technologies, NIDEC, Panasonic Shikoku Electronics, Sanwa, Schneider Electric, Siemens, Sumitomo Wiring Systems and Varta Batteries. The other parks are of less importance, but still represent some well-known companies in the E&E industry. Philips is currently in operation on Panbil Industrial Estate, Getronics and Jovan Technologies are located on Union Industrial Park, while OSI Electronics and Panasonic Electronic Devices are located on Cammo Industrial Park.

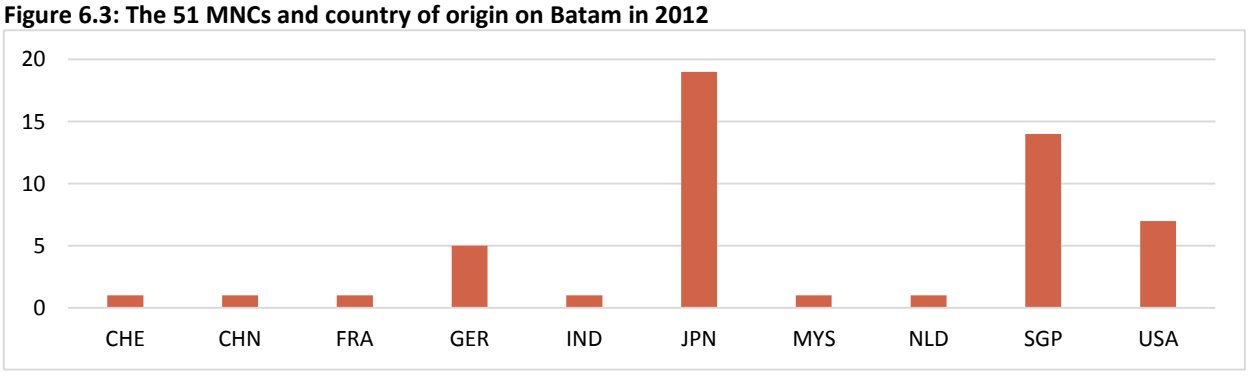
Figure 6.2: The 62 MNCs located on twelve industrial parks on Batam in 2012



Source: own data

For 51 companies of the total number of 62 MNCs in the E&E industry in 2012 the country of origin is known. When looking at the country of origin for these companies, the biggest group (19), which is 37 percent of the total number of companies, has its origin in Japan (figure 6.3). After Japan, Singapore is the most important country of origin, with fourteen companies (27%). Together, MNCs originated from these two countries have a share of 64 percent of the total number of companies in the E&E industry. Almost a quarter is originated from the USA (7) and Germany (5)(22%). Of the remaining six companies (12%) the countries of origin are divers: China, France, Indonesia, Malaysia, The Netherlands and Switzerland.

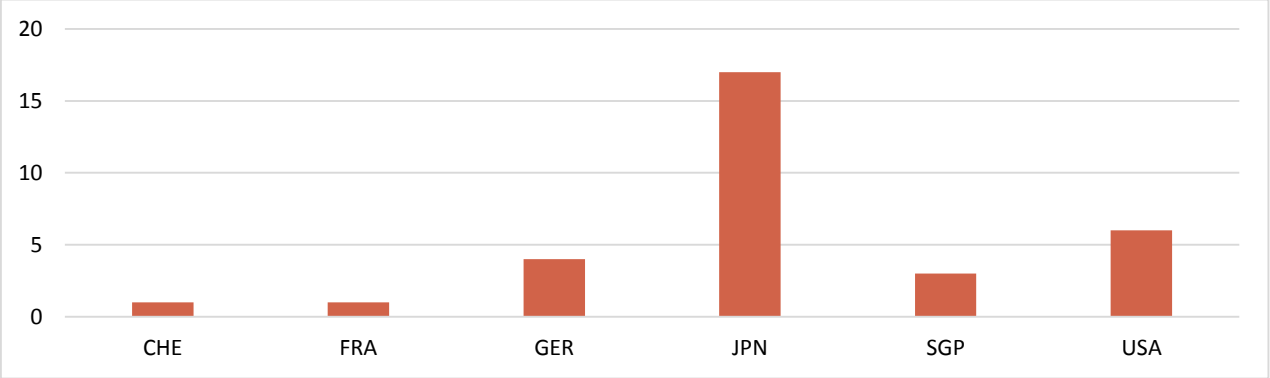
Figure 6.3: The 51 MNCs and country of origin on Batam in 2012



Source: own data

When taking a closer look at the country of origin of the companies on BIP the Japanese MNCs are strongly represented (figure 6.4). Of all 19 Japanese companies only two are located on other industrial parks. Remarkable is the low number of Singaporean companies (3) on BIP. The other eleven MNCs are distributed over eight industrial parks. In contrast, the vast majority of the MNCs from the USA and Germany are located on BIP. The only MNCs from France and Switzerland, Cicor ESG Panatec and Schneider Electric, are also located on BIP. Apparently, BIP is especially an attractive location for companies from outside Asia.

Figure 6.4: Country of origin of the 32 MNCs on Batamindo Industrial Park in 2012



Source: own data

6.4 EVOLUTION OF THE TECHNOLOGICAL COMPOSITION

Due to insufficient data it is difficult to get a good overview of the technological composition of the E&E industry of Batam. This is the reason why the technological composition is analyzed according to the most important companies (based on revenues and innovativeness) of E&E industry of Batam. In 1994 the technological composition is a group of thirteen interesting MNCs: AT&T, Casio, Epson, Fujitec, Kyocera, Nidec, Panasonic, Philips, Schneider Electric, Seagate, Telkomsel, Thomson, Varta Microbatteries (table 6.7). Of this group Casio, Epson, Kyocera, Panasonic, Philips, Thomson and Varta Microbatteries are all involved in the production of consumer electronics. AT&T and Telkomsel are both involved in telecom services. Seagate manufactures hard disk drives and Nidec produces electric motors for multiple appliances and are therefore both active in the electronic components branch. Fujitec is involved in the production of in a wide variety of (full) products: elevators, escalators, moving walkways. Schneider Electric is involved in appliances for energy control systems and is therefore active in the electronic components branch.

The technological composition of 2003 differs from that of 1994 and consists of twenty companies (table 6.7). Nine important players in the E&E industry start doing business on Batam while one company leaves, the newcomers are: ABB, Getronics, Hitachi, Infineon Technologies, Sanmina-SCI, Siemens, Sony and Yokogawa. Hitachi, Siemens and Sony entered the consumer electronics branch. ABB is active in energy and automation, Getronics and Yokogawa are both involved in measurement and control appliances, Infineon Technologies is active in semiconductors and Sanmina-SCI in PCB. They are all part of the electronic components branch. Before 2003 also one company left the region, this is Telkomsel. The technological composition of 2012 becomes smaller despite the two newcomers Epcos and Xenon Technologies and consists of fourteen companies (table 6.7). Both Epcos (sensors) and Xenon Technologies (flash lights) manufacture components. ABB, AT&T, Casio, Hitachi, Kyocera, Seagate, Sony and Thomson left Batam between 2003 and 2012.

The technological composition of important firms in the E&E industry changes (table 6.7). Epson, Fujitec, Nidec, Panasonic, Philips, Schneider Electric and Varta Microbatteries are important MNCs present during the whole time period from 1994 to 2012. During this period, the domination shifts from the consumer electronics branch to the electronic components branch. With a share of 57 percent this branch is currently the largest and it has been growing compared to 1994 (23%) and 2003 (40%). Declining branches are the telecom service branch that in 2012 is not present anymore, while in 1994 it has share of fifteen percent and in 2003 of five percent.

Table 6.7: Important companies of Batam's E&E industry in 1994, 2003 and 2012

Branch	1994 (13 firms)	2003 (20 firms)	2012 (14 firms)
Consumer electronics (full products)	Casio, Epson, Fujitec, Kyocera, Panasonic, Philips, Thomson, Varta Microbatteries	Casio, Epson, Fujitec, Hitachi, Kyocera, Panasonic, Philips, Siemens, Sony, Thomson, Varta Microbatteries	Epson, Fujitec, Panasonic, Philips, Siemens, Varta Microbatteries,
Telecom services	AT&T, Telkomsel	AT&T	
Electronic components (audio and video equipment, automotive parts, printed circuit board (PCB))	Nidec (electric motors), Schneider Electric (energy control), Seagate (HDD)	ABB (energy control), Getronics (measurement and control), Infineon Technologies (semiconductors), Nidec (electric motors), Sanmina-SCI (PCB), Schneider Electric (energy control), Seagate (HDD), Yokogawa (measurement and control)	Epcos (sensors), Getronics (measurement and control), Infineon Technologies (semiconductors), Nidec (electric motors), Sanmina-SCI (PCB), Schneider Electric (energy control), Xenon Technologies (flash light), Yokogawa (measurement and control)

Source: own data

6.5 CONCLUSION

This paragraph aims to answer the following sub question: how can the E&E industry of Batam be characterized from 1990 to 2012? When considering the evolution of the E&E industry of Batam from 1990 to 2012 one could notice that the E&E industry, as well as the whole economic development, of Batam is strongly influenced by the proximity of Singapore, since almost all MNCs are located on Batam as well as in Singapore. In absolute terms, the E&E industry of Singapore has grown through the years. However, in comparison with other manufacturing industries the position of the E&E industry has become of less importance. Since 1990 the composition of the E&E industry of Singapore has experienced major change. Of all branches within the E&E industry only the semiconductor branch is still growing, while the other branches (computer peripherals, consumer electronics, data storage and other electronics components) are strongly declining (Van Grunsven, 2013). Wong and Ng (2009) state that since 1998 also on Batam the E&E industry lost importance compared to other manufacturing industries. However, according to our data, the total numbers of MNCs in the E&E industry was still growing till 2003. From that moment the number of MNCs started to decrease with the strongest decline in recent years. Currently, the E&E industry of Batam counts 62 MNCs. Most of the subsidiaries are owned by Japanese and Singaporean MNCs (figure 6.3). Together, these two countries have a share of 64 percent of the total number of companies in the E&E industry. The subsidiaries of the MNCs in the E&E industry of Batam mainly focus on manufacturing and assembly of consumer electronics and electronic components. The E&E industry can thus be roughly divided into five branches: consumer electronics, audio and video equipment, automotive parts, printed circuit boards (PCB) and other components and parts (cables, wires, wire harnesses, sensors, connectors, etc.). The technological composition of the E&E gradually shifts from a domination of the consumer electronics branch to the electronic components branch. However, due to data limitations it is hard to determine whether industry-level upgrading has occurred. Therefore, it is necessary to analyze individual subsidiaries of MNCs in the E&E industry.

7. EVOLUTION OF SUBSIDIARIES IN THE E&E INDUSTRY

7.1 FINDINGS ON EVOLUTION AND UPGRADING

7.1.1 SUBSIDIARY EVOLUTION

GENERAL INFORMATION

Among the thirteen interviewed subsidiaries five are of Singaporean origin (Atech Electronics, Leonix, Awatronics, Jovan Technologies and Sanwa Engineering), three of Japanese origin (Epson, Sumitomo Wiring systems and Yokogawa) and two of German origin (Epcos and Infineon Technologies). The location of the parent companies of the other three subsidiaries are China (Amber Karya), France (Schneider Electric) and Switzerland (Cicor ESG Panatec). In total eight subsidiaries are greenfield investments, while five subsidiaries are acquisitions of other firms already located on Batam. The three Japanese subsidiaries are all greenfield investments established at the beginning of the 1990s (1990, 1991, 1995). From the five Singaporean subsidiaries four are greenfield investments established in the 2000s (2002, 2003 (2), 2008), while only one Singaporean subsidiary is an acquisition of another firm established in 1993. Infineon Technologies is a greenfield investment established in 1996, while Epcos is an acquisition established in 2008. However, the preceding firm already produced for the German multinational. Amber Karya (2012), Schneider Electric (1991) and Cicor ESG Panatec (2000) are all acquisitions of firms already located on Batam. Seven subsidiaries are located on Batamindo Industrial Park (BIP), among them all three Japanese subsidiaries, Sanwa Engineering, Infineon Technologies, Schneider Electric, Cicor ESG Panatec. The other Singaporean subsidiaries are distributed around several industrial parks such as Kara Industrial Park, Puri Industrial Park 2000, Citra Buana Centre Park I and Union Industrial Park. Amber kayra is located on Sarana Industrial Point and Epcos on Panbil Industrial Estate.

The number of workers per subsidiary varies between fifteen and 3200 with an average of 1067. The two German subsidiaries have a relative large workforce with 1950 and 3000 employees. Also the Japanese subsidiaries have a large workforce, but with more variety (350, 1400, 3200). Schneider Electric employs 1080 workers. The Singaporean subsidiaries have a relative small workforce with fifteen, sixty and 174 workers. Only Jovan Technologies employs 1200 workers. Amber Karya and Cicor ESG Panatec are in the middle with 250 and 432 workers.

FUNCTIONS

All thirteen subsidiaries are involved in production activities at the start of operating as well as at the present (table 7.1). Eleven subsidiaries are also responsible for procurement at the start as well as at the present. They have to take care of purchasing materials and/or spare parts whether or not in consultation with the (regional) headquarter.

Table 7.1 Evolution of the mix of functions per subsidiary

Mix of functions	(Number of subsidiaries) At the start	(Number of subsidiaries) At the present
Production, procurement	6	4
Production, procurement, sales/marketing	3	4
Production, procurement, sales/marketing, D&D	1	1
Production, procurement, R&D, D&D	1	2
Production, sales/marketing	1	1
Production, sales/marketing, R&D	1	0
Production, sales/marketing, R&D, D&D	0	1

Source: own data

About half of the subsidiaries (6) was involved in sales and marketing activities at the start of operating. Currently, there are seven subsidiaries involved in sales and marketing. Cicor ESG Panatec

and Leonix are the only subsidiaries involved in design and development (D&D) activities at the start of operating as well as at the present. Only the latter is also involved in research and development (R&D) activities at the start as well as at the present.

Three subsidiaries experienced upgrading of their charter (table 7.2). Jovan Technologies extended its function, besides production and procurement activities, with sales and marketing. Schneider Electric and Epcos acquired an extended charter for development activities. The former had no development activities at the start and is currently involved in R&D and D&D, while the latter only had R&D activities and is currently also involved D&D. Sanwa Engineering and Yokogawa Manufacturing experienced a change in activities which is not reflected in table 7.1: they has outsourced assembly activities to China and is only still involved in manufacturing.

Table 7.2 Functional upgrading in the E&E industry of Batam

Subsidiary	Mix of functions at the start	Mix of functions at the present
Epcos	Production, sales/marketing, R&D	Production, sales/marketing, R&D, D&D
Jovan Technologies	Production, procurement	Production, procurement, sales/marketing
Schneider Electric	Production, procurement	Production, procurement, R&D, D&D

Source: own data

PRODUCTS

The subsidiaries manufacture a wide variety of products though almost all manufacture components and parts instead of full products. Jovan Technologies and Schneider Electric produce connectors, Infineon Technologies produces semiconductors, Epcos produces sensors and Sanwa Engineering plastic parts, all for the electronics industry. Cicor ESG Panatec produces, besides plastic- and electric parts, also full products, namely face- and body shavers/treatment equipment. Epson produces scanners and ink cartridges and so-called devices (parts for ink cartridges). Amber Karya and Sumitomo Wiring Systems are involved in the production of wire harnesses and industrial (electric) cables. The former, for vending machines for brands such as Mars and Nespresso, the latter for the automobile industry for famous brands such as Daihatsu, Mitsubishi and Toyota. Atech Electronics and Awatronics Manufacturing manufacture and assemble printed circuit boards (PCBs). Leonix produces machines for the assembly of PCBs for the electronics industry, but also for the food and beverage industry. Finally, Yokogawa Manufacturing is involved in the production of distributed control systems (DCS) and optical time-domain reflectometers (OTDR).

About half of the subsidiaries (7) indicate to have experienced a change in the product portfolio since the start of operating (table 7.3), while the other half (6) indicate to have continuously produced the same products since their start. A couple of subsidiaries who did undergo changes expanded their product portfolio. Cicor ESG Panatec for example only produced parts, now it also produces full products. Epcos produced only sensors, now cables, probes and small systems are added to their portfolio. There can also be a change in the number of types. Jovan Technologies for example still produces connectors, but expanded the number of types overtime. A subsidiary can also produce the same product, but for an extra market. In this case, relatively small adoptions are already sufficient. For example, Leonix first produced machinery for the assembly of PCBs for the electronics industry and now also produces machinery for the assembly of PCBs for the food and beverage industry. Within some subsidiaries, an old product is replaced by a new one. However, the difference between the two products can be relatively small. For instance, Amber Karya started carrying out an extra, relatively simple, activity that adds more value to the end product. First, this subsidiary produced cut cables and wires and now it produces completely connected or assembled cables and wires. Only a few subsidiaries have experienced a radical change in the product portfolio and produce a completely new product. Yokogawa initially produced meters (for measurement) and power supply components and switched overtime to DCSs and OTDRs using related technology. Another example is Epson, where watches and ICs are replaced by scanners and ink cartridges. In this case, the link between the former and latter products is hard to recognize. The subsidiaries who experienced change differ a lot. They originate from Europe (Germany and Switzerland), East Asia

(China and Japan) and Southeast Asia (Singapore) and manufacture a wide variety of products, from components and parts to full products. There is no clear link with the branch they are operating in.

Table 7.3 Product upgrading in the E&E industry of Batam

Subsidiary	Product portfolio at the start	Product portfolio at the present
Amber Karya	Cut cables and wires	Assembled cables and wires
Cicor ESG Panatec	Parts	Parts and full (consumer) products
Epcos	Sensor	Sensors, cables, probes and small systems
Epson	Watches and ICs	Scanners and ink cartridges
Jovan Technologies	Connectors	Connectors
Leonix	Machines for PCBA for E&E	Machines for PCBA for food and beverages
Yokogawa Manufacturing	Meters and power supply compnents	Distributed control systems (DCS) and optical time-domain reflectors (OTDR)

Source: own data

A change in the product portfolio can be expressed in an improvement of the quality of the products (high-end) and the complexity of the products. Also the degree of specialization within the product portfolio can change. A change in the product portfolio does not necessarily have to be an improvement. Sometimes a subsidiary is forced to (depending on the decisions of the HQ) manufacture products with lower complexity and according to lower quality standards. But one could say that it would be everyone's purpose to strive for higher complexity and quality. Despite the fact that only seven subsidiaries indicate to have experienced a change in the product portfolio, nine subsidiaries claim to have experienced a change of the product portfolio from lower- to higher-end. Only Atech Electronics, Leonix, Sanwa Engineering and Sumitomo Wiring Systems indicate no change of the product portfolio as to low- or high-end. There were no subsidiaries that have experienced a change from higher- to lower-end products. When it comes to complexity of the product portfolio even ten out of the thirteen subsidiaries claim to have experienced a change from lower to higher complexity. The other three, Atech Electronics, Epson and Sanwa Engineering, experienced no change. Again, none of the subsidiaries experienced a change from higher to lower complexity. Regarding specialization, compared to quality and complexity only six subsidiaries indicate a change from a less to a more specialized product portfolio. Six others indicate that they did not experience a change in specialization. Only Leonix indicated that the product portfolio had changed from more to less specialized since it expanded its market scope. Only Atech Electronics (PCB) and Sanwa Engineering (plastic parts) indicate to have neither change in the product portfolio nor an increase in quality (high-end, complexity) or specialization.

PROCESSES

The subsidiaries' production processes can be characterized by the workforce and machinery. Interesting characteristics of the workforce are the average skill level of the employees, the ratio between technicians and assembly workers, foreign and domestic workers, and the number of engineers. For machinery the degree of sophistication and automation are relevant factors. Of course, also the ratio between labor and capital gives a good insight in the production process of the subsidiaries. The subsidiaries often have more low-skilled than high-skilled personnel. Seven subsidiaries indicate to have a workforce with 70 to 100 percent low-skilled and 0 to 30 percent high-skilled employees. Only Leonix and Yokogawa Manufacturing indicate to have a workforce with only 0 to 25 percent low-skilled and 75 to 100 percent high-skilled employees. For four subsidiaries the exact percentages of high- and low-skilled workers are unknown. The same distribution is applicable to the ratio between technicians and assembly workers. In total ten out of thirteen subsidiaries have no more than 30 percent technical workers versus at least 70 percent assembly workers (table 7.4). Again only Leonix and Yokogawa Manufacturing claim to have up to 80 percent technical workers versus no more than 20 percent assembly workers. For one subsidiary the exact percentages are unknown. A similar distribution is also applicable to the number of engineers within a subsidiary. Ten

subsidiaries have no more than 20 percent engineers. Only Leonix has between 20 and 40 percent engineers. For two subsidiaries this number was unknown.

Table 7.4: Share of technical workers compared to assembly workers

Technical vs. assembly workers	Number of subsidiaries
5% - 95%	3
10% - 90%	3
20% - 80%	2
30% - 70%	2
80% - 20%	2
Unknown	1

Source: own data

The number of foreign employees is extremely low. For seven subsidiaries the number of foreign employees stays below one percent. Four other subsidiaries a number of foreign employees between one and three percent. For only one subsidiary this number lies between three and seven percent. Again for one subsidiary the number of foreign employees was unknown. Foreign employees were mostly involved in management or technical functions and mostly originating from the countries of the parent company.

When it comes to the ratio between investments in machinery versus investments in labor it is clear that all subsidiaries consider machinery very important. Only Amber Karya (assembly of cables) indicate to invest relatively little in machinery in comparison to labor. While five subsidiaries have medium and even seven subsidiaries have high investments in machinery. Regarding the sophistication of the machinery the subsidiaries show a balanced situation. Six subsidiaries have medium sophistication of the machinery, while three subsidiaries have a low and four have a high sophistication of the machinery. Most subsidiaries (8) indicate to have a high automation of the production process. Only Cicor ESG Panatec, Epcos and Epson have a medium automation of the production process. All three subsidiaries were partially involved in assembly activities. Both wire and cable manufacturers, Amber Karya and Sumitomo Wiring Systems, have a low automation of the production process. The manufacturing and assembly of wires and cables are very labor-intensive activities. There is a clear trend that the process of further automation will continue. Most subsidiaries (9) expect to strongly increase the use of machines in the future. Awatronics Manufacturing and Infineon Technologies only expect a slight increase in the use of machines in the future. Only Leonix expect the number of machines to remain exactly the same, but instead the efficiency and productivity of the current machines will increase. The main reasons for this strong urge to advanced automation is mostly to make the production process more cost-efficient and productive. Machines have to replace the increasingly expensive labor. However, all subsidiaries are to a greater or lesser extent involved in assembly activities and Amber Karya and Infineon Technologies emphasize that certain assembly activities will remain manual processes so only limited automation will be possible. Other factors that force the subsidiaries to increase automation is an increase of production (whether or not because of higher client demand), technological developments or to increase flexibility.

TECHNOLOGY

The creation and acquisition of new technology is necessary to improve and optimize products and production processes. In a rare case a subsidiary is able to create new technology in-house, but most of the time the subsidiaries are forced to acquire new technology from other sources, such as their (R)HQ, clients and other subsidiaries within the MNC. When it comes to the acquisition of new product technology it is clear that most subsidiaries (9) get new technology from the headquarter (table 7.5), sometimes in combination with clients and suppliers (4). Remarkable are the three subsidiaries, Atech Electronics, Leonix and Sanwa Engineering, who only acquire new product technology from clients. These Singaporean subsidiaries possibly have a strong position within the

MNC and therefore less interference of the HQ. Only Awatronics Manufacturing indicates to neither acquire new technology from other sources nor create new technology itself.

Table 7.5: Acquisition of new product technology

Acquisition of new product technology	Number of subsidiaries
From the (R)HQ	4
From the (R)HQ/clients/suppliers	4
From the (R)HQ/other subsidiaries	1
From clients	3
No acquisition of new technology	1

Source: own data

For the acquisition of new process technology the (R)HQ is still very important. However, own development of new process technology is done by in total six out of thirteen subsidiaries (table 7.6). With the acquisition of new product technology in total seven subsidiaries indicate the importance of clients. Probably because clients' requirements have a strong influence on the final product. However, with acquisition of new process technology only three subsidiaries indicate the importance of clients. This can be explained by the fact that it is more likely that clients have knowledge about and requirements for products than processes, since the way of production is less important the client than the final product. The production process is therefore more a matter of the subsidiary. Again one subsidiary, Leonix, indicates to neither acquire new process technology from other sources nor create new technology in-house.

Table 7.6: Acquisition of new process technology

Acquisition of new process technology	Number of subsidiaries
From the (R)HQ	3
From the (R)HQ /own development	4
From the (R)HQ /clients	2
From the (R)HQ /other subsidiaries	1
From the (R)HQ /other subsidiaries/own development	1
From clients/own development	1
No acquisition of new technology	1

Source: own data

In-house development of new technology is very unfamiliar for the subsidiaries. Most of them (9) indicate not to be involved in research and development (R&D) and/or design and development (D&D) activities. The four subsidiaries who indicate to be involved in development activities, Cicor ESG Panatec, Epcos, Leonix, Schneider Electric, mostly do product adaption, often in direct cooperation with clients. They also perform some production process adaption, new production process development and only Epcos also performs little product development. The exact proportions of these development activities are unknown. Still it is remarkable that three of these subsidiaries originate from European MNCs. Only Leonix is Singaporean, but can act relatively independent. The Japanese subsidiaries seem to have less autonomy. However, practically all subsidiaries state to adjust their products (and sometimes processes) to clients' requirements, but some do not consider this actual R&D/D&D activities. That is the reason that almost all subsidiaries indicate not to have R&D/D&D workers. Though it is clear that almost all subsidiaries are involved in product and process adaption and product design. The subsidiaries (12) are not involved in the filing of patents. Only Leonix indicates to have patents, but the kind of patents and the importance are unknown.

MARKETS

As with the R&D/D&D activities, all subsidiaries indicate not to do sales and marketing activities and/or to have marketing workers, that's only a matter of the (R)HQ. However, many subsidiaries (9)

seem to maintain relation with already established clients. A few subsidiaries, Awatronics Manufacturing, Jovan Technologies and Leonix, also acquire new clients (3) and explore new markets (2) itself. Noteworthy is the fact that these are subsidiaries of Singaporean MNCs, often the only production facility outside Singapore. These subsidiaries probably have a strong position in the MNC. Epson (who indicate not to do any marketing activities) emphasizes the strong relations with (local) suppliers instead of clients (table 7.7).

Table 7.7: Number of subsidiaries with marketing activities

Marketing activities	Number of subsidiaries
Maintain relations (with established clients)	6
Maintain relations and acquire new clients	1
Maintain relations, acquire new clients and explore new markets	2
No marketing activities	4

Source: own data

The subsidiaries almost never have direct customers. Products are first shipped to distribution centers, (R)HQs or other subsidiaries within the MNC before they go to the customer. Among the customers of the parent company are some big names in a wide range of sectors (**table 7.8**) as well as remarkable and unexpected brands as Nespresso and Mars.

Table 7.8: Most important clients per branch and their country of origin

General electronics	Apple (USA), IBM (USA), Epson (JPN), Hi-P (SGP), Maxtor (USA), Molex (USA), OSI Electronics (SGP), Osram (DEU), Panasonic (JPN), PCI (SGP), Philips (NLD), Sanmina (USA), Sanyo (JPN), Schneider (FRA), Siix Electronics (JPN), TEC (SGP), Toshiba (JPN), TT-Electronics (UK)
Household appliances	Arcelik (TUR), Behr (DEU), Bosch (DEU), Danfoss (DNK), Electrolux (SWE), Fisher & Paykel (NZL), Indesit (ITA), Liebherr (DEU), Siemens (DEU), Whirlpool (USA)
Automotive	Audi (DEU), BMW (DEU), Continental (DEU), Daihatsu (JPN), Delphi (USA), Denso (JPN), Ford (USA), Mitsubishi (JPN), Renault (FRA), Tata (IND), Toyota (JPN), TRW Automotive (USA), Valeo (FRA), Visteon (USA), Volkswagen (DEU), Yatz Electronics (SGP)
Oil and gas processing	Esso (USA), Shell (NLD), Pertamina (IDN)
Construction solutions	Giken (JPN)

Source: own data

GROWTH AND EXPANSION

Most of the subsidiaries (10) experienced an increase of the production volume. Only Amber Karya and Leonix experienced a decrease of the production volume and for Infineon Technologies the production volume remained similar since the start of operating. An almost similar distribution is applicable to the change in employment. Most subsidiaries (8) experienced a increase of employment. For Sanwa Engineering and Yokogawa Manufacturing the employment decreased. However, their production volume increased which could indicate an increase in productivity. For both subsidiaries the decrease in employment is caused by the outsourcing of assembly to China. Despite a decrease of the production volume, the number of employees of Leonix remained unchanged. Remarkable are two subsidiaries, Amber Karya and Epcos, who emphasize that the number of employees depends on and follows economic cycles with ups and downs, and therefore increases as well as decreases overtime. Nine subsidiaries have had a physical expansion since the start of operating including all European and Japanese subsidiaries. All expansions took place on the same location as where the subsidiary is currently located. From the other four subsidiaries who have not had a physical expansion, Amber Karya, Atech Electronics, Leonix and Sanwa Engineering, yet only Atech and Sanwa experienced an increase of the production volume, but an expansion in the number of buildings was not necessary. The main reason for physical expansion was an increase of production, often related to an increase of clients' demands, but sometimes because of an improved

charter. Another reason was to improve the production process or so to say optimize the production 'flow.'

CAPABILITIES

The distinction between different kinds of manufacturing can help explain the capabilities of the subsidiaries. The first kind of manufacturer is the original equipment manufacturer (OEM). This kind of manufacturer only manufactures components and parts and assembles these to final products. In the next stage, a subsidiary can be an original design manufacturer (ODM) and can besides manufacturing also be involved in design and development activities (in-house). In the last stage the subsidiary can become an original brand manufacturer (OBM) who is responsible for full manufacturing, research and development, marketing under their own brand. However, components and parts of the final product can be and often are produced by OEMs and ODMs. Seven subsidiaries consider themselves OEMs. They produce components and parts (connectors, wires, cables, sensors etc.) for other companies. None of the subsidiaries consider themselves full ODMs, but four subsidiaries, Cicor ESG Panatec, Epcos, Leonix and Sanwa Engineering see themselves as a combination of OEM and ODM. Only Schneider Electric and Yokogawa Manufacturing manufacture products under their own brand and consider themselves as OBM. Yokogawa Manufacturing indicate to produce all components and parts of the final product in-house, while Schneider Electric procures components and parts from suppliers. However, Epson can also be considered an OBM since it produces ink cartridges and scanners under the name of Epson.

When considering the production capabilities, a distinction between low-, mid- and high-end production is possible. On a scale from 'very bad' to 'very good,' nine subsidiaries think their low-end production skills are good, while the other four subsidiaries, Epson, Infineon Technologies, Sumitomo Wiring Systems and Yokogawa Manufacturing, do not consider themselves as manufacturer of low-end products (table 7.9). When it comes to mid-end production also nine subsidiaries think their skills are good. However, two subsidiaries are neutral about their skills, while Amber Karya think their mid-end production skills are bad. Seven subsidiaries do not consider their products as high-end. The other six subsidiaries who do consider themselves as manufacturer of high-end products also think their good at it.

Table 7.9: Low-end, mid-end and high-end production capabilities

Evaluation of capabilities	Low-end	Mid-end	High-end
Very bad	0	0	0
Bad	0	1	0
Neutral	0	2	0
Good	3	2	2
Very good	6	7	4
Not applicable	4	1	7

Source: own data

Subsidiaries create and/or absorb new product and process technology. The lack of new product and process technology creation within the subsidiaries follows the lack of actual R&D/D&D activities. Instead, subsidiaries get new technology mostly from their (R)HQ and clients (table 7.10). All subsidiaries consider themselves flexible. Four think they are good, while nine think they are very good in flexibility.

The most important learning process is intra-establishment labor training. All subsidiaries provide employees with in-house labor training. New employees normally have little to no related education and experience and therefore get a training of a couple of weeks depending on the type of job. Many subsidiaries (10) also have intra-company protocol transfer. A protocol contains guidelines according to which a subsidiary has to operate. Only four subsidiaries, Epcos, Epson, Schneider Electric and Sumitomo Wiring Systems (European and Japanese), develop such a protocol for in-house use only. Normally the intra-company protocol is already seen as sufficient, especially in the

subsidiaries of Singaporean MNCs. Five subsidiaries recruit specifically skilled labor. Only Epcos claims to be involved in governmental education programs.

Table 7.10: New product and process technology absorption and creation capabilities

Evaluation of capabilities	Absorption		Creation	
	Product	Process	Product	Process
Very bad	0	1	0	0
Bad	0	1	1	3
Neutral	0	0	0	0
Good	10	8	3	4
Very good	2	2	1	0
Not applicable	1	1	8	6

Source: own data

Most subsidiaries (11) have very specialized focus. They execute only a limited number of activities, such as manufacturing and assembly, on a limited number of products, such as connectors and sensors. So their scope is rather narrow. On the other hand, Cicor ESG Panatec manufactures not only components and parts, but also assembles final products, ready for the market. Their scope is rather wide, but not really deep and specialized. Yokogawa Manufacturing thinks it has the combination of a wide scope as well as a very deep and specialized focus. This subsidiary also manufactures components and parts and assembles them to full products, but these products are rather sophisticated.

Twelve subsidiaries have obtained quality control certificates. Only Leonix has no certificates. The most common certificates are ISO 9000, obtained by ten subsidiaries, and ISO 14000, obtained by eight subsidiaries. Other obtained but less common certificates are OHSAS 18001 (3), ISO 13485 (2), ISO 16000 (1) and ISO/TS 16949 (1). All subsidiaries consider the quality control certificates as very important. The main reason for the importance of quality control certificates are the guarantee of quality of the products and production processes by following international standards. In fact, the control certificates are basic requirements of and satisfactory to clients and customers.

Most of all the key asset to profitability on Batam is the proximity to and the connectivity with Singapore. Many subsidiaries have a (R)HQ, R&D/D&D facility, associated subsidiaries and/or distribution center in Singapore. Singapore is the main source of investments and provides many services to MNCs located on (both Singapore and) Batam. For subsidiaries with a less clear link Singapore remains important. Practically all subsidiaries first ship their products to Singapore before shipping it to other locations worldwide. Twelve subsidiaries named the proximity to Singapore to be an important asset. Another important asset is cost advantages. Batam provides not only low labor costs, but also low facility costs, low utility costs and attractive tax rates. Ten subsidiaries think costs advantages are important for profitability. Finally, characteristics of the labor force are also considered to be an asset of Batam. Batam has a high labor availability, the workers are qualified enough and their cultural background is conducive. Three subsidiaries emphasize the conduciveness of Batam's labor force characteristics.

7.2 UNDERSTANDING SUBSIDIARY EVOLUTION

7.2.1 REGIONAL CHARACTERISTICS

When considering the role of the local environment for the functioning and upgrading of the subsidiary, nine subsidiaries attach very little value to the local environment. Subsidiaries state that the business environment of Batam improves slower than the business environment of China. Besides, the Singaporean local environment is more conducive for the functioning and especially upgrading, because of incentives for R&D. However, four subsidiaries indicate the importance of the local environment for functioning and upgrading. For example, Cicor ESG Panatec state that the "local government cares more than before." The following sections elaborate on the importance and

the evaluation of multiple indicators of the local environment that can possibly have influence on the functioning and upgrading of subsidiaries.

LABOR, INFRASTRUCTURE AND CONNECTIVITY

Ten firms indicate that the availability of labor is important, two are neutral. Only Yokogawa Manufacturing consider the availability of labor as very unimportant. When looking at the importance of labor costs two subsidiaries indicate this as unimportant, two are neutral, while nine subsidiaries evaluate labor costs as important. Also labor skills are generally seen as important factors for the functioning and upgrading of the subsidiary. However, Amber Karya and Leonix consider labor skills as unimportant (table 7.11).

The physical infrastructure is of high importance; three subsidiaries are neutral, but ten consider infrastructure important. Remarkable is the level of importance of the international connectivity; all thirteen subsidiaries indicate this as important and twelve even as very important. In contrast, the local and national connectivity are of much less importance. Only Sumitomo Wiring Systems indicates the national connectivity as important (table 7.11). The other subsidiaries indicate the national connectivity as neutral or unimportant. The local connectivity is considered more important than the national connectivity. Schneider Electric indicates the local connectivity as very important, 35 percent of total output of Schneider is for local customers on Batam. Most other subsidiaries consider the local connectivity as neutral to the functioning an upgrading of the subsidiary (table 7.11).

Table 7.11: Importance of labor, infrastructure and connectivity

Importance	Labor			Infrastructure	Connectivity		
	Availability	Costs	Skills	Physical	International	National	Local
Very unimportant	1	0	0	0	0	3	0
Unimportant	0	0	2	0	0	4	1
Neutral	2	1	2	3	0	5	8
Important	7	5	8	6	1	1	3
Very important	3	7	1	4	12	0	1

Source: own data

The availability of labor on Batam is evaluated as neutral (7) or important (6)(table 7.12). Atech Electronics states to find trainable employees easily. Despite that Infineon Technologies, Cicor ESG Panatec and Schneider Electric confirm this statement, they also point out that it is hard to find higher-educated employees. Notable is the difference between the importance and the evaluation of labor costs. While together twelve subsidiaries indicate the labor costs as important, only seven subsidiaries evaluate the labor costs as good. The remaining six subsidiaries evaluate the labor costs on Batam as neutral. Jovan Technologies and Schneider Electric state that the labor costs on Batam are rapidly rising, while almost ten subsidiaries state that labor costs are a key asset for the competitiveness of the subsidiary and profitability on Batam. Labor skills are mainly evaluated as neutral or good, only Schneider Electric, Infineon Technology and Leonix evaluate this as bad.

The physical infrastructure is seven times evaluated as neutral and six times as good. Atech Electronics mentions the traffic jams, but they do not hinder the traffic flow very much. The evaluation of international connectivity is exactly the same as the indicated importance. Twelve subsidiaries assess the international connectivity as very good, one subsidiary as good. The national connectivity is not evaluated as good. Only Sumitomo Wirings Systems considers the national connectivity as good. Eleven subsidiaries assess this topic as neutral, while Jovan Technologies considers the national connectivity as very bad.

Table 7.12: Evaluation of labor, infrastructure and connectivity

Evaluation	Labor			Infrastructure	Connectivity		
	Availability	Costs	Skills	Physical	International	National	Local
Very bad	0	0	0	0	0	1	0
Bad	0	0	3	0	0	0	0
Neutral	7	6	4	7	0	11	9
Good	4	5	6	6	1	1	3
Very good	2	2	0	0	12	0	1

Source: own data

TECHNOLOGY BASE

When considering the importance of the technology base for the functioning and in situ upgrading of the subsidiaries, generally the subsidiaries indicate labor training institutions, research institutions, educational institutions and government technology programs as unimportant or very unimportant upgrading (table 7.13). These institutions and technology programs are mainly evaluated as unknown, bad or very bad because the regional environment of Batam lacks these institutions but at the same time they don't connect to the type of functions carried out by the establishments (table 7.13). In contrast, seven subsidiaries indicate technology from other firms as import or very import. Remarkable is that both Infineon Technologies and Atech Electronics consider these technology transfers very important but evaluate these transfer as neutral and bad. Furthermore, from the 5 subsidiaries that indicate technology transfers from other firms as important it is evaluated 3 times as good, one as neutral and one as bad.

Table 7.13: importance and evaluation of the knowledge infrastructure

Importance of knowledge	Number of subsidiaries	Evaluation of knowledge	Number of subsidiaries
Very unimportant	4	Very bad	0
Unimportant	2	Bad	4
Neutral	1	Neutral	1
Important	1	Good	1
Very important	2	Very good	0
Unknown	3	Unknown	7

Source: own data

LOCAL SUPPLIERS

The quality and diversity of local suppliers is mainly indicated as important or very important for the functioning and upgrading of the establishments (table 7.14). 7 Subsidiaries evaluate the quality of local suppliers good, 3 neutral and 3 don't know. The evaluation of the diversity of local suppliers is a little more diverse. One subsidiary evaluates this topic as very bad, 1 as bad, 4 as neutral, 3 as good. 4 Subsidiaries indicate that they don't know about the extent of diversity of local suppliers. The 8 subsidiaries that indicate the quality of local supplier as important or very important evaluate it mainly positive; 6 times as good, 2 times as neutral and 1 time as unknown. This is in contrast with the more negative evaluation of the diversity of local suppliers (table 7.14). Only 3 of the 8 subsidiaries that indicate the diversity of local suppliers as important, evaluate it as good, 2 evaluate it as neutral, Jovan Technologies and Leonix, evaluate the diversity respectively as bad and very bad, one is unknown.

Table 7.14: importance and evaluation of the quality and diversity of the local suppliers

Quality local suppliers			
Importance	**Number of subsidiaries**	**Evaluation**	**Number of subsidiaries**
Very unimportant	0	Very bad	0
Unimportant	0	Bad	0
Neutral	2	Neutral	3
Important	7	Good	7
Very important	2	Very good	0
Unknown	2	Unknown	3

Source: own data

Table 7.15: Importance and evaluation of the diversity of the local suppliers

Diversity local suppliers			
Importance	**Number of subsidiaries**	**Evaluation**	**Number of Subsidiaries**
Very unimportant	0	Very bad	1
Unimportant	1	Bad	1
Neutral	2	Neutral	4
Important	2	Good	3
Very important	0	Very good	0
Unknown	2	Unknown	4

Source: own data

NATIONAL AND LOCAL GOVERNMENT

When comparing the importance of the national government and the regional government, it becomes clear that the regional government plays a more important role for the functioning of the establishments and upgrading than the national government (table 7.16 & 7.17).

Table 7.16: Importance of national government characteristics

Importance	Efficiency	Policies & incentives	Pro-activeness	Political stability	Interaction potential
Very unimportant	0	0	0	0	0
Unimportant	4	3	5	2	4
Neutral	3	6	3	5	5
Important	3	1	2	3	1
Very important	0	0	0	0	0
Unknown	3	3	3	3	3

Source: own data

Table 7.17: Importance of local government characteristics

Importance	Efficiency	Policies & incentives	Pro-activeness	Political stability	Interaction potential
Very unimportant	1	1	1	1	1
Unimportant	0	0	0	3	1
Neutral	2	8	5	3	3
Important	9	2	6	5	7
Very important	0	1	0	0	0
Unknown	1	1	1	0	1

Source: own data

On each of the five indicators: efficiency, policies & incentives, pro-activeness, stability and interaction potential, the subsidiaries indicate that the regional government is more important than the national government. While the majority of the subsidiaries are neutral or believe that the role of the national government is unimportant, they are neutral or believe that the role of regional government is important. Most important for the regional government to be according the

subsidiaries is efficiency, also the interaction potential and pro-activeness are indicated as important. Less but still important on the regional level are policies & incentives and political stability.

When evaluating the national government on these five indicators the vast majority gives an evaluation of indicators as neutral or unknown (table 7.18). This in combination with the fact that the subsidiaries often indicate the national government as unimportant, it looks like not many firms have experiences with the national government. Nevertheless three subsidiaries see political stability in Indonesia as important for the functioning of the establishments and upgrading.

Table 7.18: Evaluation of national government characteristics

Evaluation	Efficiency	Policies & incentives	Pro-activeness	Political stability	Interaction potential
Very bad	0	0	0	0	0
Bad	1	2	2	1	1
Neutral	6	6	3	5	4
Good	0	0	2	4	1
Very good	0	0	0	0	0
Unknown	6	5	6	3	7

Source: own data

On regional level 2 subsidiaries weren't able to evaluate the regional policy. The other subsidiaries evaluate efficiency (7 times), policies & incentives (9 times) and pro-activeness (6 times) mainly as neutral. The efficiency is also 3 times evaluated as good. Only Leonix evaluates the efficiency of the regional government as bad. The other Singaporean subsidiaries evaluated this topic 2 times as neutral 2, once as good and once as unknown. Pro-activeness is besides the neutral evaluation, also 4 times as good an one time as bad evaluated (table 7.19).

Table 7.19: Evaluation of regional government characteristics

Evaulation	Efficiency	Policies & incentives	Pro-activeness	Political stability	Interaction potential
Very bad	0	0	0	0	0
Bad	1	1	1	1	1
Neutral	7	9	6	2	4
Good	3	1	4	8	6
Very good	0	0	0	0	0
Unknown	2	2	2	2	2

Source: own data

Remarkable is that the regional political stability is evaluated 8 times as good while for the national government this was only evaluated 4 times as good. Only Epcos experiences the political stability as bad. The interaction potential of the regional environment matches well with the interest attached to this interaction potential. 6 Subsidiaries experience the interaction potential of the regional government as good, 4 times as neutral, 1 time as bad and 2 times unknown.

LIVING ENVIRONMENT

When it comes to the influence of the living environment on the functioning and upgrading of the establishments schooling, congestion, crime and health-care facilities are, according to the subsidiaries, the most important elements of the living environment. Cultural amenities, pollution and housing are less important for the functioning and upgrading of the establishment (table 7.20). When evaluating these factors the vast majority of the subsidiaries evaluate the cultural amenities as bad. Furthermore no other elements of the living environment are evaluated as bad. The subsidiaries are most satisfied about crime, pollution and housing and mainly neutral about congestion, health-care facilities and schooling table (7.21).

Table 7.20: Importance of living environment characteristics

Living environment	Pollution	Congestion	Crime	Cultural amenities	Housing	Health-care facilities	Schooling
Very unimportant	5	0	0	2	0	1	1
Unimportant	1	1	3	7	5	4	3
Neutral	3	5	3	3	4	2	1
Important	4	7	7	0	4	6	8
Very important	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0

Source: own data

Table 7.21: Evaluation of living environment characteristics

Living environment	Pollution	Congestion	Crime	Cultural amenities	Housing	Health-care facilities	Schooling
Very bad	0	0	0	0	0	0	0
Bad	0	0	0	9	2	1	2
Neutral	5	8	1	2	4	7	7
Good	7	4	8	0	6	4	3
Very good	0	0	3	0	0	0	0
Unknown	1	1	0	2	1	1	1

Source: own data

7.2.2 REGIONAL PRODUCTION NETWORKS

MNC'S ECONOMIC ACTIVITIES IN SINGAPORE

The RPNs in Southeast Asia of fifty MNCs in the E&E industry of Batam is known. These MNCs own (including the Batam subsidiaries) in total 63 establishments in Indonesia. Only seven MNCs own more subsidiaries in Indonesia than only their Batam subsidiary. Remarkable is the fact that almost all MNCs (48) own one or more subsidiaries in the nearby city-state of Singapore (table 7.22). These MNCS have in total 64 subsidiaries in Singapore. MNCs often locate their (R)HQ, R&D or distribution centers in Singapore. All MNCs with Singaporean origin located their headquarters in Singapore. Four companies with origins outside Singapore located their headquarters in Singapore as well. These are Hi-tech Displays from Malaysia, PCI Limited and Flextronics from the USA and Xenon Technologies from Germany. In addition, Flextronics also allocated an R&D centre in Singapore. Also NIDEC, Philips, Infineon, Sanmina-SCI, Siemens, SIIX Electronics, Primo Microphones and Toshiba TEC have R&D activities in Singapore. Eight MNCs located their RHQ in Singapore. These are the Zhongli Group, Cicor Technologies, Seiko Epson, NOK, OSI Electronic, Philips Consumer Lifestyle, Yokogawa and Infineon Technologies.

Table 7.22: Functions of MNCs located in Singapore

Functions	Number of MNCs with establishments in Singapore
One or more subsidiaries	48
Headquarter (HQ)	18
Regional headquarter (RHQ)	8
Research and development (R&D)	9
Sales and marketing	13
Manufacturing and assembly	7

Source: own data

Only three Japanese MNCs have established their regional headquarters in Singapore. From the other five MNCs that allocated their regional headquarters in Singapore, Cicor Technologies, Infineon Technologies and Philips have their origins in Europe, while OSI Electronic has its origins in the USA

and Zhongli in China. While only three Japanese MNCs have their regional headquarter allocated in Singapore, eight Japanese MNCs have sales activities in Singapore. In addition, the MNCs from Germany, Infineon Technologies, TDK-EPC and Siemens, and the MNCs from the USA, Excelitas Technologies and KEMET Electronics also have sales activities located in Singapore. Finally, seven companies have manufacturing and assembly activities located in Singapore. These are Fujitec, Panasonic Electronic Devices, Panasonic Shikoku Electronics, Toshiba TEC and Yokogawa Manufacturing from Japan and IntriCon and Sanmina-SCI from the USA.

MNC'S ESTABLISHMENTS IN ASIA-PACIFIC

According to our data, the fifty MNCs in the E&E industry on Batam own in total 573 subsidiaries dispersed over seventeen countries in the Asia-Pacific region: Singapore, Indonesia, Malaysia, Japan, China, Hong Kong, India, Philippines, Taiwan, Korea, Thailand, Vietnam, Cambodia, Sri Lanka, Myanmar, Australia and New-Zealand. The eighteen Japanese MNCs collectively have 386 subsidiaries (67%) in the Asia-pacific region. This is an average of 21 subsidiaries per MNC. The fourteen Singaporean MNCs have 51 subsidiaries (9%). The average number of subsidiaries per Singaporean MNC is about four. The eight European MNCs together own about 79 subsidiaries (14%) from which 54 are German (9%), twelve French (3%), eight Dutch (1%) and five Swiss (1%). This is an average of ten subsidiaries per MNC in the Asia-Pacific region. The seven American MNCs have 64 subsidiaries (11%). That's an average of about nine subsidiaries per MNC. Finally, the only Chinese MNC, Zhongli Sci-Tech, owns nine subsidiaries, while the only Indonesian MNC, HW-Genting and the only Malaysian MNC, H-Displays, both own three subsidiaries in the Asia-Pacific region. There are nine MNCs with more than twenty subsidiaries in Asia: Foster Electric (25 subsidiaries), Flextronics (27 subsidiaries), Siemens Healthcare (28 subsidiaries), Panasonic Sanyo (29 subsidiaries), Seiko Epson (30 subsidiaries), Panasonic Electronic Devices (32 subsidiaries), SIIX Electronics (36 subsidiaries), Yokogawa Electric (40 subsidiaries) and Sumitomo Wiring Systems (86 subsidiaries).

The largest share of these subsidiaries are located in China and Japan. Japan houses 146 and China 147 subsidiaries. Of these 146 subsidiaries in Japan, 137 (94%) are owned by Japanese MNCs. With 29 establishments Sumitomo Wirings Systems owns the most subsidiaries in Japan. Panasonic Electronic Devices has nineteen and Seiko Epson Corporation sixteen subsidiaries. The other Japanese MNCs each own less than fifteen subsidiaries. The remaining part of the subsidiaries is owned by German (4%) and American (2%) MNCs.

Also in China the largest share of subsidiaries (64%) is owned by Japanese MNCs, with in total 94 subsidiaries. Again, Sumitomo Wiring Systems has the most subsidiaries (26). Zhongli Sci-Tech is the only Chinese MNC in the E&E industry on Batam and owns seven subsidiaries in its home country. Remarkable is that the Japanese MNCs Yokogawa Electric, SIIX Electronics and Foster Electric all own more subsidiaries in China than in their homeland. Yokogawa Electric owns nine subsidiaries in China and three in Japan, SIIX Electronic has twelve Chinese subsidiaries and five in Japan and Foster Electronic has eight subsidiaries in host country China and seven in its homeland. Five American MNCs together established 26 subsidiaries in China, that is a share of 18 percent. With a total of fourteen Flextronics has the biggest American share in Chinese subsidiaries. Sanmina-SCI owns five and KEMET has three subsidiaries in China. PCI Limited has one establishment in China. Five German MNCs together own 7 percent (10 subsidiaries) of the total subsidiaries in China. Of these ten, six are owned by TDK-EPC. The remaining subsidiaries in China are owned by four Singaporean MNCs (5%), Philips from the Netherlands two subsidiaries (1%) and the Swiss MNC Cicor Technologies one subsidiary (0,5%).

Furthermore twenty to thirty subsidiaries are to be found in Thailand, The Philippines, Vietnam, India and Malaysia. The vast majority of the Thai (85%), Philippian (84%) and Vietnamese (68%) subsidiaries are in particular owned by the Japanese MNCs while the majority of the Indian subsidiaries are owned by European MNCs (50%) of which are 23 percent from France, 23 percent from Germany and four percent from The Netherlands. Looking closer at Thailand no other subsidiaries of Asian MNCs can be found. The remaining fifteen percent is distributed over the German (10%) and American MNCs (5%). Also in The Philippines the remaining part is distributed

over the German (4%) and American MNCs (12%). In Vietnam the German MNCs are with 27 percent stronger represented than in Thailand and The Philippines. One subsidiary from Swiss origin is presented (5%). Although the Japanese MNCs have the biggest share in subsidiaries in Malaysia (44%), with 25 percent the Singaporean MNCs are strongly overrepresented. Also the American MNCs are overrepresented in Malaysia (19%). The remaining subsidiaries are of German (6%), Indonesian (3%) and Malaysian (3%) origin.

In Taiwan fifteen and in Korea and Hong Kong both fourteen subsidiaries are in operation. With sixty percent (9 subsidiaries) the Japanese MNCs are relative underrepresented while with about fourteen percent (2 subsidiaries) the German MNCs are a little overrepresented. The remaining subsidiaries are owned by Indonesian and American MNCs. In Korea the Japanese MNCs are strongly overrepresented, together they own about 86 percent of all the subsidiaries. The two other subsidiaries are owned by Siemens Healthcare. However, in Hong-Kong the position of the Japanese MNCs is less influent while they own 57 percent of the subsidiaries here. The American MNCs are strongly represented in Hong-Kong with about 21 percent. The remaining subsidiaries are of German (14%) and Singaporean (7%) origin.

In total only fifteen subsidiaries are to be found in Australia, New-Zealand, Cambodia, Sri Lanka and Myanmar. Notable is that in these five countries only three European and two Japanese MNCs have subsidiaries in operation. In Australia nine establishments can be found Schneider Electric owns four, Sumitomo Wirings Systems and Yokogawa Electric both own two, Philips Consumer Electronics owns one. In New-Zealand two subsidiaries are to be found and are both owned by Yokogawa Electric. The only two subsidiaries Cambodia are owned by Philips Consumer Lifestyle and Sumitomo Wiring Systems. In Myanmar one subsidiary is to be found and is owned by Philips Consumer Lifestyle. The one subsidiary in Sri Lanka is owned by Siemens Healthcare. When looking closer at the fourteen Singaporean MNCs and its 51 subsidiaries in Southeast Asia it's noteworthy that the MNCs mainly invest in neighboring countries. The main part of the Singaporean subsidiaries can be found in Singapore itself (39%). However, the major part of the Singaporean subsidiaries, 45 percent, can be found in the two neighboring countries Indonesia (29%) and Malaysia (16%). Fourteen percent of the subsidiaries can be found in China, two percent in Hong Kong.

REGIONAL PRODUCTION NETWORKS

For the thirteen interviewed subsidiaries (based on the interviews and company websites) their Southeast Asian RPNs are mapped (table 7.23). The vast majority has strong linkages with Singapore; twelve companies own an establishment in Singapore whereof eleven are an HQ (4) or RHQ. The four headquarters in Singapore are owned by Singaporean MNCs. Exceptions are Awatronics, this company located its management functions on Batam and its sales and R&D activities in Singapore and EPCOS that located sales and R&D activities in Singapore and only has a headquarter in Germany. Eight other MNCs did locate their headquarter in the country of origin. The three Japanese MNCs, Amber Karya, Cicor ESG panatec, Infineon Technologies and Schneider Electric have an RHQ in Singapore.

When comparing the RPNs of the Singaporean MNCs it is remarkable that their production networks strongly correspond with each other. The Singaporean MNCs are the smallest companies according to number of subsidiaries. Atech Electronics, Awatronics Manufacturing, Jovan Technologies and Leonix all have one or two establishments in Singapore and only own one foreign subsidiary, located on Batam. An exception is Sanwa Engineering that owns two Indonesian, three Malaysian and three Chinese subsidiaries.

Amber Karya, Epson and Sumitomo Wiring Systems have most establishments in their home country. Instead, Yokogawa has more subsidiaries in the host countries China and Malaysia. When looking closer at the three Japanese MNCs Yokogawa equally distributed its thirty-one establishments across twelve different countries. Exception is China with nine subsidiaries. The subsidiaries of Sumitomo Wiring Systems are less equally distributed. Of the 86 subsidiaries 55 are to be found in Japan (29) and China (26) the remaining 41 subsidiaries are spread over eleven other countries with peaks in the Philippines (8) and Vietnam (5). Epson's RPN is most unevenly distributed,

the thirty subsidiaries can be found in six companies. Most subsidiaries are allocated in Japan (16) and China (8). The remaining establishments are to be found in Singapore, Indonesia, Malaysia and the Philippines. Noteworthy is that all three Japanese MNCs invest in Malaysia and Philippines while in these countries only twenty to thirty subsidiaries of the total subsidiaries of the fifty MNCs can be found.

Table 7.23: Regional production network of the interviewed subsidiaries

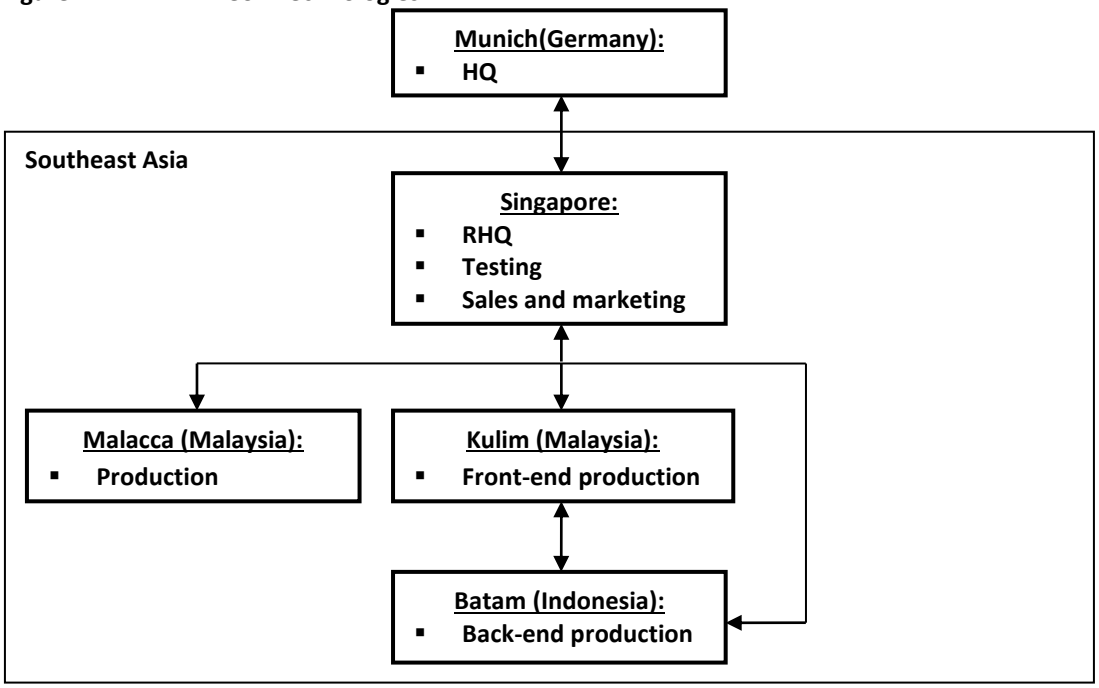
Batam subsidiary	Parent company (country of origin)	Activities in Singapore	Establishment Singapore	Subsidiaries in Southeast-Asia	Total number of subsidiaries
Amber Karya	Zhongli Group (China)	RHQ	Stargazer Link Technology	Singapore (1), Indonesia (1), China (7)	9
Atech Electronics Indonesia	Atech Technologies (Singapore)	HQ	Atech Technologies	Singapore (1), Indonesia (1)	2
Awatronics Manufacturing	Awa Electronic (Singapore)	Sales R&D	Awa Electronic	Singapore (1), Indonesia (1)	2
Cicor ESG Panatec	Cicor Technologies (Switzerland)	RHQ	Cicor Asia	Singapore (2), Indonesia (1), China (1), Vietnam (1)	5
EPCOS Indonesia	TDK-EPC Corporation (Germany)	Sales R&D	EPCOS	Singapore (1), Indonesia (1), Malaysia (1), China (6), India (3)	12
Epson Batam	Seiko Epson Corporation (Japan)	RHQ	EPSON Singapore	Singapore (2), Indonesia (2), Malaysia (1), Japan (16), China (8), Philippines (1)	30
Infineon Technologies Batam	Infineon Technologies (Germany)	RHQ R&D Sales	Infineon Technologies Asia Pacific	Singapore (1), Indonesia (1), Malaysia (2), Japan (1), China (1), Taiwan (1)	7
Jovan Technologies	Jovan Tech (Singapore)	HQ	Jovan Tech	Singapore (1), Indonesia (1)	2
Leonix	PTS System (Singapore)	HQ	PTS System	Singapore (2), Indonesia (1)	3
Sanwa Engineering Batam	Sanwa Plastic Industry (Singapore)	HQ	Sanwa Plastic Industry	Singapore (5), Indonesia (2), Malaysia (3), China (3)	13
Schneider Electric Manufacturing Batam	Schneider Electric (France)	RHQ	Schneider Electric Singapore	Singapore (1), Indonesia (1), India (6), Australia (4)	12
Sumitomo Wiring Systems Batam	Sumitomo Wiring Systems (Japan)	RHQ Sales procure-ment	Sumitomo Corporation Asia & Oceania	Singapore (1), Indonesia (2), Malaysia (2), Japan (29), China (26), India (3), Philippines (8), Taiwan (1), Korea (2), Thailand (4), Vietnam (5), Cambodia (1), Australia (2)	86
Yokogawa Manufacturing Batam	Yokogawa Electric Corporation (Japan)	RHQ	Yokogawa Electric Asia	Singapore (3), Indonesia (3), Malaysia (4), Japan (3), China (9), India (3), Philippines (2), Taiwan (2), Korea (2), Thailand (2), Vietnam (2), Australia (2), New Zealand (2)	40

Source: own data

The role of the subsidiary and their autonomy within the regional production network play a role in the functioning and upgrading of the subsidiary. However, not many subsidiaries are able to make decisions on their own (table 7.23). One exception is Awatronics, this company has located its management functions on Batam and its sales and R&D activities in Singapore. In this way the Batam

establishment is able to make decisions for itself without interference of a (regional) headquarter. In addition, it should be mentioned that most Singaporean MNCs lack a regional headquarter.

Figure 7.1: RPN Infineon Technologies



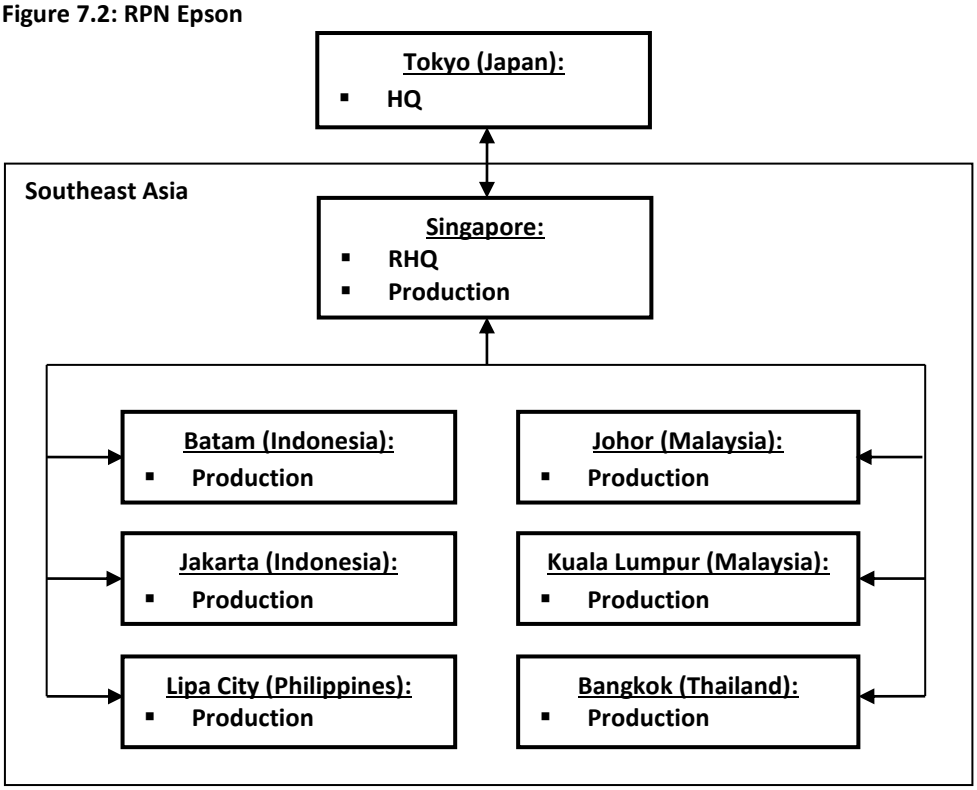
Source: own data

A closer look at the RPN of the German semiconductor MNC Infineon Technologies shows a broad division of activities (figure 7.1). The HQ is located in Munich, Germany. Singapore is the RHQ for Southeast Asia. This establishment is also responsible for testing, sales and marketing. Production facilities are located in Indonesia and Malaysia. Especially the subsidiaries in Kulim and on Batam have to cooperate since they both work on the same production line: components and parts manufactured in Kulim are assembled on Batam.

Japanese MNC Epson has its HQ in Tokyo, Japan. Within Southeast Asia the Singapore establishment functions as RHQ (figure 7.2). This establishment is also involved in some production. The subsidiary on Batam is one of many production facilities. Other subsidiaries are located in Malaysia, Philippines and Thailand. The local manager state not to compete with other manufacturing subsidiaries for the acquisition of additional functions. There is no ambition to acquire new functions. Instead, the subsidiary only competes on the performance of production. The objective is to optimize the current production process and to improve the products. At best, this can lead to an extent of the production portfolio or volume. Other more high value-adding activities as R&D and D&D seem to remain in Japan.

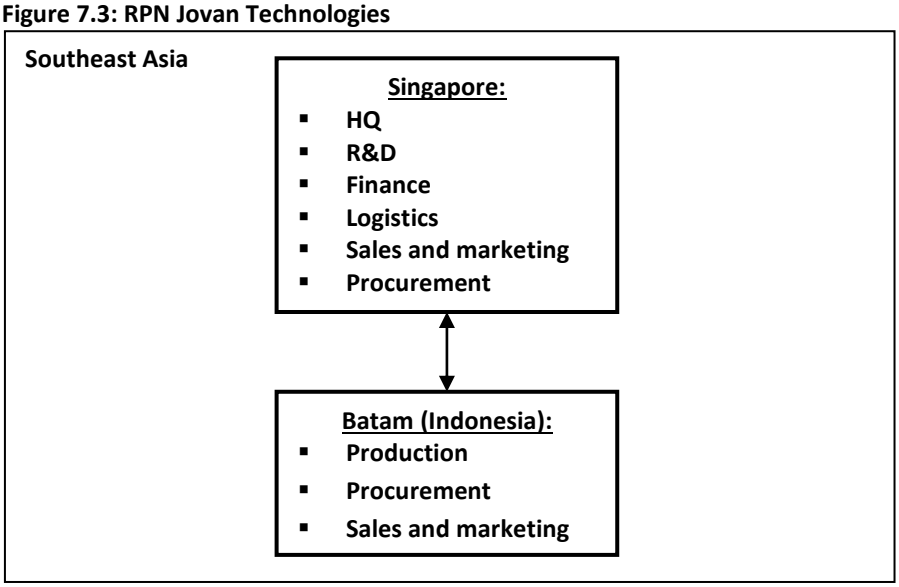
The RPN of the Singaporean electronic components MNC Jovan Technologies is much more simplified (figure 7.3). Jovan has two establishments, one in Singapore and one on Batam. The Singaporean establishment functions as the HQ and is also involved in R&D, finance, logistics, sales and marketing, and procurement. The subsidiary on Batam is responsible for the production, but also some procurement and sales and marketing.

Figure 7.2: RPN Epson



Source: own data

Figure 7.3: RPN Jovan Technologies



Source: own data

Decisions about the functions of the subsidiaries are mostly top-down oriented. Of a total of thirteen subsidiaries eleven times decisions about these matters are made top-down, in nine cases the headquarter makes a decision about these matters, in two cases the regional headquarter. For four Singaporean MNCs, the three Japanese MNCs and the two German MNCs, decisions about these matters are made at the headquarter. In the Chinese MNC Zhongli and the Swiss MNC Cicor ESG Panatec the regional headquarters make decisions regarding functions of establishments in the RPN. Less top-down decision making takes place at Schneider Electric where decisions about the allocation of functions are made collectively between the HQ, RHQ and subsidiary (table 7.23).

The allocation of product lines in the Batam subsidiary is also strongly top-down decided, eight times at the headquarters and two times at the regional headquarters. Again the three Japanese MNCs make decisions for the allocation of product lines in the headquarter in Japan. The same applies to the two German companies and three Singaporean MNCs. Again for the MNCs Zhongli and Cicor ESG Panatec the regional headquarter decides about these matters and decisions about the allocation of product lines at Schneider Electric are made collectively between the HQ, RHQ and subsidiary. In the case of Leonix the allocation of product lines is decided collaboratively between the headquarter and subsidiary (table 7.10).

Table 7.24: Level of decision making

Decisions	HQ	RHQ	Subsidiary	In collaboration
Allocation functions	9	2	1	1
Allocation of product lines	8	2	1	2
Product portfolio	7	0	1	5
Production process	3	0	1	9
Procurement	0	1	3	9

Source: own data

Less top-down, is the making of decisions regarding the product portfolio. Decisions of these matters are seven times made in the HQ but five times collaboratively. In particular the Japanese and Singaporean MNCs make decisions regarding this issue in the headquarter. The decisions about the product portfolio of the Batam subsidiary of Schneider Electronic are made in collaboration by the headquarter and regional headquarter. The subsidiaries Amber Karya, Leonix, Cicor ESG Panatec and Sanwa Engineering make decisions about the product portfolio together with the (regional) headquarter (table 7.23).

Decision about changes in the production process are a more bottom-up topic (table 7.23). Three times, in the cases of Yokogawa, Sumitomo and Leonix, decisions regarding changes in the production process are made at the headquarter while in the other cases the subsidiary takes part in the decision process about changes of the production process. An almost similar situation applies to decisions of procurement. Only in the MNC Cicor ESG Panatec the regional headquarter makes decisions regarding this topic. In the twelve other cases the subsidiaries take part in decisions regarding procurement.

Table 7.25: Autonomy in decisions making and change in autonomy

Autonomy in decision making	Number of subsidiaries	Change in autonomy	Number of subsidiaries
Yes, autonomous decision making	3	More autonomy	7
Yes, occasionally autonomous making	9	Less autonomy	1
No autonomous decisions	1	No change of autonomy	5

Source: own data

In conclusion, decisions about the allocation of function, product lines, product portfolio are often made top-down by the headquarter or regional headquarter but decisions about changes in the production process and procurement are mainly made in collaboration with the headquarter or regional headquarter (table 7.23). The subsidiaries are seldom able to make autonomous decisions. However, twelve subsidiaries indicate that they are able to make decisions autonomously (table 7.24). These decisions include “small issues as financial matters, manpower, transport and equipment, small adjustments in the production process, adjustments to product design and procurement.” Only Yokogawa Manufacturing indicates to be unable to make autonomous decisions. Seven subsidiaries stated that they got more autonomy over time, five subsidiaries did not become more autonomous, while Sanwa Engineering has less autonomy then before (table 7.24). 6 Of the subsidiaries that gained more autonomy are from Japanese or Singaporean origin. Also Schneider

Electric states that it is able to take decision more autonomously. According the subsidiaries, determining factors for the level of autonomy are the performance and the range of competencies of the establishment. Locational factors, HQ strategy as well as the position in the RPN to other subsidiaries are of influence on the autonomy of the subsidiary.

Looking at the relations within the RPN, eight subsidiaries indicate that they collaborate with other establishments, while five subsidiaries don't collaborate. Six Subsidiaries indicate that they mainly work in complementary with other subsidiaries in the RPN. Especially the Singaporean subsidiaries state that they work complementary for example, Leonix, Jovan and Awatronics. These three subsidiaries are all part of an RPN with only one other establishment; a headquarter in Singapore. Also Cicor ESG Panatec, Infineon Technologies and Epcos Indonesia indicate that they have complementary relations with other subsidiaries in the RPN. For example, Infineon Batam is involved in the 'back-end' production, while in Kulim, Malaysia, is involved in the 'front-end' production. Four subsidiaries are complementary to other establishments in the RPN but compete with them at the same time. This simultaneous competition and complementarity takes place within three Japanese RPNs (Sumitomo Wiring Systems, Yokogawa Manufacturing and Epson) and between the subsidiaries of Schneider Electric. For example Sumitomo Wiring Systems produces for its own market in Southeast Asia while the Chinese subsidiary produces for the Chinese market. The different subsidiaries of Epson all produce specific parts for the final products However there is competition between the subsidiaries on price level and quality. Competitors within the RPN are mainly based in China, India, Vietnam and Korea but can also be found in England. Only Sanwa Engineering states that the relations between the subsidiaries are neutral while there are production subsidiaries in operation in China and India.

When it comes to the importance of relations between subsidiaries, it is remarkable that only Sanwa Engineering considers these relations as very unimportant. While most other subsidiaries value these relationships as important or very important. Yokogawa Manufacturing and Epcos consider subsidiaries' relations as neutral. For four subsidiaries this question is not applicable while they have only relations with the headquarter. Regarding the position vis-à-vis the other subsidiaries, five subsidiaries feel that they have an equal position in the RPN (Cicor 2000, Infineon 1996, Awatronics 2003, Sanwa 1993, Sumitomo 1991) while the other four feel they have a strong position in the RPN compared to the other subsidiaries (Epson 1991, Epcos 1990, Yokogawa 1993, Schneider 1991). Regarding the position vis-à-vis the (regional) headquarter Cicor ESG Panatec feels it has a weak position, six subsidiaries feel they have an equal position and 5 think they have a strong position. Remarkable is that the subsidiaries that feel they have an important position are mainly Singaporean firms with as only one other establishment a headquarter in Singapore.

7.4 CONCLUSION

This paragraph aims to answer the second, third and fourth sub questions. The second question is: how can the firms in the E&E industry of Batam be characterized from 1990 till 2012? The third question addresses the influence of RPNs on in-situ evolution: to what extent do regional production networks influence the evolution of firms in the E&E industry of Batam? The fourth sub question is: to what extent does the local environment influence the evolution of firms in the E&E industry of Batam? When it comes to the thirteen interviewed subsidiaries of MNCs in the E&E industry of Batam the dominance of Singapore and Japan is clear. Five subsidiaries are of Singaporean and three from Japanese origin. Seven out of these eight are also greenfield investments. The other subsidiaries are from Germany (2), China, France and Switzerland. The number of workers per subsidiary varies between a wide range of 15 to 3200. Epson has the largest workforce (3200), but especially the large number of workers of the German subsidiaries (1950 and 3000) is remarkable. The subsidiaries are mostly involved in relatively simple functions as production and procurement, while development functions are very rare. Especially components and (plastic and metal) parts are produced on Batam (connectors, semiconductors, sensors, plastic parts, wire harnesses and electric cables, PCBs), while only few subsidiaries produce full products (face- and body shavers/treatment equipment, scanners

and ink cartridges, distributed control systems (DCS) and optical time-domain reflectometers (OTDR). Little subsidiaries experienced a change of the product portfolio (an expansion (i.e. more types), the same product for a new market, old product replaced by a new one). However, most subsidiaries still claim to have an higher-end, more sophisticated and more specialized portfolio then previously. The workforce is more low- than high-skilled with almost no foreign workers. Instead, the subsidiaries consider machinery very important. The production process is relatively automated (some assembly will always be manual) and due to rising labor costs the future trend shows an a further increase in the use of machines. The subsidiaries are hardly involved in development activities and acquire new technology mainly from the headquarter and clients. However, all subsidiaries claim to be involved in product and process adaption in cooperation with clients (design). Sales and marketing activities is foremost a matter of the (regional) headquarter, although many subsidiaries maintain relations with established clients (general electronics, household appliances, automotive and oil and gas processing). Practically all subsidiaries experienced growth in production volume, employment and buildings over the past years. Only three subsidiaries manufacture products under their own brand (Epson, Schneider Electric, Yokogawa).

The subsidiaries have an overall positive feeling about the local environment of Batam and consider the environment to be improved over the last five years. Especially, the physical infrastructure, housing and living environment with new shopping malls have improved. But despite of the importance of labor characteristics the quality is not always as good. There is for example a clear lack of skills. The international connectivity is most important and experienced as very good. Local government is more important than national government, however, the actions of both governments are not experienced as really conducive. The local environment seems to have little influence on in-situ upgrading. Instead, the regional production network seems more important.

Decision making about the allocation of functions and product lines takes mostly place at the (regional) headquarter, while subsidiaries have more to say about the production process and procurement. The level of autonomy therefore seems to be limited. However, the subsidiaries are able to make autonomous decisions on relatively small issues. The relations between subsidiaries are experienced as important and the position of subsidiaries within the regional production networks is mostly experienced as equal to or even strong compared to other establishments. These relations can be complementary (collaboration) as well as competitive.

8. DISCUSSION

8.1 CONCLUSION

In this paragraph the main research question is answered: how has the E&E industry of Batam evolved from 1990 till 2012 and what factors have influenced this evolution? To answer this question it is useful to go back to the emergence of economic development on Batam. The economic growth of the First and Second Asian Tigers relied heavily on foreign direct investment (FDI). The Second Tigers (Indonesia, Malaysia, Thailand and Philippines) shifted from natural resources and agriculture to manufacturing activities as main source of income and driver of economic growth. Relocation of manufacturing of electronics from Japan and from the First Tigers to the Second Tigers stimulated this industrialization. Besides the relocation of manufacturing activities from the First to the Second Tigers, the Second Tigers aimed at the attraction of multinational corporations (MNCs) from all over the world (Hobday, 1995). The Growth Triangle shows the importance of FDI in the economic development of Southeast Asian countries and the strong relation between one First Tiger (Singapore) and two Second Tigers (Batam in Indonesia and Johor in Malaysia). Within the Triangle each region has a different complementary role. When considering the economic development of Batam and its E&E industry, especially Singapore's influence is evident.

As well as the other First Tigers, Singapore relied heavily on an export-oriented industrialization (EOI) approach that was almost fully based on inward foreign direct investments. In other words, the growing Singaporean economy relied on the allocation of MNCs to the city-state. Manufacturing industries, in particular the electrical and electronics and biochemical industries, and supporting financial and business services developed rapidly. However, in the 1980s Singapore faced new competitors in the Second Tigers. These countries found themselves in an earlier stage of industrial development accompanying lower production costs especially lower wages, while Singaporean land and labor costs were slowly rising. This situation resulted in the relocation of MNCs from Singapore to surrounding countries. Singapore expressed the ambition to upgrade to a knowledge-based economy and the Strategic Economic Plan should encourage upgrading to higher value-adding activities in Singapore while stimulating the outsourcing of low value-adding activities (Perry, 1995). Minimum wages were deliberately raised and education and training was stimulated. By the early 1990s Singapore had built the reputation of a hotspot for R&D and management functions in Southeast Asia (Yeung, 2000). Relocation of low value-adding activities was stimulated by the Regional Industrial Parks Programme that recognized and aspired the utilization of opportunities in the Second Tigers. Singaporean government-linked corporations (GLCs) fully developed foreign industrial estates outside Singapore. Convinced by the non-corrupt Singaporean government, Singapore's former success and strategic investment plans, host governments including Indonesia were willing to collaborate because the local economy was likely to benefit from Singaporean development efforts. This led to the development of Singapore's first foreign industrial park on the island of Batam in 1990: Batamindo Industrial Park (BIP). Most investments in Batam were done by American, European and Japanese MNCs who already had operational establishments in Singapore. Batam aimed at a wide range of FDI from light to heavy export-oriented industries, but especially the E&E industry developed fast and became the largest industry of Batam in 2002 (Yeoh et al, 2004).

The evolution of the E&E industry on Batam is analyzed with use of the concept of branching. The industry, subdivided into branches, slowly evolves since firms enter and exit the industry (Boschma, 2011; Neffke et al, 2011). All firms are assigned to a specific branch, so when firms enter and exit the industry, the composition of a specific branch changes and therefore the whole industry changes. The direction in which a branch or industry develops can be designated as industrial up- or downgrading. Industrial upgrading is a broad definition of overall increase of productivity, expanding value-adding functions and/or moving to related more technological sophisticated branches (UNCTAD, 2013). If the sum of all branches becomes more sophisticated, the industry experience industrial upgrading.

Currently, the E&E industry of Batam consists of 62 MNCs. The most MNCs are from Japanese and Singaporean origin. The MNCs in the E&E industry of Batam mainly focus on manufacturing and assembly of audio and video equipment, automotive parts, printed circuit boards (PCB) and other computer-related components and parts (cables, wires, wire harnesses, sensors, connectors, etc.).

When considering the evolution of the E&E industry (and the whole economy) of Batam from 1990 to 2012 the influence of Singapore is evident. As well as in Singapore, Wong and Ng (2009) state that the E&E industry of Batam lost importance compared to other manufacturing industries since 1998. However, according to our data, the total number of MNCs in the E&E industry was still growing till 2003. From then the number of MNCs started to decrease with the strongest pace from 2010 to 2012.

This strong influence of Singapore shows itself in the evolution of the E&E industry of Batam. While the output, value-added and employment in the consumer electronics branch in Singapore started to decline from the period 1991/1995. When looking at the industrial composition with important firms of Batam after 1990 this branch started growing. When looking at the industrial composition of important firms the consumer electronics branch dominated the E&E industry of Batam in 1994 and 2003. After 2003 when the consumer electronics branch further decreased in importance in Singapore this branch also decreased in importance on Batam. A similar development also applies for the declining other electronics components branch in Singapore and the growing electronics components branch on Batam. In 2012 this branch was the most dominant branch in the E&E industry of Batam. The data storage branch in Singapore started declining from 1996/2000. Accompanied with this decline also the important firm involved in this branch Seagate leaves Batam after 2003. The fourth declining branch of Singapore, the computer peripherals branch, is not represented on Batam. The branch that increases in importance in the Singaporean E&E industry is the semiconductor branch. When looking at Batam's industrial composition this branch also starts to increase. Two important firms (Sanmina-SCI and Infineon Technologies) involved in this branch are in operation since 2003. Sanmina-SCI produces PCBs and Infineon Technologies that produces semiconductors. When it comes to the interviewed companies four are involved in supporting activities for the semiconductor branch. Infineon already active since 1996 on Batam produces (as discussed before) semiconductors. The other three companies are of Singaporean origin and started their operations on Batam later: Atech (2002) and Awatronics (2003) both produce PCBs, while Leonix (2008) produces machines for the production of PCBs. The two subsidiaries that produce full products for the consumer electronic branch arrived relatively early on Batam, this are Epson (1990) and Cicor ESG Panatec (2000). Their years of entrance correspond with the decline of the consumer electronics branch in Singapore. Yokogawa Manufacturing produces full products for the industrial electronics. The remaining six subsidiaries are all involved in the production of electronic components, four of them started between 1990 and 1993, one in 2003 and one in 2009. This corresponds with the increasing importance of the other components branch in Singapore.

As expected the development of the E&E industry of Batam is characterized by an early increase in number of subsidiaries. It looks like that the relocation of low value-adding production activities out of Singapore partly landed on Batam and stimulated the growth of Batam's E&E industry. The development of the E&E industry of Batam is also characterized by a later decrease in number of subsidiaries this is accompanied by the declining importance of the E&E industry of Singapore. Despite an overall decline in numbers of subsidiaries, E&E subsidiaries on Batam start to get involved in supporting activities for the growing high value-added semiconductor industry in Singapore. The expectation that the E&E industry of Batam is characterized by a constant overrepresentation of Singaporean subsidiaries is not true. In contrast, Singapore strongly has strongly influences the evolution of the E&E industry of Batam.

8.1.1 UPGRADING

In addition, the fifth and last sub question can be answered: to what extent can the evolution of the E&E industry of Batam be characterized as industrial upgrading? In general, a change from lower to higher value-adding is regarded as in-situ upgrading. For regions it is necessary for their economies to move up the value chain and not remain engaged only in labor-intensive assembling activities. Technology transfer and upgrading is an essential element of this process. Upgrading contributes to the increase of local wages and local skill formation (Thorbecke et al, 2010). As expected the E&E subsidiaries on Batam have experienced little to no industrial upgrading.

First, despite that some of the interviewed subsidiaries added new functions to their charters, industrial upgrading of functions is not to be found on Batam. Almost all subsidiaries in the E&E industry of Batam are involved in relatively low value-adding activities as production and procurement. Production consists mainly of manufacturing and assembly activities. Higher value-adding activities as sales and marketing and development activities are very limited. Sales and marketing is approximately done by half of the subsidiaries, but consists only of maintaining relations with already established clients. Though practically all subsidiaries stated to be involved in product adaption to clients' requirements and production process adaption to increase efficiency, actual development activities (D&D and R&D) at the technological frontier seem very rare. There haven't been radical changes in functions. Most subsidiaries maintained the same functions overtime. Only a few subsidiaries acquired extended charters for sales/marketing or development activities, but as stated above the scope of these activities is very limited.

Second, there is also little to no product upgrading. The subsidiaries manufacture a wide variety of products, but mainly components and parts. About half of the subsidiaries has experienced a change in the product portfolio overtime. These were expansions in number of products and product types, replacements of old products by a new products or production for new markets. Overall, the changes in the product portfolio were experienced as an improvement of quality. There is a clear shift from lower- to higher-end and an increase of complexity. However, the difference between the old and new products was often relatively small. The question raises whether the changes are actual upgrading or are rather basic technological developments within the global E&E industry.

Third, there is little process upgrading. The vast majority of the workforce of the subsidiaries is low-skilled. There were mostly assembly workers and very little technicians, engineers and foreign employees (management functions). This can be explained by the relatively simple activities performed by the subsidiaries (manufacturing and assembly). Workers start with very little education, but the intra-establishment labor training of all subsidiaries is sufficient to do the job. Sometimes (foreign) engineers are hired for product and process adaption. Remarkable is the strong trend of automation. All subsidiaries emphasize the increasing importance of machinery. There is an increasing use of machinery and an increased technology, efficiency and productivity of the existing machinery because of technological advancements. However, the sophistication of the machinery is very divers. The main reasons for this clear trend are the rising labor costs and the general search for more efficiency and flexibility. Some assembly activities however will always be manual processes.

8.1.2 UNDERSTANDING EVOLUTION AND UPGRADING

Subsidiary evolution and in-situ upgrading are roughly influenced by the embeddedness of the subsidiary in the RPN and local networks, and the local characteristics of the host region. Overall, the influence of Singapore is evident. First, a subsidiary is internally embedded in the RPN and externally in the local network of the host region (Meyer et al., 2011). The performance and capabilities of a subsidiary are evaluated by the headquarter (HQ) or regional headquarter (RHQ). The (R)HQ determines which functions a subsidiary executes. Decision making about the allocation of functions and product lines mostly is a top-down process in which the (R)HQ is leading. Subsidiaries have more influence on the production process and procurement. The level of autonomy of the subsidiaries is limited. Only on operational matters and small issues the subsidiaries are able to make autonomous decisions. This limited autonomy possibly influences the ambitions of the local subsidiaries for in-situ

upgrading. The position of the subsidiary within the RPN is mostly experienced as equal to or even strong compared to other establishments. Relations between subsidiaries are experienced as important and can be complementary and competitive at the same time.

Second, performance, capabilities and evolution of a subsidiary is influenced by local characteristics. The subsidiaries have an overall positive feeling about the local environment of Batam and consider the environment to be improved over the last five years. However, there is clear lack of skilled labor and actions from the local as well as from the national government are not experienced as conducive for functioning and upgrading on Batam. Upgrading to more value-added function, processes or products isn't stimulated by the local environment. A technology or knowledge base barely exist. According to Rasiah et al. (2008) for evolution and upgrading it is crucial to establish R&D parks and links between firms, research centers and universities. Due to the lack of a conducive environment for upgrading firms focus on being more efficient and optimize their production process to raise their competiveness compared to other production facilities in the RPN. The current local environment influences the ambitions of the local subsidiaries for in-situ upgrading. Therefore the local environment influences upgrading more bottom-up. The local subsidiaries

A third factor is the influence of Singapore on subsidiary evolution and in-situ upgrading. Singapore's influences is huge on both decision making in the RPN and the development of the local environment of Batam. Singapore has a positive effect on the economic development of Batam. Almost all MNCs in the E&E industry of Batam have establishments in Singapore and these establishments have a strong position in the RPN ((R)HQ, R&D, sales & marketing, services, transport). Many MNCs were first located in Singapore and in search for a low-cost location (low land and labor costs) for manufacturing facilities they started investing in Batam. This means that the presence of the MNCs in the E&E industry in Singapore strongly influenced the investments in Batam's E&E industry. Low value-adding, labor-intensive activities relocated from Singapore to Batam, while the higher value-adding, knowledge-intensive activities remained in Singapore. According to the subsidiaries Batam is well-connected to Singapore. Almost all transport goes first to Singapore before it goes to other places world-wide. However, Singapore also has a negative effect on the development of Batam. Because many MNCs established subsidiaries on Batam for low value-adding activities, in-situ evolution only seldom happens. Singapore provides a perfect environment for high value-adding activities, hence there is no need for MNCs to upgrade their low-cost manufacturing facility to high knowledge intensive facility because Singapore is just around the corner. Therefore, the proximity to Singapore hinders the evolution of the technology and knowledge base of Batam. There is still a silver lining for Batam's E&E industry: it looks like E&E subsidiaries on Batam bit by bit start supporting activities for the high value-adding, high-tech semiconductor branch in Singapore. This can lead to higher value-added activities on Batam in the future. However, this development will be limited when functions will mainly remain focused on the lower-added activities of the production process.

Noteworthy is the fact that the E&E industry is a highly-dynamic technology-creating industry (Rasiah, 2010). The replacement of an old product by an new one within a subsidiary can simply be the outcome of (global) technological developments instead of an innovation by a single subsidiary and thus in-situ upgrading. Assumptions about whether there is actual in-situ upgrading should therefore be handled carefully.

8.2 FUTURE PROSPECTS AND RECOMMENDATIONS

8.2.1 POLICY RECOMMENDATIONS

- Besides the acquisition of firms and promoting Batam as an interesting place for doing business, it is also a task for the regional investment agency (BIFZA) to stay in touch with firms and help them to find their way around, assist them to be profitable and competitive. Finally as indicated by (Rasiah, 2009) the local business environment needs to be improved for existing firms and should be conducive for local start-ups. Especially local start-ups can stimulate industrial upgrading because they are not limited to knowledge transfer with the RPN. As Edgington & Hayter (2013b) state: despite potential cost advantages Japanese MNCs continue to see the co-location of R&D together with prototype production in Japan as a key advantage over its competitors.

- According to Atzema et al (2009), a shift to automation and mechanization leads most of the times to a situation where firms start to expect more of the skills of their workforce. Often a strongly automated and mechanized production process needs a higher and different skilled workforce compared to a more manual production process. It's thinkable that unqualified employees have to leave while better qualified employees are attracted from outside the region. To counter these negative effects for the workforce of Batam there is need for training facilities to prepare the workforce. At the same time, knowledge spillovers from outside Batam assist the development of the technology base of Batam.

- Despite Singapore being the economic hub in Southeast-Asia and in certain ways hinders the economic development of Batam, the proximity of Singapore also creates opportunities. Because of this status of economic hub together with its scarce land, prices for land and labor will probably keep on rising in. An improved business environment of Batam that is interesting for activities that add more value and are of higher knowledge depth than manufacturing and assembly enables Batam to attract these higher value adding activities.

- Batam's economic development strongly depends on FDI. According to our data, in 20 years development of Batam's E&E industry 134 MNCs entered but also exited the region between 1990 and 2012. This indicates the relatively footloosness of MNCs. To be less dependent on the comings and goings of these MNCs local entrepreneurship should be stimulated.

8.2.2 RESEARCH RECOMMENDATIONS

- To fully understand the position of subsidiaries in the RPN it is necessary to talk to headquarters and regional headquarters instead of only interviewing the specific RPN. A more comprehensive study should include interviews with (R)HQs

- This research can help regions to climb up the value chain. Climbing up the value chain and upgrading contributes to the increase of local wages and local skill formation (Thorbecke et al, 2010). Conducting this research in other regions can help to raise welfare and economic development.

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10. APPENDIX

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Study on the development of the Electrical & Electronics (E&E) industry in Batam

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Subsidiary name: …….

Name of respondent: …….

Job title of respondent: …….

Subsidiary address: ……..

Telephone number: ……..

Company website: ……..

10.1 GENERAL INFORMATION

1. Year of establishment of this subsidiary ……..

2. What is the investing company of this subsidiary? ……..

3. Is the investing company also the parent company of this subsidiary?

☐ Yes (please proceed to question 4)

☐ No (please proceed to question 5)

4. If yes, what is the location of the parent company? …….

5. If no, what is the status of the investing company? (e.g, Sub/regional HQ/)

……

6. What is the parent company of this subsidiary? ……..

7. According to our registration this subsidiary is wholly foreign owned. Is this correct?

☐ Yes

☐ No, ownership status ……

8. What kind of investment of the investing company would you consider this subsidiary to be?

☐ Greenfield investment

☐ Acquisition of another firm

☐ Joint venture

☐ Other, ……

9. Has this establishment operated under other names previously?

☐ Yes

☐ No

10. If indicated "yes", under what name(s) has this establishment previously operated?

……

11. To what unit within the company does this subsidiary/establishment report?……

12a. How many people does this establishment currently employ? ……

12b. Have there been any significant changes in the number of employees over the past 10 years (if established less than 10 years ago, since establishment)?

☐ Yes, an increase

☐ Yes, a decline

☐ No

12c. If yes, when and what was the main reason for this increase/ decline?

……

13. What would you consider to be the core business of the parent company?

……

10.2 SUBSIDIARY-EVOLUTION

14. Please indicate the functions of this establishment and changes therein since start
Short intro

	Production	R&D/ D&D	Procurement of materials	Sales/ marketing	Management	Other (please specify) ……
Current						
Year: ……						
Year: ……						
Year: ……						
Year: ……						
Start						

Note: D&D = Design and Development

- If indicated that the establishment is currently NOT involved in production anymore please proceed to question 15.
- If indicated that the establishment is currently involved in production please proceed to question 17.

Products

15. What were the prior products that have been produced, right before closing down production?

……

16. Why has it been decided to close down production operations?

☐ The former product no longer part of the product portfolio of the company

☐ The former product replaced by a new generation that is produced elsewhere

☐ Production has been outsourced

☐ Production was moved to other locations, because of:

☐ Market reasons

☐ Costs

☐ Consolidation

☐ Other.....

☐ Other, such as: .....

17. Currently, the main product(s) of this subsidiary is/are: ……

18. Has the production volume changed over the past ten years (or since establishment)?

☐ Yes, increased

☐ Yes, decreased

☐ No

19. Have there been any changes in the product portfolio of this subsidiary over the past 10 years (or since subsidiary establishment)?

☐ Yes (please proceed to question 20)

☐ No (please proceed to question 24)

20. If yes, please indicate these changes, when these changes occurred and the reason

	Products	Reason for the change
Current		
Year: ……		
Year: ……		
Year: ……		
Start		

21. At time of implementation, was the main product manufactured in this establishment new for the parent company?

……..

22. At time of implementation, was the product manufactured in this establishment new for the market?

……..

23. Would you consider the change in the product portfolio over the past ten years (or since establishment) to be:

☐ From lower to higher-end

☐ From higher to lower-end

☐ No significant change

☐ From lower to higher complexity

☐ From higher to lower complexity

☐ No significant change in complexity

☐ From more specialized to less specialized

☐ From less specialized to more specialized

☐ No significant change

Processes

24. What is the composition of employment in this subsidiary?

	100 / 76 %	75 / 51%	50 / 26%	25 / 0%
High skilled employees / Low skilled employees				
Technicians / assembly workers				
Foreign employees / Local employees				

25. Please indicate the share of engineers in total employment of this establishment: ……..%

26. How would you consider the following in this subsidiary?

	High	Medium	Low
Investment in machinery versus labor			
Level of sophistication of machinery			
Level of automation of the production process			

27a. What is the dominant trend in these indicators?

……..

27b. Could you please explain the answer to question 27a? (E.g, Labor costs; Overall labor availability; Availability of high skilled employees; Product-driven change (higher technology content of new products)

……

Technology, Research & Development

28. How do you acquire new technologies?
a. Products

- ☐ From the HQ
- ☐ From other subsidiaries
- ☐ From clients
- ☐ Own R&D
- ☐ By imitating / copying other firms (acquisition other firms)
- ☐ Other (specify) ……

b. Processes

- ☐ From the HQ
- ☐ From other subsidiaries
- ☐ From clients
- ☐ Own R&D
- ☐ By imitating / copying other firms (acquisition other firms)
- ☐ Other (specify) ……

Answer questions 29-31 ONLY if indicated in question 14 that currently R&D/D&D is carried out in the establishment

29a. If involved in R&D/D&D activities, what kind of activities are executed by this subsidiary?

- ☐ New product development
- ☐ New production process development
- ☐ Product adaptation
- ☐ Production process adaptation
- ☐ Other, such as: ……

29b. What percentage of your labor force is currently involved in R&D? ……. %

29c. Has this percentage R&D workers changed over the last ten years (or since establishment)?

- ☐ Yes
- ☐ No

If indicated “yes”, how has this percentage changed?

☐ Strongly increased

☐ Slightly increased

☐ Slightly decreased

☐ Strongly decreased

29d. What would you consider to be the main reason for this change in the percentage of R&D workers?

……

30. Is this establishment involved in the filing of patents?

☐ Yes

☐ No (please proceed to question 33)

31. If yes, how important would you consider these patents to be for the parent company?

☐ very important

☐ important

☐ neutral

☐ unimportant

☐ very unimportant

Answer question 32 ONLY if indicated in question 14 that currently no R&D/D&D is carried out in the establishment, but such activity was in the establishment earlier.

32. If this subsidiary used to be involved in R&D, but not anymore, why were R&D activities stopped?

☐ Another subsidiary is now responsible for the R&D activities

☐ Not enough human capital available anymore

☐ Consolidated by the HQ

☐ Not enough local support institutions

☐ Other (specify) ……

Markets

Answer questions 33 and 34 ONLY if indicated in question 14 that currently marketing is carried out in the establishment

33. What percentage of you labor force is currently involved in marketing activities? ……. %

34. Do your marketing activities involve (multiple answers possible):

☐ Maintain relations with established clients

☐ Acquisition of new clients

☐ Explore new markets

☐ Other, such as.....

35. Who do you consider to be your most important clients?

……

Expansion

36a. Has this establishment applied for an approval(s) for follow-up investments?

☐ Yes (please proceed to question 36b)

☐ No (please proceed to question 37)

36b. If yes, in what year(s) and what purpose?

……

37. Have the premises of this subsidiary physically expanded over time?

☐ Yes, expanded on the same location (please proceed to question 38)

☐ Yes, expanded to a different location (please proceed to question 38)

☐ No (please proceed to question 40)

38. In what year(s) has this physical expansion taken place?……

39. What would you consider to be the main reason(s) for this/these expansion(s)?.....

……

Capabilities

40. What would you consider to be the main focus of your product portfolio?

☐ OEM

☐ ODM

☐ OBM

41. How would you qualify the following capabilities of this establishment?

Production

Low end	high	5	4	3	2	1	low	NA
Mid end	high	5	4	3	2	1	low	NA
High end	high	5	4	3	2	1	low	NA

Absorption new technology

Product	high	5	4	3	2	1	low	NA
Process	high	5	4	3	2	1	low	NA

Creation new technology

Product	high	5	4	3	2	1	low	NA
Process	high	5	4	3	2	1	low	NA

Marketing

Client liaison	high	5	4	3	2	1	low	NA
Client procurement	high	5	4	3	2	1	low	NA
Flexibility (client specifications)	high	5	4	3	2	1	low	NA
Other (specify) ……..	high	5	4	3	2	1	low	NA

42. Can you elaborate on the learning processes in the establishment (multiple answers possible)?

☐ Intra-company protocol transfer

☐ Intra-establishment labor training

☐ Intra-establishment protocol development

☐ Recruitment of specifically skilled labor

☐ Participation of workers in labor training institutions (such as PSDC)

☐ Participation in government programmes, aimed at Human Resources

☐ Industry seminars/conferences (e.g. organized by association)

☐ Other (specify) ……..

What is the most important way of learning in the establishment?

……

43. Capabilities in this establishment related to the value chain are rather deep

☐ Agree ☐ Disagree

44. Capabilities in this establishment related to the value chain have a rather wide scope

☐ Agree ☐ Disagree

45. What would you consider to be the key asset(s) to profitably operate in Batam:

……..

46. Has this establishment obtained quality control certificates?

☐ Yes (please proceed to question 47)

☐ No (please proceed to question 49)

47. If yes, please indicate which certificates:

☐ ISO 9000 (International Organization for Standardization)

☐ ISO 14000 (International Organization for Standardization)

☐ SQC (Statistical Quality Control)

☐ TPM (Total Preventive Maintenance)

☐ TQM (Total Quality Management)

☐ QCC (Quality Control Circles)

☐ MRP (Materials Requirement Planning)

☐ MRPI (Materials Resource Planning)

☐ MRPII (Integrated Materials Resource Planning)

☐ JIT (Just In Time)

☐ Other, specify: ……

48. How important would you consider the certificates to be regarding your capabilities?

……

10.3 LOCAL ENVIRONMENT AND OTHER LOCAL DRIVERS

49. Which of the following regional characteristics do you perceive as important for the functioning of the establishment and upgrading? How do you evaluate each of the characteristics?

Indicator		Importance					Evaluation
		1	2	3	4	5	
Labor	Volume						
	Costs						
	Skills						
	Training institutions						
Technology base	Other companies						
	Research institutes						
	Educational institutes						
	Government technology programs						
Infrastructure	Physical						
	ICT						
	Knowledge						
Connectivity	International						
	National						
	Regional						
Supply base	Quality of local suppliers						
	Diversity of local suppliers						
Government Federal	Efficiency						
	Policies & incentives						
	Pro-activeness						
	Political stability						
	Interaction potential						
Government State	Efficiency						
	Policies & incentives						
	Pro-activeness						
	Political stability						

	Interaction potential						
Living environment	Pollution						
	Congestion						
	Crime						
	Cultural amenities						
	Housing						
	Health-care facilities						
	Schooling						

Importance: 1 = Very important, 2 = Somewhat important, 3 = Neutral, 4 = Unimportant, 5 = Very unimportant

Evaluation: 1 = Excellent, 2 = Good, 3 = Fair, 4 = Bad, 5 = Very bad

50. What is your perception of recent changes (in the past 5 years) in the overall regional environment?

☐ Much improved

☐ Improved

☐ No change

☐ Worse

☐ Much worse

51. Has any of the above indicators played a major role in the (lack of) upgrading of this establishment?

☐ Yes

☐ No

52. If yes, which indicators(s)?

……

53. If no, what other factors have been at play?

……

54. How do you compare Batam with other regions in Asia where your company operates as to local environment?

……

55. Is your establishment currently engaged in local public-private partnerships, and if so: in which?

……

10.4 REGIONAL PRODUCTION NETWORKS

56. Has the number of subsidiaries in Asia changed over the past ten years (or since establishment)?

☐ Yes, the number of subsidiaries has increased

☐ Yes, the number of subsidiaries has decreased

☐ No, the number of subsidiaries has remained equal

57. Have there been shifts between countries?

☐ Yes ☐ No (proceed to question 60)

58. Countries that have experienced an increase:

……

59. Countries that have experienced a decline:

……

Responsibilities

60. Where are decisions made about:

Item	HQ	RHQ	Subsidiary	Other, ……
Allocation of product lines				
Product portfolio				
Process changes				
Functions (e.g. R&D)				
Procurement materials				
(Resolution of) operational matters				

61. Can this establishment make decisions autonomously?

☐ Yes (proceed to question 62)

☐ Occasionally (proceed to question 62)

☐ No (proceed to question 64)

62. If yes (or occasionally), on what domains can the establishment make decisions?

……

63. Have there been any changes in the level of autonomy?

☐ Yes, it became larger

☐ Yes, it became smaller

☐ No

64. What factors would you consider to determine the level of autonomy within the company for this establishment?

☐ Performance of the establishment

☐ Range of competencies of the establishment

☐ Growth (potential) of the market

☐ Position with respect to other subsidiaries

☐ Locational factors of the establishment's region

☐ Other, such as: …….

Intra-company subsidiary competition

65. Do you feel that subsidiaries:

☐ Compete with each other (please proceed to question 68)

☐ Complement each other (please proceed to question 66)

☐ Neutral (please proceed to question 69)

66. If indicated "complement", do the subsidiaries collaborate?

☐ Yes (please proceed to question 67)

☐ No (please proceed to question 69)

67. What is the division of activities?

……

……

68. If indicated "compete": the most important direct competitors to this establishment are subsidiaries in: please indicate regions and/or countries:

……..

69. If indicated "compete", what is the basis of competition between subsidiaries?

☐ Performance (productivity/efficiency)

☐ Product lines

☐ Functional activities

☐ Other, such as: ……

70. How would you value the mutual relationships between Asian subsidiaries within the company?

☐ very important

☐ important

☐ neutral

☐ unimportant

☐ very unimportant

71. How would you rate the position of this establishment vis-à-vis...?

a) Regional head-quarter ☐ very strong ☐ strong ☐ same ☐ weak ☐ very weak

b) Other subsidiaries in Asia ☐ very strong ☐ strong ☐ same ☐ weak ☐ very weak

72. In your view, have there been any changes in this subsidiary's position with respect to other subsidiaries in Asia within the company over the past ten years (or since establishment)?

☐ Yes, the position of this establishment has become stronger

☐ Yes, the position of this establishment has become weaker

☐ No change

73. With respect to change, has the establishment taken initiatives on its own accord regarding its position within the company?

☐ Yes

☐ No

74. If indicated “yes”, what kind of initiatives?

.....

.....

10.5 FUTURE PROSPECTS

75. Within the next five years, what are your expectations with respect to this establishment?

	Increase	Decline	Same
Product line(s)			
Activities/functions			
Quality (upgrading)			
Position in company			

76. In your opinion, what are the prospects of this establishment for the next five years?

.....

.....