

August 2012

Evolution of the automation industry in Penang 2005-2011

Exception on the national stagnation?



Thesis by Inge Witte

3279308

Master Business Geography

Faculty of Geosciences

Utrecht University

Supervised by dr. L.M.J. van Grunsven

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Masterthesis by Inge Witte
Student number: 3279308
Master of Business Geography
Faculty of Geosciences
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Foreword

This report is the product of the final assignment of the master Business Geography. The master program is completed with a thesis of 22,5 ECTS and an internship of 7,5 ECTS

The subject for this thesis was proposed by my lecturer, dr. L.M.J. van Grunsven. I was enthusiastic about doing research in Malaysia and to be part of a longitudinal study, which I think is a good research design for evolutionary economics. With the research paper from 2005 written by a former master student I started to orientate on the subject of research: the automation industry in Penang.

I prepared my trip to Penang, while finishing my internship at Berenschot and left for Malaysia in the beginning of September. I stayed there for four months; until the end of December. This proved to be a short period of time for the completion of all interviews. The experience of going to a country far away, arranging housing and interviews by myself and living in a non-western culture has been a valuable experience that turned out well.

This last assignment has been one with some challenges. Building on previous research sounded so much easier than it turned out to be. It was difficult to get my head around all the relevant existing literature and to combine this with my new data. Furthermore, writing in English turned out to be more time-consuming than expected. Apart from the difficulties mentioned above, the research period has also been a time that has provided me with a lot of new knowledge about Asian economics, culture, entrepreneurship, automation and, last but not least, some great experiences whilst living in Malaysia. It was also amazing to be in the huge Free Trade Zone areas of Penang, where there are so many factories and there is so much production of goods that it went beyond anything I could imagine.

I want to thank a few people for their support completing my master thesis. First I want to thank my supervisor Leo van Grunsven for the opportunity of doing this research and his help in providing me with information and feedback. Second I want to thank family and friends for their support in completing the report. And last, the young colleagues of Penang Institute gave me a warm welcome, just as my Chinese housemate and his family did. They made my stay in Penang a pleasant one and I want to use this occasion to thank them for this.

Inge Witte

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List of abbreviations

ETP	Economic Transformation Plan
GDP	Gross Domestic Product
ILC	Industry Life Cycle
IP	Invest Penang
MNC	Multi National Corporation
NEP	New economic Policy
OBM	Original Brand Manufacturer
ODM	Original Design Manufacturer
PCMI	production cycle of manufacturing industries
PDC	Penang Development Centre
PLC	product life cycle
PSDC	Penang Skills Development Centre
RM	Malaysian Ringgit
SERI	Socio economic and environmental Research Institute
SME	Small-Medium Enterprise
SMIDEC	Small and Medium sized firms' DEvelopment Corporation

1. Introduction

Malaysia has seen a strong economic growth over the past decades, lifting the country from the status of underdeveloped to that of a middle-income country¹. An important share of the strong economic growth stems from the creation of an export-manufacturing economy. The government played an important role in this creation by promoting the attraction of foreign direct investments (FDI). The strategy has led to the influx multinational companies (MNCs) to designated locations that offer tax benefits for export oriented companies, the so called Free Trade Zones (FTZs). State governments could further promote their FTZs by offering help to MNCs in finding the right site, providing the necessary infrastructure and matching the MNCs with local firms for supplies and services.

This Malaysian formula to spur economic growth has turned out to be very successful in the past decades². The economy has been transformed, as is illustrated by the strong increased share of industrial activities in the composition of the GDP. But for a few years now the country is losing out on its original advantages as a low cost location. The increased welfare has resulted in higher costs for labour and land. The targeted annual Malaysian GDP growth figure of 7 % to reach high income status by 2020 was not met in the first decade of this millennium³. A negative figure for crisis year 2009 has been the worst result of these years (World Bank, 2011 p. 110).

This development has created a strong awareness of the limits of an export production economy and therefore the Malaysian government tries to become less dependent on it by upgrading the industrial activities. For Malaysia the attraction of FDIs has become harder to accomplish and small numbers of MNCs are relocating their production to other countries in Asia that are still able to offer lower costs. Relocation should not be a problem for the former host economy however, as long as the loss of employment provides opportunities for employees to engage themselves in more value-added activities. The process of relocation of labour-intensive activities in the globalized economy is considered a result of the rise of economic welfare in a location and thus provides opportunities to develop other economic activities (Dicken, 1998). However, this upgrading process seems to stagnate in Malaysia.

Malaysia is not moving upwards and is facing the so called middle-income trap (Yusuf & Nabeshima, 2009; Kharas et al 2009; World Bank, 2010). Defined as; the inability to move from a low-mix high volume industry economy to a technologically more advanced knowledge economy. Causes for this trap are summarized by the World Bank: *“the lack of an innovation-conducive framework, weak technological readiness, persistent skill mismatches, and an inadequate quality of infrastructure”* (World Bank, 2010 p. 27-41). These are causes that are stemming from different levels; industry, firms and regional institutions.

To get a specific and detailed view of this stagnation in development it is useful to zoom in on a regional level because it is at this level that processes for upgrading take place. At this level it is possible to see if the stagnating economic achievements are also present in an industry that has emerged without FDI and is not ‘created’ like for example the strongly promoted semiconductor industry in Malaysia is (Hernandez, 2004 p.3). Co-evoluted industries on the other hand are said to be successful in developing capabilities for more advanced activities in the future (Wenting & Frenken 2011). An industry that has had a co-evoluted start and is led by technological change is the

¹ The classifications low-, middle- and high-income are used by the World Bank as analytical income categories and are based on the operational lending categories, stemming from the view that poorer countries deserve better conditions from the Bank. GNI per capita is the Banks main criterion for classifying. <http://data.worldbank.org/abot/country-classifications/a-short/history>

² Malaysia is one of the 15 success stories in the World Bank Growth report ; strategies for sustained growth and inclusive development (2008)

Wawasan 2020; a vision introduced in 1990 by the prime minister to reach the status of a self-sufficient industrialized nation by 2020. With an annual growth of 7% of the GDP the country would reach the high-come status in this year.

³ Wawasan 2020; a vision introduced in 1990 by the prime minister to reach the status of a self-sufficient industrialised nation by 2020. With an annual growth of 7% of the GDP the country would reach the high-come status in this year.

automation industry in Penang. Penang is a small state in size, 1000 km², but of great importance for the Malaysian economy⁴ (see figure 1.1 for a map). The state is progressive and sometimes taken as a prime example of systemic coordination (Henderson & Philips, 2007 pp. 78-82; ITC, 2012). However, growth figures from other research show a difference from the national stagnating trend, indicating that Penang is also struggling to upgrade its industry (Rasiah, 2010; Yusuf & Nabeshima, 2009 p. 9).

Figure 1.1 The northern Malaysian state and the state of Penang with highlighted locations of the automation industry



Source: SERI, 2012 (edited)

Knowledge on the co-evoluted emergence and character of the automation industry was gained during research in 2005 on the start-up and early developments of this industry. For the purpose of that research the industry was defined and the population identified. The definition for the automation industry is:

'All producers and/or designers of automated components, equipment and/or systems or parts of systems for industrial purposes. Automation does not necessarily have to be the main activity of the company, but has to be a substantial part of at least ten percent of the output of the company' (Aaldering, 2006 p. 9)

The current research will built upon the results of the 2005 study and will focus on development in terms of performance and factors constraining or favoring this. The term development is used in this report to indicate growth or decline. It is preferred because of its

⁴ Penang accounted for over 35% of Malaysian export in 2009 (ITC, 2012)

neutrality; it does not on forehand indicate a positive outcome. The time lap between the data collection is 6 years; using data from 2005 and 2011.

1.1 Central question

The central question for this research is:

How has the automation industry in Penang developed from 2005 up to 2011 and how can this be explained by conducive and constraining factors for development on multiple analysis levels?

To be able to answer this question the following sub questions are formulated;

- How has the population of automation firms in Penang changed over the period 2005-2011 considering its composition and size, and how can this be explained?
- What have been the individual developments of the firms and how can possible encountered differences be explained?
- How has the region contributed or hinder the development of the automation industry over the period 2005-2011?

1.2 Aim and relevance of the research

The first aim of the research is to provide a description of the developments of the automation industry in Penang over the last six years. The second purpose of the research is to provide an analysis of the developments in this highly technological industry in a late industrializing country. The fact that the firms in the industry started their business locally assumes that they are entwined in regional dynamics and more susceptible for changes in the region in comparison to the relatively footloose MNC subsidiaries. A third aim of the study is to provide recommendations for the regional institutions how to promote the development of the industry. The great importance of the local SMEs for sustainable economic growth is recognized by the Malaysian government, and is getting more attention since a few years. The results of this research can therefore be valuable for policy makers concerned with the promotion of this type of firms.

This research will be done using a multi-level perspective because the problems for stagnation are identified on more than one level; micro and meso. The multi-level analysis used is inspired by (self-claimed) pioneers Fritsch and Schindele (2010) who used this multi-level analysis approach on survival and failure in German manufacturing. Multi-level analysis is also often used in the studies on entrepreneurship because it fits the characteristics of the subject; the performance of firms, industries and regions are connected and do partly determine each other.

“Entrepreneurship takes place and has effects on different societal levels simultaneously. Schumpeter (1934) already linked the entrepreneurial initiatives of individuals to the creation and destruction of industries as well as to economic development.”(Davidsson & Wiklund, 2001 p. 81)

The levels of analysis in the research of Fritsch and Schindele (2010) are quite similar to the ones in this research; industry and region on the meso level and firm on the micro level. Together they provide a complete and dynamic image of the industry developments and factors of influence. The chosen multi-level analysis fits economic evolution research as Nelson (1995) writes about the concept of economic evolution;

“The focus of attention is on a variable or set of them that is changing over time and the theoretical quest is for an understanding of the dynamic process behind the observed change; a special case would be a quest for understanding of the current state of a variable or a system in terms of how it got there”. (Nelson, 1995 p. 54)

Therefore a set of variables conducive and constraining to industry-, firm- and regional growth will be chosen from literature to form an anchor for analysis. Much literature on

entrepreneurship is based on the situation of a developed world, the framework is therefore only partly used deductively, and will more importantly serve as a base for induction on the specific context of a developing country.

1.3 *Method of conduct*

First a literature study was conducted to gain knowledge about the general mechanisms promoting or hindering industry development on industry-, firm- and regional level. To create the topics for the structured interview specific information on the case was gathered by explorative interviews, the research report from 2005 and publications about Penang, Empirical data is collected by conducting interviews on site with representatives of the automation firms. The literature research and knowledge of the automation industry in Penang provide expectations on developments and influencing factors. The examinations of these expectations using the data gathered in 2011, will answer the central question of the research. Chapter four provides more detailed information about the execution of the research.

1.4 *Outline of the report*

The report can roughly be divided in two parts. The first part starts with the results of the literature study on factors for development on the level of the industry, firm and region. The second chapter provides information about the case. These two chapters are combined to form a conceptual model for the empirical part of the research. The first part concludes with a chapter on the research method and data collection.

The second part is structured along the sub questions named above and provides the empirical results of the research. This part concludes with a chapter in which the central research question is addressed, recommendations are done and results are discussed.

2. Framework: Dynamics in industry developments

This chapter is combining knowledge on industry development from literature. The aim of this study is to create a framework for analysis on the developments of the automation industry in Penang over the time period 2005-2011. Theories about industry performance and the factors that play a role in this are gathered from literature occupied with evolutionary economics. This strand of literature is able to combine levels of analysis as this definition already shows; "Evolutionary economics occupies itself with why and how economic structure is changing under the influence of developments in economic conjuncture, technological innovation and the changing structure of society" (Boschma et al, 2002).

When creating the multi-level framework some choices had to be made in the selection of literature. The combination of firm, industry and regional studies on developments brought forward a very large amount of literature. In the selection there was a preference for research in late industrializing regions because of the location where this particular case study is done. Other theories preferred are the well-established or 'grand' evolutionary theories, as they are able to analyse dynamics but leave space for interpretation on a smaller scale.

2.1 *From industry start to successful evolution in late industrializing spaces*

An important and strong prevailing model on the commonly assumed evolution of an industry over time is the industry life cycle. Linked to this evolution on industries is the spatial evolution of industries in an international space. The emergence of industries in economic locations that are 'late' industrializers can be considered to be part of this spatial evolution. Penang is an example of a space in an emerging economy that is involved in industries that do not find their origin there. Despite this, the industry life cycle model provides anchors for analysis. The model is used to describe the development of the industry in stages; initial, mature, growth and decline. The stages of development are distinguished by the prevalence of characteristics on size of the industry, growth inclination, number of entries, the degree of market control by firms and product and process innovations. The model can graphically be visualized as a parabolic line. There are six regularities in the evolution of an industry.

The first three are concerned with the size of the industry and the firms' market share:

1. At the start of the industry the number of entrants rises quickly over time or a peak is seen at the start, eventually the number of entrants becomes small.
2. The total number of firms (incumbents and entrants) in the industry has the similar tendency as the number of entrants. There is a quick growth at the start of the industry and after reaching its peak the number of firms declines steadily, referred to as shake-out. This occurs despite a still growing industry output.
3. The speed of change in market shares of leading firms declines, and leadership in the industry stabilises.

The other three regularities are concerned with technological change:

4. Product innovations and competing versions of the product are associated with the start of the industry when the number of producers grows.
5. Companies later on start to devote more to time and energy to process innovation than product innovation.
6. At the period of growth in the number of firms the most recent entries realise a disproportionate share of the innovations in products.

(Klepper, 1996 pp. 564-565)

The application of this model in the context of a new industry in a 'late' industrializing location demands some adjustments on the initial and growth stage of the original model. The initial stage is

in these locations likely to be fuelled by international relocation or the creation of new local demand for simple supplies because of this. The model of production cycle of manufacturing industry (PCMI) describes the industry evolution considering a spatial component. The model starts when firms of a certain industry relocate from a developed to an emerging country and introduce the industry to that new location. The model describes three stages which the industry in the recipient economy goes through.

1. Technology acquisition
2. Expansion
3. Relocation/international diversification

(Lau et al, 2000 p. 33).

The expansion stage of the PCMI can be compared to the growth stage of the ILC but is in late industrializing spaces characterized by the shift from technologically low end production to globally dominant designs and technological competition instead of the development of globally dominant design that occur in spaces of origin of the industry start.

Reaching the level of technology that is used in leading global designs is a progression to higher technology that is targeted by regional stakeholders in late industrializing spaces. The emergence of more advanced industries is a sign of industrial transition that improves international competitiveness and is most welcomed in late industrializing locations. To achieve the progression in development successful local growth is required and demands a virtuous takeoff of the individual firms. The transition of an industry from the initial stage to growth (ILC), or from the stage of technology acquisition to that of expansion (PCMI) is subject to a range of conditions and circumstances that will be considered in the following literature study to produce the framework from which performance of the automation industry in Penang will be considered

2.2 The mode of emergence of a new industry

The source of birth of the industry is the first factor to consider for industry development. The literature on late industrialization and catch-up speaks about two modes of industry genesis. The first mode is an exogenous implementation of technology by the attraction of FDIs (like described by the PCMI) and the second is an endogenous creation mode that is also under influence of substantial state intervention. In this endogenous mode of industry genesis the state has to acquire relevant technology and transfer this to the local firms or create a way for the industry to learn (cluster) (Hernandez, 2004 p. 7).

From evolutionary economics some recent ideas on industry genesis and evolution are named here as a third mode of industry genesis relevant to late industrializing locations. This is the regional industrial branching thought in which diversification of an industry leads to the genesis of related industries. It privileges the autonomous development of the industry and states that firms in new industries need not to be new firms (Boschma & Frenken, 2009; Boschma et al, 2012). The relatedness is reflected in terms of products, processes and technology requirements that have similarities with the 'mother', in case the new industry has grown out of an 'old' one. A second way branching occurs is in a recombination of competences from regional industries.

The 'create and grow' mode of industry genesis has had mixed results in creating successful industries. The constraint of the mode is a misdirected state intervention that is not providing the right incentives for the industry to reach a stage whereby further growth on the global market can be achieved. The local branching theory is increasingly accorded to be a more successful mode of industry genesis, when some entrepreneurial factors are considered that are not present in a 'create and grow' mode. The prevalence of experienced entrepreneurs with related skills and knowledge is a conducive factor for early growth.

Firms in new industries display different types of entries. Entries by existing firms that diversify their activities into the new industry are labeled diversifiers. The second type are new firms that are founded by an experienced or inexperienced entrepreneur, with or without knowledge on the industry concerning. When the experience of the founder is gained in incumbent firms in the same or main client industry the firm entry is labeled 'de novo' (Klepper, 2001). The diversifying type

of firm is considered a routine-replicator that spurs regional branching and creates knowledge spillovers. Empirical research has shown that firms that enter by diversification initially outperform 'de novo' entries in a new industry. However, later 'de novo' entries often displace diversified firms in a later stage of the ILC (Klepper, 2002).

2.3 *Technological regime of an industry*

In the description of the stages of the ILC is mentioned that the speed in which an industry passes the cycle is dependent on the radical and incremental product- and process innovations. The products, processes and technological regime of an industry are interrelated. The technological regime of an industry is determining the possibilities for innovations in products and processes (Nelson and Winter, 1977 p. 57). The technological regime of an industry can transform when its core rules change (Poel, 2003 p. 52) and this can be initiated in different ways, but most of the time outsiders of the regime play an important role.

Poel (2003) has constructed four industry innovation patterns with the help of Pavitts (1984)⁵ classification of types of innovating firms. He made this classification based on the user needs, source of technology and means of making benefits of the firm (for classification see table 2.1, column 3). The four innovation patterns and the characteristics of the industries are summarized in table 2.1. An important distinction between the patterns is the actor that drives the innovation. A brief look at the patterns shows a well-fitting pattern for the industry of the particular case of research; automaton. The pattern that fits the industry of the case study is discussed in more detail; the user-driven innovation pattern.

The innovations in the user-drive innovation pattern derive from new requirements posed by the users. Innovation is mainly incremental and is dependent on the developments at the users market. Knowledge generation for innovation and new technological configurations will take place between supplier and user. Opportunities for innovation therefore arise from changing functional requirements of the users. A constraint for proactive development of innovations is the short term focus of the users, (Poel, 2003 p. 61) what makes it hard to regain investment costs. The user-driven pattern is the most constraining pattern for processes of transformation (Poel, 2003, p. 63).

Table 2.1 Characteristics of Poel's four innovation patterns

Innovation Pattern	Type of innovating firm	Type of user	Source of innovation	Typical sectors
Supplier-dependent innovation pattern	Supplier-dominated; scale intensive	Anonymous consumers	Suppliers (component parts)	Housing Traditional manufacture
User-driven innovation pattern	Specialized suppliers	Professional users	Users (functional requirements)	Machinery Instruments
Mission-oriented innovation pattern	Pavitts (fifth category)	Government as client	Governmental actors	Infrastructure
R&D-dependent innovation pattern	Science based	Mixed	R&D (technological promises and presumptive anomalies)	Electronics Chemicals

Source: Poel (2003, p. 54)

The technological character of an industry is important for defining factors and circumstances that will positively or negatively contribute to the development of the industry. The

⁵ In Poel (2003), Pavitts Sectoral patterns of technical change: towards a taxonomy and a theory. Research Policy, 13

highly technological based industries are often marked by a concentration of capability and resources in a few firms. These firms start to dominate the industry and are able to shift the technological frontier at substantial speed. It enables them to create a relation between demand and innovation that transit to supply driven. The few lead firms capture a large part of global higher end market, leaving opportunities for other firms only in lower end segments and at the same time confronting catch-up firms with a 'distance' or gap to the technological frontier that is extremely hard to bridge. This leaves amongst others little technological opportunities (Klepper & Malerba, 2010) making these lead firms in charge of the further development of the industry. Late industrializing countries entering a new industry are always confronted with a 'gap' and strive to bridge this as best as possible.

2.4 Firm characteristics for survival and growth

From the work of Fritsch & Schindele on firm survival some factors are gathered to examine possible exits of the industry on specific characteristics. These are for example the liability of newness and that of smallness. The reasons for the liability of smallness are related to that on the industry level; reaching a minimum efficient scale and on a regional level; acces to labour and capital. In their research the qualification of the entrepreneur is a third factor that is useful for the analysis on exits. For entries Fritsch & Schindele found that conducive to their survival chance is a higher level of qualifications of employees (Fritsch & Schindele, 2010).

Roberts et al. (2011) have written about the entrepreneurial experience of the founder of the firm and the influence of this in causing differential development paths. It builds on the empirical evidence of a higher survival rate of experienced starting entrepreneurs in comparison to inexperienced people (Roberts et al, 2011, p. 1516). Empirical testing on a set of data from wine producers in Australia and New Zealand brings forward that firms started by entrepreneurs with prefounding experience in the same industry are initially larger and remain so in the next 20 years. The research also shows that experienced and inexperienced firms expand their export scope in the same speed as they grew older; confirming the assumption of the authors that learning opportunities persist for all types of firms (Roberts et al, 2011 p. 1535).

Not just the pre founding experience of an entrepreneur is influencing the developmental path. Cultural aspects of the entrepreneur are important to consider has research on overseas Chinese business revealed. The research was concerned with overseas Chinese business characteristics and their potential impact on the development of their firms. Many Asian countries have a large population of overseas Chinese entrepreneurs, (Taiwan, Singapore, Malaysia and Hong Kong) and are all occupied with economic performance and how to encourage more indigenous fast growth entrepreneurship. Mostly the discussions on this subject emphasize the need for the encouragement of more start-ups, but in the case of a large number of Chinese owned firms, policy should also encourage the Chinese founders to overcome certain traditional characteristics in doing business. These characteristics are; the nature of family business, tight control of information, centralized decision making, reluctant to outside financing, and a negative view on brand building (they rather diversify into unrelated areas like property than invest in a core business). These characteristics in Chinese business culture cause a reluctance to outside influence, unwillingness of sharing decisive authority and not sharing knowledge (Ahlstrom et al, 2004).

Klepper & Thompson (2006) have done research on the development of firms in relation to the number of submarkets it operates in. The firms' growth is negatively related to the number of submarkets in which it is active. The survival of a firm however is positively related to the number of submarkets. Furthermore the research found out that the number of submarkets a firm is operating in increase with age (Klepper & Thompson, 2006 p. 863)

Growth of the firm caused by its unique startup capabilities and the development of them is explained with the resource-based theory. The theory believes the assumption that resources and capabilities of an organization provide its strategic importance. The resources are defined as tangible and intangible assets tied to the firm. The capabilities and assets are firm-specific and define the development of the firms as they can be source for competitive advantage (Brush & Chaganti, 1998).

Rasiah, (2001) has made an attempt to stage the process of upgrading of capabilities. He describes five stages of technological capabilities in the machine and tool sector in Malaysia. In the first stage firms produce just crude parts, moving to jigs & fixtures, precision engineering of small components and eventually to stage four where semi-automated machinery is produced. The fifth is reached when OEM manufacturing starts. The highest stage to reach is number six in which original design manufacturing and original brand manufacturing is started. It was noted by Rasiah that the activity in stage five or higher does not automatically lead to the abandoning of earlier activities, in contrary.

The improvements made on capabilities and the development of new capabilities occurs through a learning process. How learning occurs is mostly described from a regional level. This will later be discussed but first learning on a micro level is described. Theory on learning within firms without directly using external factors to explain the emergence of new capabilities is for example created by Cantwell & Fai (1999). They stress the important share of learning that is done while the firm is doing its everyday activities. Learning by doing is prevalent in every firm but the continuity of the process is depending on the activities of the firm and therefore the role of learning by doing for firm and even industry development is not similar.

2.5 *The role of innovation systems and clusters in the development of industries*

The basic characteristics of a region determine the first image on the economic value of it. These are the location, infrastructure, labour, market and the prevalence of economic activity. systemic characteristics like cooperation initiatives, innovativity and policy influence are harder to distinguish and need effort to get to know. This paragraph will provide scientific knowledge on the systemic aspects of a region to be able to analyse how they are influencing industries and firms developments.

To be able to notice how a region is conducive for industry development research on regional clustering and regional innovation systems is presented. A well-developed innovation system is essential for regions that want to decline the technology 'gap'. The relation between GDP and a strong innovation system is proven. Countries that have succeeded in closing 'the gap' have shown to give high priority to this manner of development. An innovation system is incrementally developed over time and can be hampered history or culture (Fagerberg & Srholec, 2008). Clustering is generally accepted to be conducive for development in terms of transactions, technology and knowledge spillovers. Groups of firms that are co-located quickly get the status of a cluster. Benefits are only yielded of when the co-location leads to interaction.

Rasiah (2009) provides an example of how such a dynamic cluster is composed. He presents a systemic squad in which four pillars are essential for dynamic clustering. The first pillar consists of basic infrastructure and stability. The second pillar is high-tech infrastructure, critical for promoting learning and innovation. It includes licensing, training, and regulations on intellectual property rights. The third pillar refers to network cohesion and integration and the institutions that provide the possibilities for this. The fourth pillar of a dynamic cluster is global connectedness of the cluster in terms of markets and value chains. From research using this four pillar cluster approach on four clusters in Asia (one is Penang) is concluded that the cluster need considerable institutional strengthening to support upgrading in order to achieve the level of capabilities in Korea and Taiwan (Rasiah, 2009).

Empirical work done on the success of clusters and their start characteristics has led to results for late industrializing spaces. By doing research on biotechnology clusters in the US and China a distinction was made in spontaneous emergence and policy driven emergence. The clusters showed to have the same success factors, knowingly; the human and financial capital. The clusters however differ in the underlying processes of creating and sharing these assets. The most fundamental differences arise from the impact of entrepreneurship, social capital and network patterns on the cluster's configuration. It was too early to make statements on the most successful strategies in using the assets (Su & Hung, 2009).

Another research that has focused on development and the mode of emergence of the cluster is that of Suire & Vicente (2009). They corroborate on the growing trend that clusters are not a panacea for knowledge based economies. They mention work of Ter Wal & Boschma, 2007 and Menzel & Forhal, 2007 to state that the evolving knowledge and network structures of clusters are an important factor for the life cycle of a cluster. Their own research has shown that the reasons for co-locating are influential on the willingness to share knowledge and the prevailing knowledge spillovers. If firms base their decision of the location choice on the decision of fashion leaders, a close cognitive group will emerge to benefit from the growing reputation and geographical charisma. The outcome of this co-location can display a too close cognitive proximity which will result in risk avoiding of unintended spillovers. This leads to knowledge-waste, mistrust and tensions on the local labour market. Firms that decide to co-locate because of the intention of improving their external knowledge accessibility are slower in decision taking on relocation. Clusters that are slowly formed are more likely to become Silicon-Valley type of clusters. The benefit an industry gets from its environment differs during the life cycle of the industry. For young industries a local diverse economy is beneficial, but turns to be insignificant for industries in the intermediate stage. They even become negative for industries that have reached the mature stage. Local specialization increases in importance for the industry as it matures (Neffke et al, 2011 p. 63).

The body of literature presented provides multiple factors to be considered in the developments of the industry. The next chapter will zoom in to see how these factors were in the automation industry in 2005.

3. Introduction of the case: Penang & the automation industry and the Penang automation industry

This chapter gives a short description of the location of the case and the automation industry in general. Then it continues with the information available on the automation industry in the specific location; the Penang automation industry. This information describes the start-up characteristics of the firms in the industry and the firms' developments from their start up to 2005. The chapter serves as basis for understanding the early evolution of the industry and help to draw up the conceptual model.

3.1 Penang

The state of Penang is the most densely populated state of Malaysia with 1.6 million people on 1000 square km and is divided in two areas; the island Pulau Pinang and Seberang Perai. Penang is located in the Straits of Melacca (figure 1.1). This Malaysian state is unique because of its strong presence of Chinese in its racial mix; over 40% is Chinese, 10% Indian and another 40% is Malay (SERI, 2011). The largest city in the state is Georgetown, that has recently received the status of Unesco world heritage site and attracts a lot of tourists, who are an important source of income.

Mentioned in the introduction already, Penang is one of the top performing states in Malaysia and has a strong presence of MNCs located in the FTZs. Electrical and electronics manufacturing are the most important sectors, followed by textiles and garments. SMEs account for 88% of the manufacturing and related services in Penang and account for 26% of the total employment in the sector. Key SME sectors in Penang comprise fabricated metal products; automation, machinery & precision tooling and food & beverages. The chief minister of the state is the first Chinese to gain this position. The state government is promoting more transparent politics and a green Penang. The investment agency Invest Penang is occupied with attracting new FDIs and does this in markets with a considerable growth potential. According to Invest Penang these growth markets are; LED, photo-voltaic, aerospace and medical devices. Core economic activity of the region is still the semiconductor industry but a diversification is opted⁶.

Box 3.1 A brief history of Penang

Already from the 16th century the port of Penang has been used by many traders. The first westerners to discover the island were Portuguese on their way from Goa to the Far East in search of spices. The location of Penang at the northern entry to the Straits of Malacca provided a sheltered port for Asian, Arabian and European ships during the monsoons.

Penang came under British rule in 1786 in an exchange made by the Sultan of Kedah. In return he wanted British military protection from Siamese and Burmese armies threatening Kedah. The location of the island attracted the British East India Company who used it as home base for their trading ships. The settlement on the island was named after King George the III; Georgetown. The island was declared a free port to compete with the Dutch who were then ruling the trade in the East Indies. The strategy attracted many immigrant traders to Penang and the population grew rapidly at the end of the 18th century.

In 1826 Penang became part of the Straits Settlement, which came under direct British rule in 1876 as a Crown Colony. Georgetown has shortly been the capital of the Straits Settlements but its status was lost to the rapidly developing Singapore.

With the opening of the Suez-Canal in 1869 the British trade with the Far East expanded further and Penang prospered, attracting more people from all over the world. By then Penang became a true melting pot of diverse cultures, which is still visible in the cultural heritage of the island.

⁶ Interview with miss Anna Ong, Invest Penang.

During World War II Penang was captured by Japanese forces because of an early withdrawal of the British. For three and a half years the Japanese ruled Penang with cruelty and many of the local population fled to the plantations on the mainland.

In 1945 the British concurred the Japanese but the end of British imperialism was near. In 1946 Penang became member of the Malayan Union, to become a state of the Federation of Malaya in 1948. The Federation gained independence in 1957.

In 1969 the free port status of Penang was ended, which presided into high unemployment. To counter this backdrop in trade and unemployment the state opened the Free Trade Zone which quickly became very successful as Penang became one of the largest electronics manufacturing base of Asia.

Source: Wikipedia History of Penang

3.2 *Automation Industry*

The term automation was not widely used before 1947, when General Motors established their automation department and the industry found its start. Since then the technologies to automate processes have changed constantly on a high speed.

The automation industry is concerned with the production and development of systems and machines to increased throughput or productivity, to gain an improved quality of products. The difficulty in automating processes is the unpredictable developmental costs generated. The cost of automating a process may exceed the cost saved by the automation itself. In relation to this is the high initial cost in comparison to the cost of the product. Automation is interesting from a certain critical mass of production. The high costs are reason for automation firms to work in close cooperation with clients demanding automated processes (Mintchell, 2010).

The industrial automation industry is an industry that is characterized by small production volumes and a tremendous variety of applications. The industry often utilizes technologies that are developed in other markets. The firms in the industry are good at customizing to specific needs. Some firms have profited from technology developments that offered growth opportunities in niches and did this by offering better specifications and good marketing. The industry however only has a few firms that grew very large (Automation, 2004).

Box 3.1 Clarifying the concepts used in the automation business with some examples

Related industrial automation products:

Jigs & fixture

A fixture is a work-holding or support device used in the manufacturing industry. The main purpose of a fixture is to locate and in some cases hold a work piece during either a machining operation or some other industrial process. A jig differs from a fixture in that it guides the tool to its correct position in addition to locating and supporting the workpiece.⁷



Precision tooling

⁷ Source: [http://en.wikipedia.org/wiki/Fixture_\(tool\)](http://en.wikipedia.org/wiki/Fixture_(tool))



Machine parts

Advanced industrial automation products:



Machines



Fully integrated automated systems

3.3 The Penang automation industry

The first challenge in the start of the research in 2005 was to define the industry and identify the population of automation firms. This process yielded 37 Penang automation firms. Of these firms 27 have participated in the research. The relevant results and conclusions of this research will be summarized. These are stemming from the report of M. Aldering (2006) and publications based on this research (van Grunsven, 2007) and an article citing this publication (SERI, 2008).

The regional context in which the industry emerged was that of a growing influx of foreign MNCs into the FTZs of Penang. These opened in 1970 and soon became a hub for semiconductor companies followed in the '80s by consumer-electronics companies and in the '90s the hard disk drive industry settled itself in the FTZs of Penang. The companies were from diverse backgrounds; US, Canadian, European and Japanese. The settlement of these large companies created supply opportunities for local SMEs. Backward linkages were soon established with the foreign MNCs and resulted in an integrated economy by the '90s. This happened with the help of the Penang Development Center (PDC, now Invest Penang), which was erected soon after the opening of the FTZs. The PDC occupied itself with attracting FDIs, creating appropriate infrastructure and matching the incoming MNCs with local firms. The new connection between the local SMEs and foreign MNCs resulted in an upgrade of products and value add by the SMEs in Penang that was significant higher of that elsewhere in Malaysia. It was in this time period that the automation industry emerged.

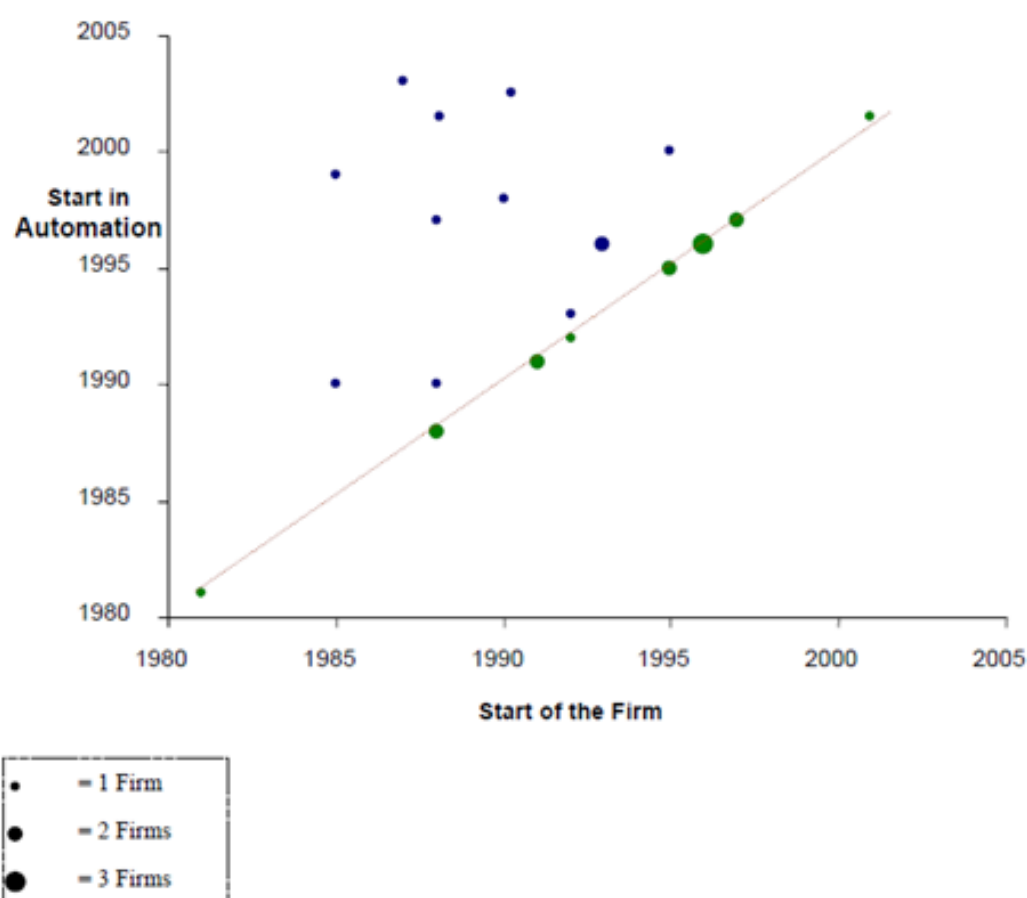
3.3.1 The start-up characteristics of the industry

The most firms have started to operate in automation in the '90 although some firms were already existent before this, they did not produce automation products till then (figure 1.1). The majority of the automation firms are founded by a person with a local Chinese background. There were just two internationals found in 2005; one Japanese subsidiary (Atem Advantest engineering) and one Canadian subsidiary (ATS) had set up automation activities in Penang. Meaning the industries emergence was not fuelled by direct FDI inflow, but is the result of a branching process.

The local entrepreneurs that started automation activities can be divided in two types. The first type is the 'diversifying entry'; 16 firms that entered the automation industry by a related diversification of their product portfolio. Products that they were producing before moving in to automation were jigs & fixtures, machine parts and precision tooling (see box 3.2). The most important reason for the firms to diversify was because the demand for automation products came from their current (MNC) clients, who asked the firms to supply them with automated products.

The second type of entries is the 'de novo' firm. Firms that started to produce automation products straight from their start (11 firms). The reason for the 'de novo' firms to start in automation products was the business opportunities seen by the founders of the firms. The majority of the founders of both type of firms previously worked for the Malaysian based MNCs active in semiconductor production. They wanted to put their experience and knowledge (gained in the MNC) to practice in their own firm. This type of firms are spin-outs as they started in a technologically less advanced business then they were working in. Some 'de novo' firms diversified some years after their start into less technologically advanced products. The reasons given for this was to serve as a one-stop-shop for their clients or to spread their risks by running a broader product portfolio. Compared to the 'diversifiers' named above this development is a reversed diversification process. In this report these 'reversed diversifiers' are still named 'de novos' to emphasize the different entry from 'diversifiers'. Table 1.1 gives an overview of the interviewed firms, their type of entry and the relationship with their first clients. For 'diversifiers' the time lap between the start of the firms and their start in automation is visible in figure 1.1.

Figure 3.1 Start of firms in the automation industry



Source: Aaldering (2006, p. 52)

Table 3.1 Entry and relationship with first client(s)

Company name	Type of entry	Relationship first Client(s)-founder
Atem Advantest Engineering (M) Sdn Bhd.	De Novo	Yes, were clients from HQ
ATS Automation Malaysia	De Novo	Yes, were clients from HQ
ViTrox Corporation	De Novo	Yes, from same MNC-background
Slendid Growth (M)	De Novo	Yes, already clients from other own companies
ER Mekatron	De Novo	Yes, one was contact from Singapore HQ
Gops equipment Designer	De Novo	No
JSI Systems	De Novo	No
AT Automation Technology	De Novo	No
SRM Integration (M)	De Novo	No
Pentamaster	De Novo	No
Excel Precision	De Novo	Unknown
Lis – Tec	Diversifier	Yes, already clients from former products
Alpha Master (M)	Diversifier	Yes, already clients from former products
LKT Automation	Diversifier	Yes, already clients from former products
Pentatronics Technology System	Diversifier	Yes, already clients from former products
Vista Equipment Manufacturing	Diversifier	Yes, already clients from former products
Zoomic Automation	Diversifier	Yes, already clients from former products
UWC Automation	Diversifier	Yes, already clients from former products
Polytool Integration	Diversifier	Yes, already clients from former products
Hillton Precision Engineering Sdn. Bhd	Diversifier	Yes, former employer
Brusia Engineering	Diversifier	Yes, former employer
Epsilon Technology (M)	Diversifier	Yes, former employer
Wanjun Technology	Diversifier	Yes, former employer
Prodelcon/Multimatic Systems	Diversifier	No
Greatch Automation	Diversifier	No
K.K. Choong Engineering	Diversifier	No
Micro Modular System	Diversifier	Yes, were already clients of sister company

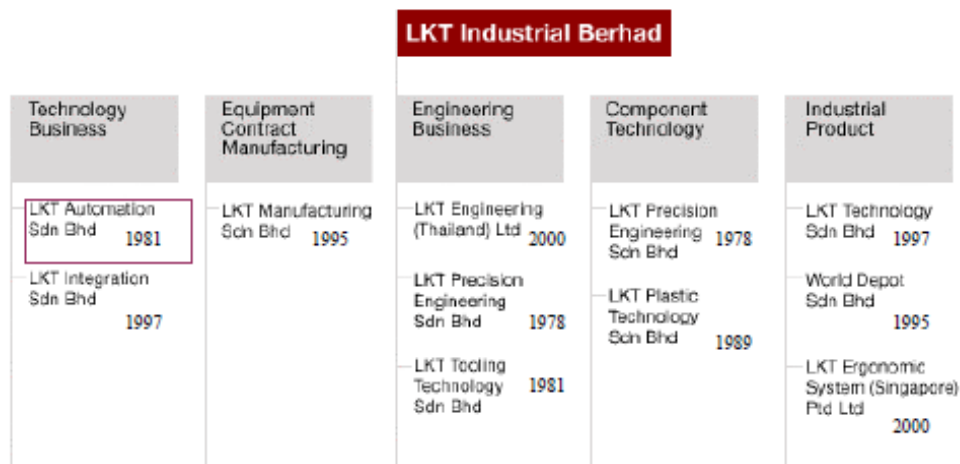
Source: Aaldering 2006 p. 70

3.3.2 Firm structure, markets and clients

The diversification in activities is displayed in the organization structure of the firms. Firms chose to organize their selves in a group structure in which old activities were still performed but under a different legal entity. The group structure in combination with start data of the different entities provides an insight in some firms' expansion in activities over time (see for an example figure 1.2). A considerable number of firms however, were organized in one single entity by 2005.

No distinctions were found between the type of entry of firms and the organization structure. The information on firm structure pointed out that some firms were internationalizing by opening subsidiaries in other Asian countries.

Figure 3.2 Example of a group structure of an automation firm



Source: Aldering 2006, p. 56

The background of the founders of the firms has helped them in setting up a client base. The first clients of the firms came from the former employer of the founder or were already clients to the firm for different products (table 3.1). This relation with the background of the founder of the firm is the reason why most of the firms are serving the local semiconductor market (24 out of 27 firms). During their existence just three firms broadened their horizon by entering new markets than the ones they served at their start. Electronics and Hard disk drive (HDD) were second most popular after semiconductor (table 3.2). The smaller product portfolio and therefore the higher degree of specialization of the 'de novo' firms resulted in serving a narrower range of markets than 'diversifiers'. Figure 3.3 displays some logos and names of the important clients of the automation industry.

Table 3.2 Markets of the Penang automation industry by 2005

Markets	Number of firms Serving the Industry
Semiconductor Industry	24
Hard Disk Drive Industry	10
Automotive Industry	7
Consumer Electronics Industry	6
Medical/Pharmaceutical Industries	3
Rubber Industry	2
Other Industries	5

Source: Aldering, 2006 p. 71

Figure 3.3 Important clients of the Penang automation industry



Source: PSDC in Aaldering, 2006 p. 76

The automation industry was active on international markets already in 2005; only a few firms did not export part of their output. For many firms the local market was still most important, especially for the smaller ones. Export varied from as much as 80% to only 10% of the output. While the grown export numbers did presume that a geographical shift of markets was taking place, it appeared though that this growth was largely associated with existing clients shifting to- and expanding elsewhere in the region, especially China. Thus it did not reflect targeting new clients abroad but rather relocation of existing ones. Some relocated MNCs stayed client to the Penang based automation. The 17 firms who reported that they had lost clients explained this with the following reasons; closure of clients, relocation to another country or replacement by other suppliers. The hard disk drive sector did not sustain its presence in the FTZ of Penang. At the end of the '90s most of it had closed down and will be responsible for the loss of clients in the automation firms.

In 2005 almost all firms claimed that internationalization was necessary to survive. A large number said to be forged to follow their clients when they would move outside Malaysia, or would set up activities abroad. Many firms showed to export to China and some firms had already established subsidiaries over there or spoke about the intention to move their whole company to China. This pointed to a high level of site-specificity for the automation industry, although the reason for moving to China does not have to be related to clients directly. The strategy for moving business can just as well be entering new markets, especially when the firms have established some contacts with relocated clients. The diversifying firms show to have developed more assets towards their clients than the de novo firms. Although some specific asset development of the firms in the automation is seen, most firms develop their assets more general.

3.3.4 Performance; promising growth figures

The majority of the firms (14) started with less than five employees. Among the larger startups with 10 or more employees (7) were the two foreign companies. All firms have experienced a strong growth in the number of employees from their start up to 2005 but were still classified as SME (<150 employees) according to the definition of the bank of Negara Malaysia.

Company Name	Custom	ODM	OBM	Integration New Technology	Flexibility	Market Monitoring	Marketing	Design
Alphamaster (M)	Fair	Na	Na	Medium	Good	Medium	Medium	Medium
AT Automation Technology	Medium	Good	Na	Medium	Good	Fair	Fair	Fair
Atem Advantest Engineering (M) Sdn Bhd.	High	High	High	Good	Good	Fair	Medium	High
ATS Automation Malaysia	High	High	High	High	High	High	High	High
Brusia Engineering	Good	Good	Na	Medium	High	Fair	Medium	Good
Epsilon Technology (M)	High	Na	Na	Good	High	Medium	Good	Good
ER Mekatron	Good	Good	Na	Good	High	Medium	Good	Good
Exel Precision	Good	Good	Good	Medium	High	Good	Medium	Good
Gops Equipment Designer	Medium	Na	Na	Fair	Fair	Fair	Medium	Medium
Greatch Automation	High	Good	Good	Good	High	High	Medium	Good
Hillton Precision Engineering Sdn. Bhd	Medium	Na	Na	High	High	Good	Good	Good
JSI Systems	Good	Good	Good	High	High	Good	Good	Good
K.K. Choong Engineering	Good	Na	Na	Medium	Medium	Medium	Medium	Medium
Lis – Tec	Fair	Na	Na	Medium	High	Fair	Fair	Medium
LKT- Automation	High	High	High	Medium	High	Medium	Medium	Good
Micro Modular System	Good	Good	Good	Medium	Good	Good	Medium	Good
Pentamaster	High	High	High	Good	High	Medium	Good	Good
Pentatronics Technology System	Good	Na	Na	Fair	Good	Medium	Good	Good
Polytool Integration	High	Good	Na	Good	High	Medium	Good	Good
Prodelcon/Multimatic Systems	High	High	High	Good	High	Medium	Good	Medium
Slendid Growth (M)	Medium	Na	Na	Good	Good	Good	High	Good
SRM Integration (M)	Na	Good	Good	Good	Medium	High	Fair	Good
UWC Automation	Medium	Medium	Na	Good	High	Medium	Medium	Medium
Vista Equipment Manufacturing	Good	Good	Na	Good	High	Good	High	Good
ViTrox Corporation	Good	High	High	Good	High	Medium	Medium	Good
Wanjun Technology	Medium	Na	Na	Medium	Medium	Fair	Medium	Good
Zoomic Automation	High	Good	Na	Good	High	Good	Good	High

Table 3.3 Capability rating by the firms in 2005

Source: Aaldering, 2006 p. 81

The performance of firms was determined by asking the interviewee about growth on four items; employees, turnover, production volume and clients. Eight firms classified as fast growers as they scored fast growth on three or more items, 16 firms reported a constant medium growth. Two firms showed a decline on one item and one firm experienced a decline on all items. A decline on number of employees or production volume does not have to be noticed as a negative development, as it can be explained as efficiency growth or more value added production as long as the turnover is increasing. With this information it can be concluded that the automation firms were experiencing (quick) growth up to 2005. It has to be considered though that there might have been firms that had to quit business because of bad results. There is no knowledge about early leavers from the industry, but there is a possibility that there were a few because they are hard to trace in a country where there is no central administration.

In contrary to the expectations from a government with a strong hand in the economy the majority of firms claimed not to have received help at their start. In the form of systemic coordination, described by Rasiah (2002) however, it can be argued that the government made efforts to provide a fruitful environment for business by creating the infrastructure and support for training and R&D. Meaning that indirectly there was some support. Another important aspect of systemic coordination is matching MNCs with local supplier firms but on this topic the automation firms have said they did not participate in linkage-programs. The reasons for not participating in available programs or funds are two-folded; the entrepreneurs did not want to waste precious time with administrative obligations and second they did not qualify for support because of regulations on size or ethnic ownership⁸. In most cases the firms that stated help by starting up their firm this was from their former employer by becoming the first client.

3.3.5 Capabilities, learning and products

The capability development of the automation firms had occurred through several learning processes. The foundation of a capability was in either related variety or in expertise gained at earlier employing firms. The findings showed that switching to automated equipment products was possible for the firms because the capabilities needed were related to existing ones or to available expertise. There has been capability extension rather than building a new set, so learning was rather fast. Many interviewees in 2005 interpreted and rated capabilities in automated equipment according to the technology and precision embedded in production equipment available. When prompted further, some insights were obtained in the level of capabilities beyond the above-mentioned aspects, i.e. embodied in employees. Many firms in 2005 rated these as medium to fairly high.

Most firms expressed that clients had played a significant role in upgrading such capabilities. This had occurred through observations made on the clients production floor, or having engineers stationed at the client for the duration of a project. Most often learning had occurred intra-firm by doing, by discussing product specifications and technical matters in meetings, and by in-house training. In case capabilities were lacking some firms acquired them by tapping into local worker mobility. Inter-firm collaborative networks or knowledge exchange were hardly mentioned as a mechanism for learning and expanding capabilities. None of the firms acknowledged a role for the government in learning processes.

The 'de novo' firms were assumed to be marked by a different learning process and curve, to the extent that they lacked the foundation of capabilities/competencies acquired in related business. Yet, it appeared that the product and technological knowledge that entrepreneurs were able to 'transfer' to their own firm had provided sufficient compensation and a good basis for product-oriented research and development, resulting in niche products.

Firms were asked to rate their capability on a 5-point scale on a number of aspects: market monitoring; marketing; design; custom/odm/obm production; mechanical and system aspects;

⁸ The New Economic Policy (NEP) is a form of affirmative action and was introduced in 1971 to raise the income and living standard of the majority (Malays), which was significantly lower than that of the Chinese minority. NEP officially ended in 1990, but some economic benefits for Malays are ongoing (Jomo, 2004).

software integration and integration of new technology (table 1.3). As to non-production aspects the two groups did not differ substantially in terms of average rating score. A cross-tabulation showed that de novo firms focused relatively more on production of standard machinery. These firms engaged relatively more in ODM and OBM and less in custom production.

Many firms started with simple machines/systems in terms of technological content, design, and systems integration; but they had upgraded to more complex machines/systems along with their learning trajectory and capability development by 2005. Most firms acknowledged that they were not able to serve the high-end segment of markets. De novo firms generally appeared to be more specialized in a limited range of products for specific processes serving 'niche' markets, and these companies stated that they still mostly served the low- and middle-end segments. Yet, some firms had managed to widen the product portfolio from made to order only to a more diversified and standard one, including own design and own brand manufacturing.

3.3.6 Connectivity

Projects by the state government to tie MNCs to local SMEs were plural. The government thinks of the capabilities and competences of SME's as helpful to reduce the cost and dependency of MNCs in imports. For this objective the Global Supplier Program and the Services Suppliers Program were developed by the Penang government in cooperation with PSDC and the Small and medium sized firms' development corporation (SMIDEC). The programs were based on a strategic partnership between PSDC and the MNC's aimed at upgrading the capability of local companies to be world-class suppliers of services and materials, not only to the MNC's in Malaysia but globally. In 2005 this program showed to have slowed down already. No relevant effects of these programs have effected development in the automation industry. Gradually the conservative attitude of entrepreneurs in the industry towards state support showed to be changing towards a call for support, as the firms wanted new markets to be found.

Many firms in the automation industry share information with their clients about important things like confidential matters, production costs, and ways to lower production costs, quality improvement and process management. This characterizes the close relation firms have with clients. At the same time, the automation industry is a business in which many customized products simply have to be made according to the client's wishes, making cooperation and sharing information unavoidable.

In 2005 a public-private initiative led to the establishment of the 'Penang Automation Cluster' (PAC). The PAC was established to promote inter-firm collaboration to address issues the industry is facing. However, by 2005 nothing could (yet) be concluded about the results this initiative was yielding. It seemed by then that the PAC memberships showed a bias towards larger companies and a number of key suppliers. It certainly did not display the heterogeneity of the industry and its clients and suppliers. This heterogeneity is said to prevent industry-encompassing collaborative action, and therefore also the attempts for a successful cluster initiative. Firms are afraid to share knowledge but are also considered too heterogeneous to work together. The problems facing the industry were summarized by the chairman of the PAC and boardmember of Pentamaster, mr Chuah (figure 1.3).

Figure 3.4 Threats for the automation industry in Penang according to Pentamaster

1.	Very dependent on semiconductor industry (cyclical industry)
2.	Manufacturing in volumes to achieve growth (now custom made production, no standard products)
3.	Lack of awareness & knowledge in industrial compliance standards (ce, ul, rohs, din, iso)
4.	Lack of resources to penetrate global market (finances, network, courage, standardized product)
5.	Shortage of appropriate skilled workforce (shortage, SMEs competing with MNCs)
6.	Lack of high-tech equipment for design (no investment in this area)

- | | |
|-----|--|
| 7. | Lack of good secondary process to support fab & sheet metal finishing (no follow up to finish the precision parts) |
| 8. | Lacking in R&D and investments in manufacturing technology (to move up value chain and strengthen capabilities) may be due to following; finance, skilled people, complacency, market intelligent. |
| 9. | Weak in supply chain (components and material sourced from overseas, not able to form strong supply network, no believe in cooperation; tend to compete |
| 10. | Global competition (unable to compete with branded companies in US, EU and Japan, unable to compete with lower cost equipment suppliers |

source: Presentation Pentamaster

3.3.7 Strategies in 2005 for future development

Related to the experienced success of a diversified client and product portfolio, it was not surprising to see that for many firms this was a strategy mentioned to keep continuity in the firm in the future. The strategies of entrepreneurs could further be divided in two goals; internationalization and improvement of capabilities. In line with this improvement of capabilities some firms have said to focus more on standardization of their products in the future, to be able to create an own brand.

Constraints that were feared by the firms in for further development were the shrinking market in Malaysia, the lack of money for investments for expansion, a growing competition in the automation sector and the lack of skilled personnel. These are all constraints that very well stroke with the problems summarized by the PAC although many small firms did not join the initiative to be able to express their problems.

Options for firms in the industry to avoid the growing competition were considered. Putting a focus on high-technology niche markets like medical devices and pharmaceuticals was one of the options heard. To be able to do this, the importance of an improvement on capabilities was recognized. Many firms produced customized products. The situation of the rising costs combined with low capabilities of these firms is predicted to lead to a shake-out of firms in the industry.

4. Conceptual model and hypotheses

This chapter provides expectations on the developments of the industry. In the conceptual model for development, influential factors are displayed and their nature in the development; conducive or constraining. Three hypotheses on development are made.

The evolution of the automation industry is described on two levels; micro and meso. The micro level will look at the results of the firms in turnover change and the change in number of employees. This will be done with the collection of data on the subjects. With help of the theories and variables of chapter 2 the expectations on developments are created. These are seen in the conceptual model, figure 4.2. The nature of the factors in development; conducive or restraining are displayed with a colored line respectively green and red. The factors named are tried to be placed in the level where they are supposed to stem from.

Variables on developments are coming from three different levels, the mode of data collection on the micro level provides results on two. Development of the industry was expressed in variables that are operationalised.

Industry developments:

- **Change in number of firms**

The number of firms active in automation activities by the time of data collection.

Firm performance:

- **Change in turnover**

The average turnover of the last two years in Malaysian Ringgit.

There is chosen for a two year average to compensate for possible peak or crisis years.

- **Change in number of employees**

The number of employees in the firm working in automation activities.

There is chosen for employees in automation activities and not total number of employees because there are many firms with diversified activities. This might give a wrong picture of how many people are actually active in automation.

The dynamics in the outcome of these variables are visible in the conceptual model. The black bold arrows in the circles of industry and firm express the expectation on performance. For the industry it is negative, for firms a differentiated picture is expected expressed by two arrows.

4.1 Hypotheses on development:

The three following expectations on development are:

Hypothesis 1; The development of the industry from 2005 to 2011 has been negative.

This assumption is based on a few factors that are considered for industry developments;

- The shift to the shake out stage of the ILC
- The mode of genesis; branching
- MNC relocation
- Strong dependence on the cyclical semiconductor industry

The mode of genesis in this list is the factor that would expect a positive development. However, this is probably not strong enough to counter the other factors.

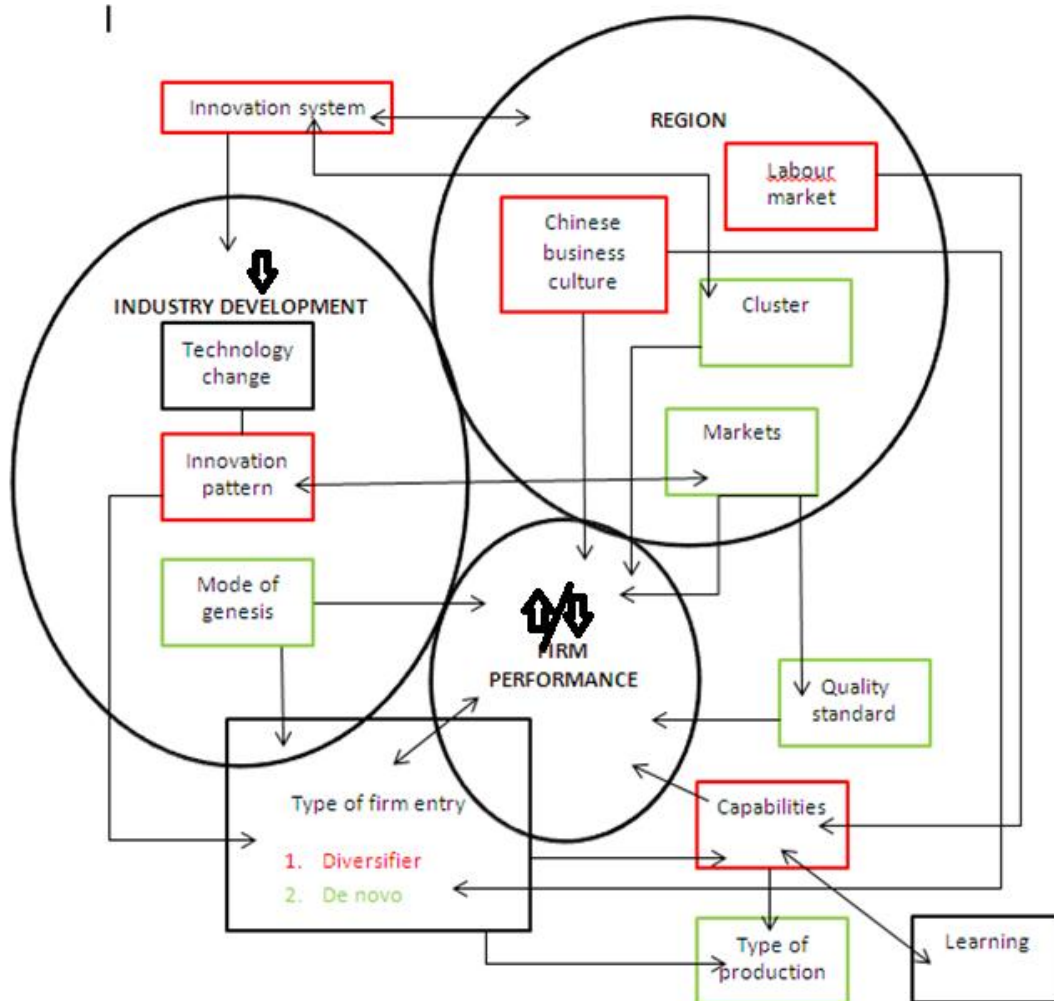
Hypothesis 2; The development of 'de novo' firms over 2005 to 2011 has been positive.

Hypothesis 3; The development of 'diversified' firms over 2005 to 2011 has been negative.

These hypothesis are based on the differential growth path mentioned by Klepper. Klepper has stated that de novo firms would start to outperform diversifiers. As de novos were already more involved with stage six of capability development of rasiah it is expected that they have reached a higher turnover growth than the diversifiers

Furthermore the number of submarkets active in do slow growth and this is probably the case for diversifiers.

Figure 4.1 Conceptual model



5. Methodology

This chapter presents the research design and elaborates on the steps taken in this research and the choices that are made.

5.1 Research design

The design that is chosen for this research is a longitudinal case study. The aim of the research is to describe the evolution of an industry and unravel the factors for this certain evolution. Evolutionary type of research prefers a longitudinal data collection (Davidsson & Wiklund, 1991 p. 95). Repetitive moments of data collection will provide insight in the situation of the firms at different times, making it possible to witness changes. For research over a longer time period a longitudinal research design is considered more valid than retrospective (trend) research, where it can occur that historic data is not remembered or registered correctly. The availability of data on the automation industry gathered in 2005 created the possibility for longitudinal research.

The longitudinal research is a case study because it focusses on a specific industry in a specific place. The case research has no pretention to be an exemplifying case, but provides a unique case. In this research the same population was targeted as the one in 2005, making this research a longitudinal case study with a panel. A negative aspect of this type of longitudinal study is the high attrition rate that occurs (Groves et al, 2004 p. 163). In this research attrition was also experienced was caused by participation refusal and firms that were no longer present in the industry. The benefit of this research design is that it is possible to ask the interviewees for reasons why they changed their vision/strategy (in comparison to results from the former collected data), which is not possible in longitudinal-cohort, or -trend studies

To ensure the continuation of the data collection of 2005 the data is collected with a structured interview method. The interview has open and closed questions resulting in quantitative and qualitative data. This is a mixed-method that serves in this research to improve the understanding of how a certain evolution path is created.

The framework for analysis that is created by the literature study is composed of popular theories on industry and firm development and regional dynamics. The study has not captured all smaller nuances that are made on the theories by new empirical research. This is because the framework is only used partly deductive. Theory is used as guide for the description of the developments but there is space for new trends that are recognized from the data. The nature of the case study is first to be descriptive and secondly to analyze results.

5.2 Research steps

Step 1: Defining the population of automation firms

The definition of the automation industry was made in 2005 and the first step in the data collection for this research was to find out which firms were eligible for participation. This search was structured with the use of the available list on automation firms from the 2005 research and list of SERIs research in 2007. Firms were checked on their active status and engagement in the automation industry by a phone call. The list that emerged out of the checks on the two lists was complimented with eligible firms found with use of the World Wide Web. Three difficulties in locating automation firms in Penang are; the automation industry is considered a sub industry, the lack of a legal obligation to register in a central list makes total numbers unknown and not all Malaysian firms are present on the web with a company website.

Not only the active firms were of interest for the research, at the start of this research one of the objectives was to find out why the 'quitters' left the industry. As it quickly after the start of the search turned out that these persons were untraceable, the objective had to be left out of the research.

Step 2: Planning and conducting explorative interviews

To get knowledge about the local issues in the automation industry people with strong knowledge about the regional economic situation or the automation industry have been interviewed. The selection of these people was made with help of my supervisor and Penang Institute. The objective was to do five interviews for orientation, but two of the chosen interview partners could not cooperate (Miss Z. Daud, director MIDA Penang and member of Penang Competitiveness Committee and director of Mini-circuits. mr.K. Kiew Kwong Sen). The names and functions of the three people that were interviewed are found in table 5.1. A small topic list for the interviews was composed from the literature study and the results of the study in 2005. This list and can be found in Appendix I.

Table 5.1 Interviewed persons for orientation purposes

Institution	Name	Function	Place and date
Khazanah Nasional (research and investment strategy)	K. Gopalan	Senior vice president	EPF building, Georgetown 13-10-2011
	A. Kevin Lee	Associate	
Invest Penang	Anna Ong	Senior Manager	PSDC building, Bayan Lepas. 9-11-2011
	Sherine Loke	Executive	
Bizwise consulting, Science Council Penang	Yoon Chon Leong	Partner of Bizwise consulting/ Secretary of Penang Science Council	Office SERI, Georgetown 9-11-2011

Step 3: Composing the structured interview list

The composition of the structured interview list comes from three sources. First source is the structured interview list that was used in 2005 to ensure a certain continuation of data collection on specific topics, and ensure a similar formulation of questions. The second source for the survey is the literature study on factors of influence on industry development, and the third source is information from the explorative semi structured interviews. For same data from 2005 no follow up is done to create time for other topics to be questioned, considering the length of the interview should not exceed 90 minutes and the topics must related to the subject of this research. This has led to the decision to delete the sections on human assets and physical assets to create more space for questions on quality standardization, networks and markets.

The interview list is structured in six sections which altogether will give information about the factors influencing the development of the firm. The sections all try to measure factors or the changes in these factors.

Step 4: Planning and conducting the interviews

The encountered firms were approached for a face to face interview by telephone. The choice to conduct the interview face to face and not use a self-completion questionnaire is made upon the general low response on this sort of surveys and the zero percent response on email requests in this specific population in 2005. After a few calls it became clear that naming my internship at Penang Institute was not working in my advantage. Most interviewees are quite reluctant to any state initiatives as was said by one of the interviewees *"we give all this information,*

and nothing is done for us". The reactions on my introduction made me change it. The average amount of phone calls conducted to arrange one meeting was five.

In all the encountered firms the CEO/director or managing director was requested to cooperate. If the person in this function were not willing or able to cooperate the question was asked if there was someone available in the company that had good knowledge about the company and its history and preferably had worked there for at least five years. This was done to assure the quality and continuity of the answers.

Sixteen interviews were planned, and almost the same amount of firms did not want to cooperate in the research. The reasons to refuse participation were research tiredness, end of year closure-busyness or principally not willing to give away information about the company to a third person.

All surveys are conducted at the location of the firm to make cooperation as easy as possible. The average time spend on conducting the survey was 75 minutes.

Step 5: Database check Invest Penang

At the last stage of data collection a new list of possible automation companies came from Invest Penang, a state funded organization, which has a directory of firms in the automation/machinery & precision tooling industries in FTZs of Penang. This data was provided in the last week of possible moments for interviews and was said to be outdated. The list consisted of 90 firms. By web research the firms on the list were checked on basic characteristics but the most important aspect of this check was to find out if the firms fit the definition of an automation firm. Unfortunately the firms that fitted the definition could not be requested to cooperate through a face-to-face survey because of a limited time presence in Malaysia. The fieldwork research period was from October 2011 until the end of December 2011.

Step 6: Data analysis

The survey data is combined with the data file from 2005 to be able to make comparisons and calculations on performance items. Because of the small amount of cases it was unfortunately not possible to perform planned statistical tests. This is the largest shortcoming of this research. Quantitative data is therefore analyzed on means and change. The qualitative data was put in a file and was used to confirm or explain observations in quantitative data.

The results from the research are presented in the next three chapters. The last chapters gives answer to the central question of the research and discusses the results.

6. Industry developments

This chapter will address the sub question: How has the population of automation firms in Penang changed over the period 2005-2011 considering its composition and size, and how can this be explained? This will be done using the data collected. The chapter will also verify or falsify the hypothesis made on industry developments; a negative development over 2005-2011. The chapter ends with a conclusion on industry developments.

6.1 Population dynamics

The identification of active automation firms in a country like Malaysia is difficult. The state of Penang is lacking a central registration system for companies on industry code. Therefore the search for firms has to be done with different sources. The state Investment agency, Invest Penang, tries to register the firms that are active in the FTZs but because firms are not obligated to register or report changes, the database is never up to date. Also the database gives no information on firms operating outside the FTZs. The results of the total number of automation firms and the dynamics in this population are therefore based on the combination of three lists⁹ of firms and complementary web research. The firms on the lists have been checked on existence.

This search for automation firms and the check-up on their active status has provided an updated population of automation firms in the industry of Penang. The population proved to have changed in total number, but also in composition over the past six years.

The automation firm population taken up in the research of 2005 existed out of 37 firms, with the notion that some firms might have been overlooked in the quest to locate all automation firms in Penang. That this has occurred can be confirmed after the new search for automation firms was executed for the purpose of this research. Two firms are encountered that were already active in 2005 but were not included in the population. The adjusted number of firms certainly active in 2005 is now 39, but again there is still a small possibility that some firms are overlooked.

The total number of firms active in automation in Penang in 2011 is set on 34 firms. The difference between the numbers is caused by exits but also by entries.

The entries were unable/unwilling to cooperate but with information from the websites of the firms some remarks can be made. The newcomers can be divided in two categories. The first is a spin-out that has started a new firm; Innogrity. The founder has a local background and the firm has its core activity in the design and production of automation systems. The firm was erected in 2006.

Then there are two new names in the Penang automation industry that are of foreign background and have established their selves using existing local automation firms. Ixmation is a MNC that put up a subsidiary in Penang in 2006 and has its headquarters in Switzerland. The Penang subsidiary is active in a niche market; leaktesting. Ixmation has taken over Excel precision engineering and built a brand new factory that shows of the new trend of corporate social responsibility that in this particular case is expressed in green and clean production. The new factory is equipped with a solar system for the provision of green energy.

Figure 6.1 New entries to the automation industry in Penang

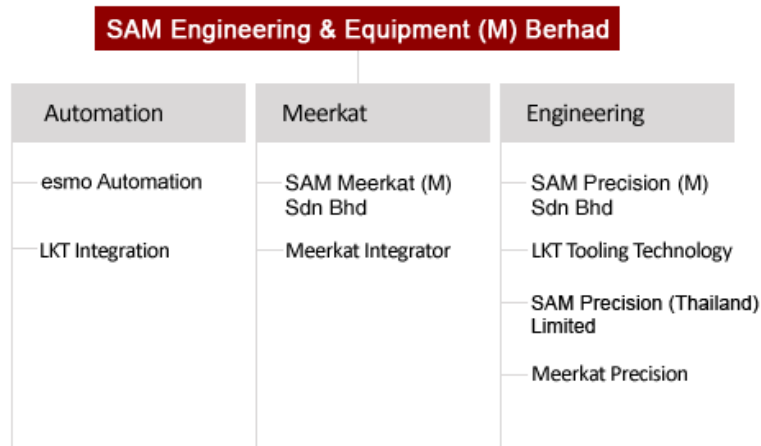


The second newcomer is SAM (Singapore Aerospace Manufacturing) has taken over LKT, a firm that by 2005 was considered as one of the largest in the industry (Aaldering, 2006, p. 56). In 2008 SAM became the largest shareholder of LKT and in 2010 the name LKT has changed into SAM

⁹ List of research by M. Aaldering, list of Invest Penang, list of research by SERI.

engineering and equipment. The new organization structure shows that the automation division now is expanded with one of the market leaders in semiconductor automation from Germany, ESMO (figure 6.1). It is interesting to see how this will develop LKT integration in the future. The reasons for establishment of the automation MNCs in Penang can only be guessed but it is typical that they have chosen to link with two of the by 2005 considered success stories in the industry.

Figure 6.2 Company structure SAM, former LKT



Source: Website SAM

The number of firms that were not longer found on the phone number, address or website that they had in 2005 are considered to have exited the automation industry in Penang. The number of exits is 9, not counting Excel and LKT. On three of the exited firms is data, the other six did not cooperate in the research in 2005. An analysis of the characteristics of the three firms no longer present does not provide a homogenous factor that might have been reason for exit. Especially Vista equipment manufacturing creates a question mark for exit because it was one of the three fastest growing firms by 2005. Hilton precision engineering and Splendid growth share the common factor that they said they had the intention to move to China and that they were only producing customized products, a capability that they rated to be 'medium' of quality. Reasons for the disappearance of the firms can also be a merger, although this is quite unlikely to be unfound on the web. Table 6.1 gives an overview of the dynamics in the automation firm population of Penang.

Table 6.1 Dynamics in the population of automation firms of Penang 2005-2011

Total of firms 2005	Total of firms 2011	Exits	New entrants	Mergers/ take overs
39	32	10	1	2

A second way to see if firms have left the automation business is to look at the share of output that is created from automation products. The definition states a 10% share is needed to be qualified as an automation firm. Many firms diversified into automation products and are still producing other products. All firms interviewed have a share of 10% or more stemming from automation products, so the prepared questions for exit are not used and the total number of firms need no further adjustment.

6.2 Strong competition and slow technological change

When the share of automation in output of 2011 is compared with 2005 a declining trend is seen. Table 6.2 shows the change of the share of automation in the output of the firm between 2005 and 2011. Remarkable is that eight firms show a decline. The average share of automation went down from 65% in 2005 to 52% in 2011.

This decline can be caused by two factors. First one is the fact that the firm has less demand or focus on automation products and the demand for other products stayed equal. The second reason for a decline in output is that the money earned with the automation products has become less indicating a lower revenue on the products.

Table 6.2 Change in share of automation products in turnover over the time period 2005-2011

Change in share of automation turnover	Number of firms
Decline	
10 to 20%	5
20 to 40%	2
40 to 50%	1
Increase	
0 to 10%	1
30%	1
Stable	2
Not available	4
Total number	16

The assumption that supports the output decline stems from lower prices is confirmed when the firms are asked the question; what is the key capability to be operating profitably in the automation business in Penang? The most heard answer is price. Sometimes price is combined with delivery time or quality (table 6.3). To illustrate that competition on price is more than just a standard answer, firms have mentioned the significance of it in terms as a 'price war', 'race to the bottom' and the impossibility for new firms to enter the industry because of the heavy competition. Also mentioned as key capabilities were skilled employees. Only one answer points to the importance of creating new products; a strong engineering team.

The dynamics in the population that are described above and the focus on price make the automation industry fit the shake-out phase of the ILC model by Klepper. In this phase where radical technology changes have become rare, a form of product standardization develops shifting competition to prices of products. This situation is furthermore supported by the majority of the interviewees' opinions about the pace of technological changes since 2005.

The majority of firms say technology change has been incremental instead of radical and three even say almost no change has occurred. Typical is that firms that have the same core business feel different about the technology change. It suggests that the perception of changes is different or that not all changes are equally noticed and adapted among the firms. Also the start to sell products in a new market may come with larger changes in products and technologies although the core business does not change. For example the semiconductor industry demands lower quality standards for machine parts than the medical devices industry does, resulting in more advanced design and production.

Table 6.3 Core business, level of innovation and competition of the automation firms in Penang 2011.

Firm	Core business	Innovations	Competition factor
Atem Advantest Engineering	Manufacturing	Radical	Product knowledge
K.K. Choong	Precision tooling	Incremental	Skilled staff
List-tec	Precision tooling	Radical	Quality, price, delivery time
Alpha Master	Fabrication of machinery	Incremental	Price
Pentamaster	Equipment handlers	Incremental	Strong human resources
JSI Systems	Vision inspection	Radical	Quality, price and network
Brusia engineering	Production jigs & fixtures	Hardly any	Relation with clients, price
Micro Modular System	Design manufacturing installation	Radical (LED) Hardly any (Semicon)	Price
AT	Precision parts Automated machines	Incremental	Price, quality & time
Wanjun	Precision tooling	Incremental	-
Zoomic Technology	Industrial automation	Incremental	Strong engineering team
Vitrox	Vision inspection systems	Radical (hardware) Incremental (software)	Ability to attract and retain talent
Prodelcon	Precision tooling Machine production Automation equipment	Incremental	Price, niche
Epsilon Technology	Custommade production	Incremental	Efficiency
UWC Automation	Design and produce jigs & fixtures Automation	Hardly any	On time delivery, price, quality
Leadman Precision Engineering	Precision tooling	Radical	Speed, reliability, price

The technological change in the industry fits the description of the user-driven type by Poel. According to this type technological changes in the industry are fuelled by changes in technology by the users of the products and therefore generally low. One firm indicated that they experienced radical change in technology for their products sold on the LED market. This industry is relatively young compared to the semiconductor industry and undergoing fast developments. The semiconductor market was the most important one for the industry as we have seen in chapter 3 and this still is the case as is seen in detail in the next chapter. The contradiction found in the pace of technological change is that the pace of innovations in the semiconductor is still considered high (Ballhaus et al, 2009 p. 10). This leads to the conclusion that the automation firms in Penang are still not involved in generating the high-end automation products for the semiconductor industry. This was seen in 2005 and confirmed in the research of SERI in 2007 that said that the MNCs are getting only a small share of their automation needs from the firms in Penang (SERI, 2008). To see whether the Penang firms have upgraded their activities they were asked about their products. This will be discussed in the next chapter.

6.3 Conclusion

In this chapter a description is given of the changes that occurred in the population of firms and they are linked to the models and factors chosen for analysis. The question “How has the population of automation firms in Penang changed over the period 2005-2011 considering its composition and size, and how can this be explained?” is now answered. The automation industry in Penang has shown a population change that point to the shakeout phase of the ILC model, the total number has decreased as there were considerably more exits than entries. More international presence of automation firms in the last years is noticed. Competition on prices is hard and the share of automation output is declining on average. Technological change is experienced differently by the firms but the overall picture is pointing to incremental change, another feature of the shakeout phase. This is out of line with the developments in the main market of the firms; semiconductor. Referring to the fact that the Penang firms are still not providing automation products on the most technological advanced level.

The phase of shake out is not conducive for future growth of the industry. The competition on price considered, it is expected more firms will leave the industry before it is moving onwards to a more stabilized situation. The size the industry will have after the shakeout stage is dependent on the strategy of the firms under strong competitive pressure. The core activities of the firms refer to a remaining diversified product portfolio which provides the firms the possibility focus on other activities. This will be discussed in the next chapter.

7. Developments on the firm level

This chapter will address the sub question; What have been the individual developments of the firms and how can possible encountered differences be explained? The expectations are tested with the data. First the growth or decline of the firms is described, followed by the characteristics of the firms and the changes that have occurred. Then it will be investigated whether growth or decline stories can be declared. The expectation is to see a different development between the entry types 'de novo' and 'diversifiers'. The hypotheses on these developments will be tested to be true or false. The chapter closes with a conclusion on the developments on the firm level and takes into account the developments witnessed on the industry level.

7.1 Firm performance

The performances of the individual firms were measured in 2005 on different topics. Two of them were based on the opinion of the interviewee about the speed of change on the subjects turnover and production volume. With new figures of turnover and number of employees the development of the firm can be expressed in more quantitative measures, since it becomes possible to calculate changes. The turnover data is collected from all firms in 2011 except Prodelcon, that did not wish to share this information. Unfortunately, for some reason a large part of the firms has not provided this figure in 2005, leaving it possible to calculate for just seven firms the turnover change (table 7.1).

Table 7.1 Development 2005-2011 in automation firms

Firm Name	Turnover 2005 in RM	Turnover 2011 in RM	Change in %	Turnover RM*	Turnover Volume*	Entry type	N markets (new)	OBM
Alpha Master	-	50.000		-/-	-/-	D	4 (+2)	
AT	22.000.000	25.000.000	13.6%	=	=	C	5(+2)	
Atem Advantest	-	12.000.000		+	+	C	1(+2)	Yes
Brusia	2.500.000	10.000.000	300%	+	+	D	3(+2)	
Epsilon	12.000.000	11.000.000	-8.3%	+/+	+/+	D	3(+2)	
JSI	5.000.000	1.500.000	-70%	-	-	C	1(+2)	Yes
KK Choong	-	10.500.000		-/-	-/-	D	3(+2)	
Leadman	-	12.000.000		=	=	D	7(+4)	
Lis-tec		10.000.000		+	+	D	3(+2)	
MMS	20.000.000	20.000.000	0%	+/+	+/+	D	3(+2)	Yes
Pentamaster	85.000.000	78.000.000	-8.2%	+	+	D	3(+2)	Yes
Prodelcon	20.000.000	-		=	=	D	3(+2)	
UWC	-	5.600.000		-/-	-	D	2(+3)	
Vitrox	12.000.000	53.500.000	345%	+	+	C	3(+3)	Yes
Wanjun	10.000.000	4.000.000	-60%	-/-	-/-	D	6(2+)	
Zoomic	12.000.000	17.500.000	45.8%	-	=	D	3(+2)	Yes

*-/- strong decline , - decline, = stayed the same, + slow growth, +/+ strong growth

The growth percentages are extremely heterogeneous. There are firms that have grown strong and firms that have declined strong. Vitrox is the firm that shows to have outgrown the SME status in the period of consideration. The firm is considered very promising as it is awarded with a top ranking in the Forbes Asia's 200 Best Under a Billion List, which consists of 200 top performing companies in Asia and the Ernst & Young Technology Entrepreneur of the Year award (2011) for director Chu Jenn Weng. Brusia also has an extreme growth percentage but is still a small player in the field.

Again the firms were asked to rate the change of turnover they experienced over the last five years. Six said to have seen a decline in turnover of their automated equipment products; of which four have even proclaimed to have had a 'strong decline'. For three firms turnover remained the same; five firms indicated an increase. Only two firms indicated rather fast growth. In the 2005 survey all but one of the re-interviewed firms had indicated moderate to fast growth in the previous five years. Some scores on growth do not match the numbers. This is explained by MMS and Epsilon to be caused by the crisis year 2009 in which many firms saw a negative change in their turnover that quickly rebounded in 2010 and the first half of 2011. Turnover figures are an average calculated over 2009 and 2010 and do not represent the six year period that is considered in the growth score.

In table 7.1 characteristics that influence development are added to see if they are conducive or constraining. The firms that operate on more than three markets are the firms with slow growth, confirming Kleppers theory. Firms that produce OBM can target larger groups for their products but this does not show in the growth figures, except that of Vitrox.

A second quantitative measure for firm development is the change in employment figures of the firms. Concerning employees, all firms but one, showed growth from start up to 2005. In contrast, in the period from 2005 to 2011 three firms have made employees redundant. Two of these also showed negative development of turnover; the third case had experienced only 13% growth (table 7.2). Brusia and Vitrox are again the strongest growers, in line with their increase in turnover. Vitrox is the only company with more than 150 employees, and grows above the restriction to fit the SME status. In the interview mr. Weng told that the aim is to grow to 500 employees in the coming 4 years, illustrating the expectations on growth of the company.

The hypotheses on a differentiated growth path based on entry type can not be verified because both type of entries perform heterogeneous. There are growing and shrinking firms, which also show a different scale of change. With help of the firm characteristics and their dynamics it is tried to declare the changes. The number of markets that 'de novo's are active on are lower than that of diversifiers, this shows that they are gaining on average more revenue from a market.

Other measures for development are the number of clients and order size per client. Notwithstanding there has been a slowdown of turnover, the majority of firms has experienced an increase in clients and order size (eleven firms). Underlying these apparent contradictory findings is a lowering of product prices resulting from market slowdown.

Table 7.2 Development in number of FTE in automation firms from start to 2011

Firm Name	FTE at start	FTE 2005	FTE 2011	Growth FTE over 2005-2011 in %
Alpha Master	3	4	5	25%
AT	4	150	130	-13.3%
Atem Advantest	50	30	42	40%
Brusia	10	15	124	726.7%
Epsilon	8	33	60	81.8%
JSI	2	15	9	-40%
KK Choong	3	35	50	42.9%
Leadman	-	-	100	-
Lis-tec	2	15	60	300%
MMS	6	59	76	28.8%
Pentamaster	9	300	100	-66,7%
Prodelcon	6	15	20	33.3%
UWC	20	35	35	0%
Vitrox	3	48	220	358%
Wanjun	5	4	6	50%
Zoomic	4	-	70	-

*- not available

Figure 7. 1 Firm logos of the automation firms in Penang



7.2 Firm characteristics

Products

All firms were asked which automation type of products and services they provided. This led to the result that the majority of firms was by 2011 active in automated systems. Only two firms did not score on the first three items of the table. These are Wanjun and KK Choong who both named precision tooling as core activity (chapter 6) and wanted to add jigs and fixture production to the list below. The firms are not involved in upgrading to more advanced products. The product portfolio of the firms has in four cases been diversified and in four cases it became more specialized, in seven cases it has specialized and diversified. This finding underlines the modified nature of the firms that prove not to change to a smaller range of specialized products. To the open question on what has been the most important change in their products, the most heard answer was that not much had changed. Also important to note is that although it was asked about change in the product, price and lead time reduction were both three times mentioned. Other answers were; change of raw material, accuracy, integration of the system and the vague answer: technology. Another example of the diversified nature of the firms is the strong presence of (expanded) group structures as well as organization structure of the firm.

Tabel 7.3 Products and services delivered by the automation firms 2011

Product or service	Number of firms
Fully integrated systems	11
Test handling systems	11
Software programming	11
Precision components	12
On site assistance	12
Maintenance	11
Design and development	15

Markets

The markets in which the firms are active have broadened slightly since 2005, however the number of markets per firm has grown strongly as mentioned before. The served markets comprise semiconductor, food, LED, electronics, hard disk drive (HDD), medical devices, automotive and energy. Yet, by 2011 still half of the surveyed firms got the main share of turnover from the semiconductor market. Other markets are still significantly smaller although after 2005 all firms have entered a new market. Moreover, some firms had started to specialize in a market in which others were not or hardly active (in addition to the few ones that had already done so by 2005). While semiconductor remains important half of the firms generate the majority of business in other markets such as electronics and HDD.

The entering into new markets does not go fluently for the majority of firms. They claim to encounter problems in quality standards, certification, or lack a network for customers. Major problems in the new markets are the small size of the local client base, forging the firms to go overseas to reach a certain amount of revenues and competing on the global market. For the rapidly changing LED market the problem lies in the lack of standards. This makes investing in new products a risky investment.

Market diversification had been inspired by the desire to become less dependent on the cyclical semiconductor industry and new opportunities arising in other markets such as medical devices and LED. However, the maximum shares of medical devices and LED in turnover encountered in the 2011 survey amount to 25% and 30% respectively. Since the firms have only recently entered other markets, it is still uncertain whether market diversification will successfully create new and

structural growth for the industry, rather than being part of a short-term profits-oriented strategy that is common among Chinese entrepreneurs.

The clients of the industry are still largely located in Penang. Recently though, their numbers are declining. Remarkable is that the two strong growers have the highest and lowest share of clients in Penang; respectively 80% for Brusia and 5% for Vitrox, the most successful firm. Producing OBM seems to relate to a larger export share. Most firms in 2005 (14) produced on a custom basis and were highly customer-oriented. Seven were producing custom and some standardized products, and just six firms produced OBM products only.

Custom production is still the main production mode in the industry in 2011 (12 firms). Patenting of R&D results/innovations is limited to just four firms, who are amongst the six firms producing own brand products (see table 7.4). The results from 2005 have shown that de novo firms focus relatively more on production of standard machinery. These firms engaged relatively more in ODM and OBM and less in custom production, especially lower-end.

Capabilities

The activities carried out by the automation firms in Penang range from design, production, sales, maintenance, market monitoring, logistics, administration to management. Many firms outsource the logistics however. When the firms were asked if any activity had gained more focus over the time of research, eight firms stated to focus a lot more on the sales and marketing activities. Two stressed the increased importance on the HR activities and two firms the R&D activities. The increased attention for sales is understandable in a highly competitive market, but it also fits the IPLC models expansion stage in which firms start to orientate on foreign markets. This trend seems to be correct, since eight firms claimed to have started to target clients outside Penang in the period of research. The other eight claimed they were already doing this for a longer time.

The attention for R&D differentiates among the firms. The share of staff involved in R&D and design activities in the majority of firms fluctuates around 15% with three firms exceeding this with a percentage that is higher than 40%. Vitrox distinguishes itself by dedicating 80% of its staff to R&D. The firm has abandoned the ISO certification systems for a few years now and is compensating this with a the introduction on the LEAN strategy. The lack of an ISO certificate has not led to the loss of clients for Vitrox, which is surprising since other firms primary reason for certification is not losing clients. Vitrox explains this by the international reputation it has created on good quality that not needs an ISO to gain confidence. The strong increased number of ISO certifications in the research period (5 firms) has led to an industry that has reached an internationally measurable standard. It improves the chances of doing business with 'overseas' as it was formulated by one of the interviewees. All firms are certified now, except Vitrox.

Despite the efforts made on R&D it appears from the interviews that the intent in investing in new products is low. More important to the firms is a diversified product portfolio in lower end products to be able to shift business to the most profitable products. This strategy fits the Chinese entrepreneurial culture of choosing short term profits above long term investments (Ahlstrom et al, 2004 p. 282).

A comparison on the qualification of a range of capabilities is done to see if firms have improved over the years. The capabilities were ranked on a five point scale ranging from high to low. The results are displayed in table 7.4 and show the ranking given in 2011 and the difference between that of 2005 expressed in increase and decrease. Two firms have started to produce in the OBM mode that is considered as the most challenging mode of production on the firms capabilities. The firms producing OBM by 2005 have not progressed on this topic. The capability that shows the most increase in score is market monitoring other capabilities do not display a clear pattern in the direction of increase or decrease. Overall improvement is strongest in Lis-tec, that has improved on all capabilities possible. Firms would like to acquire good employees to improve their capabilities, but due to the inability to pay the same salary as the MNCs do, this does not happen.

The manner in which improvement on capabilities is reached is dependent on the way of learning the firm displays. The firms were asked on nine manners of learning if they occurred in the

firm. The learning processes in the firms were inwards-oriented by 2005 and have changed slightly by 2011. Ten firms now state that an external source is the most important factor for learning. In many cases however, this is still the client. Learning for them occurs through face to face contacts; the possibility to have a look at their production floor, or having engineers stationed at the client for the duration of a project. Fairs and expositions are mentioned as a second source of new information that results in learning.

Chosen to be most important and an often mentioned way of learning, is intra-firm learning by doing. Practically this happens during the discussion on product specifications and technical matters in meetings, and by in-house training. Just four of the questioned firms say to learn from firms in their own line of business by observation or discussions, others laughed at the idea of this. This illustrates the low connectivity in the industry, a point that is further discussed in the next chapter. Around one third of the firms acknowledged a role for the government in learning processes. An example of this is the provision of information on new FDIs. This information is highly valued by the firms, but does not represent actual learning.

Constraints for the future

The constraining factors for development experienced by the firms were asked in an open manner. Two firms declared not to see any problems for their future development, but all other firms did. Two common problems were raised.

First is the experienced shortage of skilled workers to further upgrade the capabilities of the firm. The best fresh graduates prefer to work for a MNC, which has to do with image and better payments, according to the interviewees. This last argument is not valid according to the director of Vitrox, who claimed it is a choice to pay a better salary and invest in your employees. The experienced shortage of skilled personnel is a well-known problem in Penang. State investment agency Invest Penang was conducting a research in cooperation with the Penang Skills Development Centre (PSDC) among SMEs and MNCs to find out what the requested skills are now and what they will be in the near future. The research was taken place simultaneously with this research, but unfortunately the results are not yet available. The results are intended to lead to specialised training programs to address the skills shortage. The second most heard constraint for development is the high competition on the automation market from local firms and from China. The pressure on the prices prevents the deployment of investments.

A third constraint was mentioned by two firms producing OBM. They state the legal framework for patenting products is complicated and not working properly, which results in a disincentive for investments in new products. This constraint is in line with the findings of the World Bank on constraints for further development (see chapter 1).

7.3 Conclusion

All the information on firms' performance and characteristics considered, it is now attempted to answer the sub question; *What have been the individual developments of the firms and how can possible encountered differences be explained?*

The development from the start of the firms until now has been heterogeneous. The firms in Penang present different growth paths. Employment growth figures are providing a more positive picture than the growth in turnover which shows a decline for four firms.

Considering the growth numbers and the characteristic *mode of entry*, it seems there is no evidence for one best practice. Firm strategies of targeted markets, the composition of the product portfolio, and the intent to standardize and innovate products are sometimes similar for diversifiers and de novo firms and different between firms of the same entry type.

The growing firms use different strategies for development. Vitrox has one core competence and is dedicating a lot of R&D to further develop this competence and the applicability of this. Brusia, and Epsilon are examples of firms that are performing well by tapping into new markets, but remain on the same technological level. The culture of Chinese entrepreneurs is prevailing in Penang,

although there are some exceptions. The distinctions of not sharing information and the diversification strategy are good illustrations of this.

The learning mode of firms does not provide clues for the explanation in different growth but it shows to become more conducive for further development of the firms as they broaden their sources of knowledge only slightly.

The performance on the individual firm level in combination with the knowledge of the negative development on the industry level might be predictive for which firms are likely to become the next victims of the shake out. Their diversified nature will prevent them from becoming bankrupt, but also seems to hinder the way to more advanced products in automation.

Company name	CP			Odm			Obm			INT			Flexibility			MM			Marketing			Design		
Advantest	Good	-	Good	-	Good	-	Good	-	Good	High	+	High	+	High	+++	High	High	++	High	++	High	High	=	=
Alpha master	NP	x	Good	new	NP	x	NP	x	NP	Fair	-	Fair	=	Good	=	Medium	Medium	=	Medium	=	Fair	Fair	-	-
AT	Good	+	NP	x	NP	x	NP	x	NP	Medium	=	Medium	+	High	=	Fair	Fair	=	Fair	=	Good	Good	++	++
Brusia	High	+	High	+	NP	x	NP	x	NP	Good	+	High	=	High	=	Medium	Medium	=	Medium	=	High	High	+	+
Epsilon	Good	-	High	new	NP	x	NP	x	NP	Good	=	Good	=	High	=	Good	High	+	High	+	Good	Good	=	=
Jsi	Good	=	NP	x	Good	=	Good	=	Good	High	=	High	--	High	--	Fair	Medium	-	Medium	-	Good	Good	=	=
KKChoong	Good	=	Good	new	NP	x	NP	x	NP	Low	--	Low	++	High	++	Medium	Medium	=	Medium	=	Low	Low	--	--
Leadman	NP	x	High	new	NP	x	NP	x	NP	Good	new	Good	new	High	new	Good	new	new	Good	new	Good	Good	new	new
Lis-tec	Good	++	Good	new	NP	x	NP	x	NP	Good	+	Good	=	High	=	High	+++	++	Good	++	Good	Good	+	+
MMS	High	+	High	+	High	new	Medium	new	Medium	Good	+	High	+	High	+	Fair	--	+	Good	+	High	High	+	+
Pentamaster	Good	-	NP	x	NP	x	High	=	High	High	+	High	=	High	=	Medium	Medium	-	Medium	-	Good	Good	=	=
Prodelcon	Good	-	Good	-	NP	x	NP	x	NP	Good	=	Good	-	Good	-	Good	+	-	Good	-	Good	Good	=	=
UWC	Good	+	Good	+	Good	x	NP	x	NP	Good	=	Good	=	High	=	Medium	Medium	=	Medium	=	Medium	Medium	=	=
Vitrox	Good	=	Good	-	Good	-	Good	-	Good	Medium	-	Medium	-	Good	-	Medium	Fair	-	Fair	-	Good	Good	=	=
Wanjun	High	++	Good	new	NP	x	NP	x	NP	Good	+	Good	++	High	++	Good	Good	+	Good	+	Medium	Medium	-	-
Zoomic	High	=	Medium	-	Good	new	Good	new	Good	Good	=	Good	=	High	=	Medium	-	=	Good	=	Good	Good	-	-

CP custom production,
ODM own design manufacturing
OBM own brand manufacturing
INT integration new technology
MM market monitoring

Capabilities are rated on a five point scale: low, fair, medium, good, high

NP not practicing
+ increase by one step in rating in comparison to 2005
- increase or decrease by one step in rating in comparison to 2005

new newly employed production mode
x quit mode of production
* comparison not available

8. Developments on the regional level

This last chapter with results will address the sub question posed on the industry developments on a regional level; How has the region contributed or hinder the development of the automation industry over the period 2005-2011? The importance of the region on the development of the firms is described from the perspective of the firms. This is complimented with information available on state initiatives for the promotion of the industry.

8.1 Network connectivity of the industry

To gain knowledge about the connectivity of the firms with the region they have been asked about the connections they have with the different actors in the regional innovation system. This is done by asking the firms about the number of contacts, the frequency of the contacts, the exchange of knowledge with the contacts, the direction of knowledge exchange (receiving, giving or both ways) and the location of the contact (local or global). Table 8.1 provides an overview of the information on the quantitative measures.

Table 8.1 The connectivity and knowledge exchange of the automation firms in Penang with their network

Actors	Average number of contacts	Range	Average level of intensity of knowledge exchange (scale; 1 =none, 5= very high)
Competitors	1,5	0-10	2,7 (6)
Suppliers	78,5	21-200	3,2 (16)
Clients	28,8	7-100	4,7 (16)
Public research institutes	0,1	0-1	4 (2)
Education institutes	0,75	0-4	3,5 (6)
State government bodies	0,9	0-2	3 (8)
Federal government bodies	0,9	0-5	3,3 (8)
Private network	35	0-150	3.9 (13)
Consultants/Advisors	1,1	0-3	4,1 (9)

The first player discussed in the regional innovation system is the competitor. There is a very low number of firms that have contact with other firms in the same branch as them. The information on the problems in creating an automation cluster are reflected in this outcome. Only six firms have contact with each other and the average number of the contacts is 1,5. Cooperation is not taking place according to the number in combination with the intensity of knowledge exchange. Firms have said to be afraid to give away information that underestimates their own competitive position.

The second player discussed is the supplier. The firms in the industry have a large network of suppliers and share knowledge with them on a basic level about specifications of the materials and products demanded. The frequency of the contacts is high; most firms state to speak to their suppliers at least on a weekly basis. The same frequency of contacts is seen with the clients of the industry. Also these actors in the network of the firm are often spoken. Different from the supplier relation is the level of knowledge exchanged with clients. This is higher than with suppliers and has a prevailing receiving character. The direction of knowledge that firms exchange in their contact with suppliers is provision of knowledge. The clients of the automation firms are said to be providing the firms of the most valuable knowledge and are therefore the most important source for new information.

The firms of the industry have hardly any connections with research institutes or educational institutions. This is not a surprising result because most of the firms are quite small SMEs and not involved with innovative product development. Striking is the fact that the most successful firm of this moment is the one with the most contacts with educational institutes; Vitrox cooperates with four universities to attract talent and to do research. If this cooperation has resulted in the strong growth, or that this cooperation is a result of Vitrox's growth, is unfortunately not becoming clear with this single point of time data.

The number of firms that are in contact with government bodies is just half of the group. The information direction is of a receiving nature. The information from the state government on new attracted investments is strongly appreciated. The reluctance of the Chinese entrepreneurs against the Malaysian government might be a cause for the low number of contacts although this should change slowly now Penang is seeing more Chinese people working in state government bodies like Invest Penang and the PSDC.

The results of the numbers of private network connections show that the interviewees are using their private networks quite differently. Some prefer not to talk about business with friends and family, others use them as a valuable source of information. The private networks of the interviewees are the second global pipeline seen. The clients of the industry are the other global pipeline because they are often bringing in information from a global scale. The suppliers of the firms are for 7 firms mostly locally represented and 9 firms have local and global located suppliers, however as mentioned before they do not bring new information to the automation firms.

Nine firms value the knowledge that is given by consultants as high. The firms used the consultants help to acquire ISO certification or for organizational issues. One firm stressed the importance of sales representatives for the firms network because they gained a lot of knowledge for the firm about markets and business opportunities. Not just this firm, but all firms agreed that networks are important to keep new knowledge flowing into the firm. The answer given to the open question 'what is the most important information gained from the network' was answered the same by all firms, although slightly different formulated; new business opportunities.

The result from the network analysis is in line with the study on the RIS in Penang by Hutchinson (2010). Competing firms are hardly communicating and SME firms are (hardly) not using the initiatives provided by the government. Therefore it can be concluded that the automation firms are not part of a well-functioning and performing cluster or innovation system.

8.2 The role of the region for the automation industry

The establishment of the PAC six years ago acknowledged the potential of the industry by the state government. However, this initiative has not resulted in any action. During the interviews the PAC was not once mentioned and no other information was found on the active status of this organization. The strong resilience of Chinese entrepreneurs against information sharing with firms in the same business will certainly have contributed to prevent a success.

State intervention in the business of the automation firms in the last six years is encountered in two interviews where the 'pioneer' status for a new subsidiary was granted. Wanjun and Epsilon have entered the medical devices market and received the 'pioneer' status what is as much as some subsidy. For Epsilon the new market meant a further diversification of the group structure. Wanjun started a new company under the name Orthomedic Medical Devices. The products made by the firms have a low level of technology (needles, scalpels, tubes, rubber gloves) but the expectation is that the firms will soon engage themselves in more automated products. Pentamaster, also active on the medical devices market, proudly presented a cleaning machine for rubber gloves this year, showing how the upgrading of products can develop.

Offering a pioneer status to SMEs that enter the medical devices market is an example of the on-going effort the states investment agency makes to link the targeted FDI with the local SMEs. The state portrays an attempt in the diversification of the business environment¹⁰ and this is reflected in

¹⁰ Interview miss. Ong, Invest Penang

the market broadening by the automation firms. Attempts to promote the specialisation or capabilities of SMEs are not heard in the conducted interviews.

The SME firms in Penang have recently gained more attention from the State government as this fragment from a speech by chief minister Mr. Lim Guan Eng illustrates¹¹:

“Our investments are still predominantly foreign investments. This means that we are very vulnerable to the vicissitudes of the world economy. To alleviate the impact of the global economy on our domestic economy, we need to develop our own local companies, as in the case of Taiwan, South Korea and Japan”. (Speech for the Penang SME forum on 22nd of May 2012)

The establishment of the SME centre as incubator for growth and development of market leaders and the erection of the Penang Science Council are just a few examples of the increased intention. The influence they will have on the automation firms for their future development will probably be nil. The firms are not expressing a clear issue that they need help with, so they probably do not go look for it either.

8.3 Conclusion

The connectivity of the automation firms with suppliers and clients in the region is strong. Suppliers and clients are important for the firms' knowledge flow. The engagement in research and development activities with other actors is low. This is a characteristic of the user-driven innovation type in which the relation with the client is providing the incentives and cooperation for new developments. Also the number of firms that are creating their own branded products is small and for firms who do not strive for patenting products the reasons for connecting with research institutes are not there at all.

The sub question; *“How has the region contributed or hinder the development of the automation industry over the period 2005-2011?”* is partly answered in the previous chapter. The shortage of skilled employees in the region is constraining the firms in their development. The automation industry has a large share of their clients in Penang and the attraction of new FDIs in new markets provides new business opportunities for the firms.

¹¹ <http://www.penang.gov.my/index.php/en/pusat-media/koleksi-ucapan-yab-km/1607-the-launching-of-penang-sme-forum>

Conclusion and discussion

This research focuses on the automation industry in a region that is experiencing a stagnating economic growth. The following question has been answered;

“How has the automation industry in Penang developed from 2005 up to 2011 and how can this be explained by conducive and constraining factors for development on multiple analysis levels?”

The export led manufacturing economy of Penang has reached its limits of growth. There is great concern for the future. The region wants to move towards a more knowledge based economy, which has not occurred through a natural process. By studying the automation industry, an industry that was in the beginning of 2000 considered as a success story of local entrepreneurial activity, leads for future development are found.

The industry has declined in terms of total numbers of firms, that are active in automation over the past six years. Hardly any new startups can be found. MNCs in automation are showing interest in the successful firms and choose to settle in Penang by merging with these firms.

The performance of individual firms shows a two folded growth path; decline and growth. The already heterogeneous group of firms has become even more heterogeneous because they are entering new markets. The semiconductor industry is still a binding factor, but sales opportunities for the automation firms in this industry are limited. The strong focus on the price of the products is a burden to the automation firms, and is the main reason for them to look for alternative business opportunities. The local government plays a strong role in the composition of the economy. The newly created markets are used for starting new business by the automation firms, but with little focus. The firms lack an own brand to procure new markets outside Penang and are strongly dependent on their established client relationships. However, an increased focus is given to sales activities, illustrating that the automation firms are aware of their situation.

The tight labour market and price war are constraints for further growth from the firms perspective. From experience and literature however, the constraint is the lack of knowledge spill overs created by cooperation. The Chinese business culture plays a strong role in the absence of investments in networks and products. Empirical research on Chinese business culture shows that the Chinese business culture is responsible for short term views in firm strategies, resulting in more diversification of markets. Most often these markets are entered with products that portray technology that stems from early products in industrial automation. The slow progression on producing more value added products makes it unlikely that a technological catch up will be made. The remaining gap leads to disincentives for investments in innovative products, resulting in a technological lock-in.

The industry is surviving, but mainly by the diverse low-end product portfolio. There is a stronger competition in the low-end automation from other Asian countries, forcing the industry to seek for alternative ways to keep growing. However, there are also success stories like Vitrox that grows tremendously by investing and focusing on one core activity.

The results from this study are based on 16 interviews, missing out on the other half of firms active in the automation industry. New entrants may provide a more positive view for the future of the automation industry. Unfortunately, interviews with these new entrants were not possible. Normally, the nature of entrepreneurs is to display the picture a little more positive than it really is, so the real situation may be even more threatening for the declining firms.

The time lap that this research covers is short, considering the problems experienced in 2005 are still topics of today's discussion. However this is also a sign of stagnation; problems are not addressed or slowly addressed. Again, the individual focus prompted by the Chinese entrepreneurs, prevents collaborative action. Collaborative action would be more effective.

The renewed attention of the state for SMEs should focus on including existing local SMEs and should provide incentives for the development of a longer term business strategy to engage firms in investments. Furthermore, research on successful upgrading in other countries, lacking

behind in technology development, shows that the regional innovation system is important and should get the appropriate attention.

Further research would be recommended to investigate if the local government is able to motivate the firms to cooperate and create solutions to the problems. At this stage, compared to other industries, the automation industry does not portray a different image on the national stagnation. In conclusion, the automation industry is no exception on the national stagnation in development.

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Appendix I; Topic list interview

Introduction to the research

Introduction of the interview partner;
Function
Relation to automation industry

Current economic issues in Penang;
Middle income trap
Global crisis
FDI trends

Problems for industry development;
Talent (human resources)
Upcoming China/India

News in automation industry;
Technological developments
Firm strategy
PAC
Expectation for the future

State involvement;
Policy
Medical sector

Appendix II; Structured interview list

Universiteit Utrecht



Department of Human Geography and Planning, Faculty of GeoSciences, Utrecht University, The Netherlands

Study on the Development of the Automation Industry in Penang

Name of the company:

Name of respondent:

Job title of respondent:

Address of the company:

Website of the company:

Structure and general information about the company

1. Has the company structure changed since 2005?

- ☐ No
- ☐ Yes ->

2. From a (structure first survey, researcher fills in from survey

2005)

.....to a

(structure)

.....

3. This structure change has taken place in: 2005 2006 2007 2008 2009 2010 2011

4. What was (were) the reason(s) for this change? (Multiple answers possible)

- ☐ Legal concerns
- ☐ Tax reasons
- ☐ Entering new markets
- ☐ Stronger financial position
- ☐ Client imposed
- ☐ Chaining of activities
- ☐ Unchaining of activities (specialising)
- ☐ Improving competitive position
- ☐ Other.....

Characteristics of the firm: size, products, markets, clients

Size

5. How many employees are working in automation activities?
..... FTE
6. What has been the average annual sales of automation related products over 2008/2009?
..... (MR)
7. What is the current share of output (production volume) of automation related products?
.....% of output
8. How would you describe the growth in turnover of the automation activities of the firm since 2005?
☐ strong decline ☐ decline ☐ stayed the same ☐ slow growth ☐ fast growth
9. How would you describe the growth in production volume of automation related products since 2005?
☐ strong decline ☐ decline ☐ stayed the same ☐ slow growth ☐ fast growth

Products

10. Which automation related products and services are delivered by the firm in Penang
- ☐ Fully integrated assembly systems
 - ☐ Test handling systems
 - ☐ Software programming
 - ☐ Precision components
 - ☐ On site assistance
 - ☐ Maintenance
 - ☐ Design & development
 - ☐
 - ☐
 - ☐
11. How would you describe the development of the product portfolio since 2005?
- ☐ More diversified
 - ☐ More specialised
 - ☐ Diversified & specialised
 - ☐ Stayed the same
 - ☐ Other;
12. How many new products has your company added to its portfolio in the last five years?
.....
12. What has been the most important change in your product in the last five years?

.....
.....
.....

13. Would you describe the technology changes in the automation industry over the last five years have been;

- ☐ Radical
- ☐ Incremental
- ☐ Hardly any new technologies

14. What is the most important activity in the firm to keep up with technology development?

.....
.....
.....

Markets

15. Which market(s) are served with this product portfolio?

	-% of total	Export Y/N	Destination(s) (EU, US, S-Am, Asia, Afr, Austr)
<input type="radio"/> Semiconductor
<input type="radio"/> Medical devices
<input type="radio"/> Food
<input type="radio"/> E&E
<input type="radio"/> LED
<input type="radio"/> Automotive
<input type="radio"/> Renewable energies
<input type="radio"/> Other
<input type="radio"/>

16. Have you entered new client markets since 2005?

- ☐ No
- ☐ Yes ->
 - ☐ Semiconductor
 - ☐ Medical devices
 - ☐ Food
 - ☐ E&E
 - ☐ LED
 - ☐ Automotive
 - ☐ Renewable energies
 - ☐ Other,
 - ☐

17. If yes, can you elaborate on the reason for entering into new markets?

.....
.....
.....

18. If no, can you elaborate why?

.....

Clients

19. The development in number of clients (on a yearly basis) since 2005;
- ☐ Increased
 - ☐ Same amount
 - ☐ Decreased
20. The development of order size per client
- ☐ Increased
 - ☐ Same size
 - ☐ Decreased
21. The duration of most client relationships is
- ☐ As long as one order/assignment takes
 - ☐ Long term
22. Can you give an explanation for the length of the relationship with your clients:.....

23. How many per cent of your clients is based in Penang (considering the last 2 years)?
 %
24. Which clients are you targeting for future development;
- ☐ Locally based (Penang)
 - ☐ Global (Everything outside Penang)
 - ☐ Both
25. Since when do you to target clients outside Penang?

IV. Competences, Capabilities and learning

1. What activities are carried out by the firm related to automation products?

			+/-	
<input type="checkbox"/> production of integrated systems	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...
<input type="checkbox"/> production of machines	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...
<input type="checkbox"/> production of (sub)components	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...
<input type="checkbox"/> research & development/design	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...
<input type="checkbox"/> sales/marketing	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...
<input type="checkbox"/> after sales	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...
<input type="checkbox"/> procurement/sourcing	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...
<input type="checkbox"/> market monitoring/information gathering	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...
<input type="checkbox"/> service provision	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...
<input type="checkbox"/> maintenance	<input type="checkbox"/> in Penang	<input type="checkbox"/> elsewhere	.....	...

- | | | | |
|--|------------------------------------|--|-----|
| <input type="checkbox"/> logistics | <input type="checkbox"/> in Penang | <input type="checkbox"/> elsewhere | ... |
| <input type="checkbox"/> management | <input type="checkbox"/> in Penang | <input type="checkbox"/> elsewhere | ... |
| <input type="checkbox"/> administration | <input type="checkbox"/> in Penang | <input type="checkbox"/> elsewhere | ... |
| <input type="checkbox"/> human resource management | <input type="checkbox"/> in Penang | <input type="checkbox"/> elsewhere | ... |
2. Which activities have gained in importance and which have become less important to the firm since 2005? (ad + or - in last column, 0 for no change)
3. What do you consider the core activities of the firm?
- ☐ ..
 - ☐ ..
 - ☐ ...
4. Are your products produced based on;
- ☐ Custom
 - ☐ ODM
 - ☐ OBM
5. If the company also designs products/engages in research and development:
How many employees are engaged in R&D/Design % of employees
6. Are you ISO/other (CE, UL, Rohs, din) certified?
- ☐ Yes, since ... certificates;
 - ☐ No
 - ☐ Becoming in ...
7. If yes or becoming certified, can you describe the importance of certificates for the firm?
-
-
-
-
8. If No, can you explain why you are not certified?
-
-
-
-
9. Has the company patented new products in the last five years?
- ☐ Yes , it has patented products
 - ☐ No
10. Can you say how important creating innovations are to your firm on a scale from 1 to 5 (1 not at all, 5 very important)
-
11. How is technology development embedded in the firm?
-
-

12. How would you qualify the following capabilities of this firm in the automation branch?

Market monitoring	high	5	4	3	2	1	low	NA
Marketing (client procurement)	high	5	4	3	2	1	low	NA
Design	high	5	4	3	2	1	low	NA
Custom Production	high	5	4	3	2	1	low	NA
ODM Production	high	5	4	3	2	1	low	NA
OBM Production	high	5	4	3	2	1	low	NA
Mechanical aspects	high	5	4	3	2	1	low	NA
System aspects	high	5	4	3	2	1	low	NA
Software integration	high	5	4	3	2	1	low	NA
Integration new technology	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

14. How did the company create/acquire the capabilities and competences is has now? (multiple answers possible)

- ☐ Intra-firm learning
- ☐ Acquired highly skilled employees from competing firms
- ☐ Acquired highly skilled personnel from MNCs locally
- ☐ Acquired skilled personnel from abroad
- ☐ Acquired capabilities by contacts with clients
- ☐ By cooperation with firms in the same branch
- ☐ With help of government programs/funding
- ☐ By training programs
- ☐ Monitoring competitors

15. Can you point out which learning processes occur in the firm? (multiple answers possible)

- ☐ Learning by doing
- ☐ Knowledge transfer from clients
- ☐ Discussions with clients about orders (like specifications)
- ☐ Monitoring market development and technological/product development in the industry (globally, regionally)
- ☐ Visiting other firms on business trips
- ☐ Participation in government programmes, aimed at Human Resources
- ☐ Industry seminars (e.g. organized by association)
- ☐ Discussions with/observing other firms in the same industry
- ☐ Other (specify)

16. What is the most important way of learning in the firm?

.....

17. Can you respond to the following statement;
The main sources of learning are external rather than internal to the firm
☐ Agree ☐ Disagree

18. What do you feel is/are the key capability to profitably operate in the automation business in Penang:

.....

.....

19. Which capabilities do you want or have to develop further in view of the corporate strategy?

.....

.....

V. Networks

1. Can you elaborate on each of the actors on the following

Number of contacts (last year)

Frequency of contact (per year)

Knowledge exchange intensity (1 none, 2 some, 3 basic, 4 high, 5 very high)

Receiving or giving knowledge or both

Local or global based

	NoC	Foc	Kel	R/G/B	L/G
Competitors					
Suppliers					
Clients					
Public research institutes					
Education institutes					
State govern bodies					-
Federal govern bodies					-
Private network					
Consultancy/advisory					
Other...					

1. Can you elaborate what is the most important you receive from your network connections?

.....

2. Networks are important to keep knowledge flowing into the company

- ☐ Agree
- ☐ Disagree

VI Asset-specificity and switchability

13. Can you respond to the following statements:

- My company can produce for more than one sector ☐ Yes ☐ No
- My company can switch to the production of other related products ☐ Yes ☐ No
- I can produce exact the products my clients demand now ☐ Yes ☐ No
- When my largest clients leave to another country, I have to follow them in order to stay in business ☐ Yes ☐ No
- My company has the ability to adjust fast to changing market situations ☐ Yes ☐ No
- The technologies that the company develops, focus on one or limited number of products/clients ☐ Yes ☐ No
- I am willing to make specific investments for specific clients ☐ Yes ☐ No

(The maintenance of) a broad orientation of assets (machinery,

labour, technological know-how etc.) is explicit strategy of the company

☐ Yes ☐ No

Maintaining a diversified product portfolio is the explicit strategy of the company

☐ Yes ☐ No

VI. Performance determinants and company strategy

1. Have there been or do you see any constraints for successful (further) development of your company?

☐ Yes ☐ No

If yes, what are they?

.....

2. Can you respond to the following statements:

There is enough growth potential in Malaysia for my company

☐ Yes ☐ No

I see internationalisation as an important step in the development of the company

☐ Yes ☐ No

For my company it is essential to improve technological standards

☐ Yes ☐ No

Government support is important for my company to continue in the future

☐ Yes ☐ No

My local clients play an important role in the company's future development

☐ Yes ☐ No

Population of firms

Do you know names of other companies in this industry that have (since 2005) joined the market in Penang? Do you know other companies in this industry that did not continue to exist or moved out of the production of automation (related) products?

.....

.....

Appendix III; Result of search for firms in the automation industry in Penang

Interviewed

1. Advantest engineering Malaysia
2. Alpha Master
3. AT automation technology
4. Brusia engineering
5. Epsilon Techonology
6. JSI systems
7. KK Choong engineering
8. Lis-tec
9. Micro modular system
10. Pentamaster
11. Prodelcon
12. UWC automation
13. Vitrox
14. Wanjun technology
15. Zoomic automation
16. Leadman

Encountered but unable to/refusing participation

17. LKT- SAM engineering
18. Pentatronics
19. Polytool
20. SRM integration
21. Berjaya Automation
22. ER Mekatron
23. ATS
24. Innogrity (new)
25. Gops Equipment designer
26. Greatech automation
27. Ixmation Malaysia (new) Excel Precision
28. Microlead precision technology
29. Walta group
30. NSW automation sdn
31. AGS automation sdn
32. Towam sdn

Active in 2005, but were not found in 2011

33. Janway industries
34. Metfab engineering
35. Vista equipment manufacturing
36. Hillton Precision engineering
37. Axis automated equipment manufacturer
38. AZS precision
39. DSM (has moved out of Penang)
40. Ever technologies

41. MH industrial automation
42. Splendid growth

Encountered but not fitting the definition

43. Flexible automation systems (distributor)
44. 3A coating technology
45. ACT components technology
46. Alliance contract manufacturing
47. Ampmas (plating)
48. Elcomp technologies (distributor)
49. HFB laser tech.
50. Myreka technologies
51. NDT software consulting
52. Pannasoft technologies
53. RC precision engineering
54. Semarak engineering
55. Sin Yen (coating)
56. U-metal engineering
57. Value first (consulting)
58. Winmac (agriculture Australia?)
59. Zengyi Holding
60. Aemulus sdn
61. Hetra automation sdn
62. Adfit automation (distributor)
63. Automation systems & services

