Innovation in

Small Scale Industries

in Kerala

Bachelor Assignment

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Innovation in Small Scale Industries in Kerala

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Summary

This research is a personal bachelor's assignment of Business Administration & Engineering study in combination with the final report of the minor 'Sustainable Development in a North-South Perspective`. Research has been done in a collaboration of the University of Twente and the Centre for Development Studies in Kerala, India.

This report is about innovation in Small Scale Industries (SSI) in Kerala. A Small Scale Industry in the Indian context is an industrial undertaking in which the investment in fixed assets in plants and machinery, whether held on ownership terms or lease or on hire purchase, does not exceed Rs 10 million, equivalent 175 thousand euro (exchange rate April 2007). (Small Industries Development Organization, 1999) In this bachelor's assignment**,** different opinions on innovation are looked at and it is tried to find out which role the Keralan SSI have regarding innovation. The research question is.

What type of innovation processes in SSI exist in Kerala, and what are their contribution to economic development?

This is researched by means of two case studies in SSI in Kerala, namely Hykon and Pilots India. The case studies in both SSI, oriented on the domestic market, support the idea that developing countries should take into account that innovations are not shared easily among firms, and should be analyzed in the historical context in which it occurred.

There are various positive factors in Kerala that enable the development of SSI and innovation within the SSI. There are enough highly-educated workers and the government has set up institutions that can support SSI. Besides that, there is sufficient expendable income amongst the population to ensure a good consumption market. Within reason, out of the two case studies, we can carefully conclude that there are enough SSI in Kerala with the capability to innovate.
True, these capabilities are on the 'learning by doing' level. However, this level of capability has often proven itself to be sufficient in daily practice for the adopting of new products and techniques. There is a positive correlation between the presence of FTC and various economic factors. There is a positive correlation between innovation that occurs on 'learning by doing' level between the two SSI and the;

- Growth and success of the SSI
- The introduction of new products
- The creating of jobs for people with a higher education

For further development of the economy in Kerala, business education is of greater importance than technological education. My advice would be for organizations of the government to take more time to address the managers' potential and to offer supporting question-oriented business courses.

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1. Introduction

In this section**,** the introduction of the assignment is given. The section starts with the background and origin of the research. Subsequently, the problem statement is given. Based on the problem statement, the main research question is described and research questions are made to support the main research question. After that the relevance of the research is described. This is followed by the scope and delimitation, and structure of the report.

1.1 Origin of the Research

This research is a personal bachelor's assignment of Business Administration & Engineering study in combination with the final report of the minor 'Sustainable Development in a North-South Perspective'. The bachelor Business Administration & Engineering evoked my interest in technological development of businesses. Within the minor 'Sustainable Development in a North- South Perspective', insight was obtained on the broad outline of the issues in developing countries. In this research, I have used a combination of the academic fields in (technological) business administration and development issues.

These fields of study were combined within the collaboration between the University of Twente and the Centre for Development Studies (CDS) situated in the Indian state Kerala. The structure and the main question for this research arose in dialogue with the CDS, represented by Dr. S. Mani. The CDS is an autonomous research institute that promotes research, teaching and training in disciplines relevant to development. Main disciplines are agriculture and natural resources, gender, migration, population, health and education, poverty, industry, trade and technology. Dr. Mani, is Planning Commission Chair Professor in development economics at the CDS. Dr. Mani's main research focus is on indicators of innovation and public innovation policies in developing countries. This research looks at innovation within small scale industries, thus it links up perfectly with the field of research of the CDS.

Besides that, this research also links up with the government organization Small Scale Industries Development Organisation (SIDO). The SIDO is a Promotional Agency for Small Scale Industries, set up as a Public Sector Undertaking of the Government of Kerala. This Corporation is rendering assistance to SSI's in the State for development; like providing infrastructure facilities, distribution of essential raw materials, marketing of the SSI products, undertaking civil and electrical works. SIDO has offered assistance during the research period by supplying information about the SSI sector in Kerala. Two SSI, Hykon India and Pilots India, have cooperated with this research. They also both function as case studies for this research.

1.2 Problem Statement

In 1934, Schumpeter described the importance of innovation for the growth of an economy. (Schumpeter, 1934) Nowadays, innovation is a more and more discussed concept in today's world economy. As a result of globalization**,** consuming markets become larger, and with that, so does the competition. To face the competition the urge to innovate has increased. Governments try to enlarge the level of innovation in their countries; economic theory considers that innovation stimulates the growth of an economy and gives a better position in the competitive world market. Innovative activities create opportunities for further investment in productive capacity and production efficiency. This is why, in the long run, innovation is considered to create more jobs and consequently more income. (OECD, 1996)

Innovation itself is defined in several ways. In developed countries**,** and in the literature, innovation is often understood as the implementation of a new product or process. (OECD, 1996, page 10) Others for example define innovation as every effort towards technology mastery, adaptation of the technology to new conditions and improvements in the technology. (Lall, 1992) This definition by Lall is often used in the context of developing countries. The definition of Lall gives a better understanding of the context of innovation in developing countries (Lall, 1992) and the ability to establish accurate causal relationships amongst factors interacting in the process of innovation at firm and national level (James and Romijn, 1997)

Given the growing consensus that national investment in innovation is essential to ensure a countries economic growth, the promotion of innovation has now begun to appear on the policy agendas of developing countries. (Lall, 2000) India is also paying attention to the concept of innovation.

This bachelor's assignment is concentrated on innovation in SSI in Kerala.[1] In Kerala, the SSI are regarded an important sector for the development of the economy in this area. (SIDO, 2002). There are more then 200.000 SSI units in Kerala. (Ministry of Small Scale Industries, 2002) The SSI units are in sectors like Information Technology, Agro-based business including food processing, readymade garments, light engineering, Biotechnology and Rubber. SSI in Kerala produces many different products in various sectors. SSI are active in traditional sectors and process the raw materials that Kerala is rich in. These products are mainly produced for the internal market and these SSI work with processes that are less complicated.

Because of the special part small scale industries (SSI) play in the Keralan economy**,** this assignment is specifically about SSI and innovation in this sector.

Different sources think SSI play an important role in the economy of Kerala. For example**,** the director of the governmental Institute of Small Enterprises Development (ISED), Dr P. M. Mathew stated that innovation in SSI is important for the economy of Kerala; "*Technology promotion and development in Kerala lie in promoting innovation in the SSI of Kerala, given the natural advantage in this sector in the State"* (Mathew, 2004, page 10)

In contrast to the statements just mentioned, some economic reports don't confirm the need to innovate in developing countries. It is presumed that there is no need for innovation, innovation in the sense of introducing new products or processes, because developing countries receive innovations from developed country innovators. In neoclassical writing**,** technology and innovation have to be freely available to all countries and to all firms within countries. (Nelson, 1998) So according to this economic literature**,** Kerala, state of a developing country, should not be concerned about innovation. However, Lall says that developing countries certainly needs to do the type of innovation he describes.

Another economic assumption is in contrast to the Indian and Kerala government's statement that the SSI needs to put emphasis on innovation. The economic assumptions are that large firms have a greater advantage in innovation than small firms because they have more and cheaper financial resources, possibilities for risk spreading, more R&D activities, and greater capacity for specialization, in people as well as equipment. (Nooteboom, 1994; Rothwell and Dodgson, 1994) According to this statement**,** there is a need to monitor and stimulate the level of innovation of large scale industries. Which means that, according to the statement**,** the level of innovation of SSI is less important.

[1] The State of Kerala is located in the south-west part of India. Kerala was formed in 1956 as part of the linguistic reorganization of the Indian States.

So there are several opinions on which role SSI play in the Indian economy regarding innovation. On one hand, we have the Ministry of Small Scale Industries of India who believe innovation is important for SSI. Lall as well**,** advocates the need to innovate for development countries, in this case India. On the other hand, we have the neoclassical literature and the economic assumptions of economy of scale. They assign no importance to SSI and innovation.
In this bachelor's assignment**,** these different opinions will be looked at and we will be trying to find out which role the Keralan SSI have regarding innovation. Is it true that there is no need for innovation because Kerala receive innovations from developed country innovators? What is actually meant by innovation in the context of SSI? Is it important for SSI in Kerala to innovate?

1.3 Research Questions

The following research question will be answered in this report:

What type of innovation processes in SSI exist in Kerala, and what is their contribution to economic development?

In this report, I will be answering the main question by means of two cases from Kerala. These cases give an insight as to which capacities form a foundation for the innovation within SSI. Besides that, I will be looking at the influence of these capabilities on the SSI. The influence on the economy can be judged by looking at the growth of the SSI, the number of employees, the amount of products in production and the perspective for the future. With the obtained insight, it will become possible to illustrate the influence of innovation for the economy of Kerala in a general sense. In order to answer the main question, a number of sub-questions have been formulated. These sub-qeustions support the main question.

In this research, what is meant by the term SSI?
There are several definitions for SSI in different contexts. I will select a definition from the literature and explain my choice.

What is the political, economical, social and technological context of SSI in Kerala?
In order to answer the main question, I will use a PEST analysis to describe the social context of the two case studies. The Pest Analysis or Political, Economic, Social and Technological is a framework to analyze the external impact on the two organizations.

In this research, what is meant by the term innovation?
In the thesis it has become evident that several definitions can be distinguished for the word innovation. Using the literature, I will describe various definitions of innovation and I will explain my choice.

How can innovation be recognized in SSI?
By means of the definition of innovation that I have chosen to follow, I will explain how innovation can be recognized within the SSI.

With the two case studies, the following questions will be answered

- *Which type of innovation processes exist in this SSI?*
- *What is the importance of innovation for these two SSI in particular?*
- *What is the importance of innovation within these SSI for the economy of Kerala?*

1.4 Relevance of the Research

Research on the connection between SSI and innovation will be relevant for different players in the field of SSI. Measuring technological capabilities in SSI is important for gaining information in the development of how innovation in SSI occur and which barriers the SSI face while developing technological capabilities. All these kinds of information and insights could be supportive for good governmental policies and incentives. In Kerala, this kind of information is useful for regional government institution SIDO to face the needs of SSI in their region.
For SSI owners, insight in their own innovation processes could be very useful to understand the growth and development of their firm. Owners and managers will be able to make more grounded decisions on investments and make smart and useful interventions in day-by-day work life by using insights in their own innovation processes. Scientific relevance of the research is a contribution on the field of innovation studies. It proposes indicators and methodologies to measure innovation in SSI. These indicators will be useful for future research.

1.5 Scope and delimitation

This assignment shall attempt to identify the technological capabilities in SSI, and the barriers to innovate for SSI orientated on the domestic market in Kerala, using two case studies of SSI. The literature covering the area of political, economic, social and technological environment of SSI will be gathered and analyzed by using the Human Resources Development report of Kerala, provided data on SSI by the government of India and Kerala and research done by the Centre for Development in Kerala. The research shall be based on two cases studies (Yin, 2003), which is not enough to cover the whole SSI sector in Kerala. Still, it gives a first insight on what type of technological capabilities exists in SSI in Kerala and what their influence is. Is this sense it shines light on the importance of technological capabilities. The assignment will also give advice for further research on SSI in Kerala.

1.6 Structure of the report

In the second section, I will discuss the literature that serves as a background and context for this research. Firstly, in this chapter, I will discuss the social context of Kerala. This will be done along the lines of a PEST analysis that describes the political, economical, social and technological context of the SSI in Kerala. Subsequently, in this second chapter, the literature on innovation will be discussed. The methodologies of the case studies are described in chapter three. In this section it will become clear how innovation can be recognized on firm level, and how this has been done during this research by means of case studies. Chapter four describes the actual study of the two SSI. These two cases will be amply discussed and we take a look at the influence of innovation on these SSI. The main research question will be answered in section five. In this chapter, insights obtained from the case study and literature will be used to make recommendations to strengthen the policy of SIDO, and to give indications for further research. The report will be finished by a reflection on reflection on the research and how innovation in SSI in India should be studied and measured in the further research.

2. Literature

In this section, I will be using the literature to describe the context of the research. The scientific and social context of the research in the two study cases will be made clear. First of all, the definition of SSI will be described. A sketch will be made of the political, economic, social and technological context of the two case studies. A selection has been made amongst these factors, based upon relevance for the SSI in Kerala. The social context will be described in the second paragraph of this section. The social context in which the research has taken place will be discussed in the third paragraph. We will be taking a look at the various definitions of innovation in a more extensive form than in the problem statement.
Different views of innovation are described in the literature, two important definitions will be discussed more extensively; Lall's definition and the OECD's definition. In the third paragraph**,** a look is taken at which definition of innovation is most useful to understand and to research. The section will take a closer look at the differences between innovation in developed countries and developing countries.

2.1 SSI

2.1.1 Small Scale Industries a definition

In the literature, several definitions of SSI are given in. There is no universal definition of small scale industries. In some countries, there are certain objective standards, which classify the units as micro, small or medium enterprises depending on the number of employees. In some countries**,** the classification is based on the investment in fixed assets in plant and machinery. In the case of India**,** the definition of SSI has been changed frequently from 1950 tup until now. The definition that has been updated and used most often in nearly all scientific research, is the definition with a boundary of Rs 10 million investments, which makes about 175,000 Euro. (Exchange rate April 2007) Governments and other official authorities also use this definition. The definition used for this assignment is the following; A Small Scale Industries in the Indian context is an industrial undertaking in which the investment in fixed assets in plant and machinery whether held on ownership terms or lease or on hire purchase does not exceed Rs 10 million, equivalent 175.000 euro (exchange rate April 2007). (Small Industries Development Organization, 1999)

2.1.2 SSI in India

In India there are more than 3 million units (SIDO, 2002). They provide employment to almost 19 million workers in small towns and villages, as well as in larger cities. The *number* of Small Scale units has increased continuously and approximately four folded in the period from 1980 up to 2000. (SIDO, 2002) In 1980 there were only 874,000 units, this increased to 3,370,000 units in 2001. Nowadays, 95 per cent of the Indian industrial sector belongs to the SSI. Analyses of the growth rates shows a growth of 5,4 per cent over the years 1991-02 to 2001-02. (SIDO, 2002) *Employment* in SSI, has increased from almost 13 million in 1992 to 19.3 million in 2001. SSI accounted for 4 per cent of total employment in 2001 (SIDO, 2002). SSI provide a wide range of *items* (more than 8,000). Items produced vary from simple items produced with traditional technology to high-tech products, produced with sophisticated new technologies. The *production* has been growing rapidly over the last decades. SSI contribute almost 40 per cent of the gross industrial value added in the Indian economy (GOI, 2001). Growth of the sector has been higher than the growth of the industrial sector in the period 1991-2001. At constant prices**,** growth

peaked at 11.4 per cent in 1995-1996 and after that it decreased to 7.7 per cent in 1998-1999. (Ministry SSI India, 2001) The SSI sector plays a major role in India's present *exports.* It is estimated by the ISOD that up to 45-50 per cent of Indian exports is contributed to by the SSI Sector. Direct exports from the SSI sector account for nearly 35 per cent of total exports in 2002. Besides direct exports, it is estimated that small-scale industrial units contribute around 15 per cent to exports indirectly. (Ministry SSI India, 2001)
SSI in India have changed from mainly craft based industries to an organized and industrialized sector. In the early stages of industrialization, SSI were mainly based on crafts and they were situated in rural areas. With the increase of industrialization, the structure of SSI has changed towards a more organized segment. The phenomenon is mainly due to the replacement of the so-called "tiny sector", which are defined as enterprises with an investment limit of 2,5 million rupees (about 45000 Euro) in fixed assets. This tiny sector in the informal sector is replaced by the relative larger and organized SSI. (Morris, 2001) The inherent advantages of small-scale units are reduction of regional imbalances, low investment, greater operational flexibility, greater geographical dispersal, utilization of local material and human resources (Bayineni, 2004) (see for SSI figures and numbers of All India).

2.1.3 SSI in Kerala

Most of Kerala's industrial regions are concentrated around major cities like Cochin and Trivandrum. However, SSI are spread across the State. The SSI units are in sectors like Information Technology, Tourism, Agro-based business including food processing, readymade garments, light engineering, Biotechnology and Rubber. SSI produce more then 2500 different products. Based on the results of the third Census of SSI Units (Ministry of Smal Scale Industries, 2002) there are more then 200.000 SSI units in Kerala. More tha 55% percent where registered as SSI, the others were unregistered.[2] The report says that out of the 200.000 SSI, more than 14.000 units were found closed. The reasons for closure were mainly financial and marketing problems and the inability to survive competition. With both the registered and unregistered units put together, there were nearly 1 million people employed in the total Keralan SSI sector. Of the total employment, 64.60 per cent was in rural areas. They accounted for a combined output of Rs 81 billion, equivalent 1,47 billion euros (exchange rate April 2007) during the time of the census. More than one-third of the registered SSI units in the State are either sick or potentially sick.[3] Reasons cited for sickness ranged from lack of demand, shortage of working capital and non-availability of raw material to power shortage, labour problems and marketing problems.

2.2. PEST-analysis

In order to make a good analysis of the case studies, the Political, Economical, Socio-Cultural and Technological environments issues that influence SSI in Kerala will be discussed in this paragraph. The Pest Analysis or Political, Economic, Social and Technological is a framework to

[2] Unregistered SSI for the purpose of the Third Census was taken to be the set of all those enterprises which were eligible for registration as SSIs but were not so registered as on March 31, 2001. (Ministry of Small Scale Insdustries, 2002)
[3] In the Third Census, the following criteria are adapted to identify sick/ incipient sick units. 1)Continuous decline in gross output compared to the previous two financial years; 2) Delay in repayment of loan, taken from institutional sources, for more than 12 months; and 3) erosion in the net worth to the extent of 50 per cent of the net worth during the previous accounting year. (Ministry of Small Scale Insdustries, 2002)

analyze the external impact on SSI. The distinction between the four dimensions is mainly from an analytical point of view. In reality, these dimensions are strongly connected and interwoven with each other. This can be seen in the descriptions in the separate paragraphs; these will partially overlap. This PEST analysis limits itself to the influences of SSI in Kerala. In the description of these influences, a choice has been made whether to describe the influences on State level or on Indian National level. The choice is based upon the amount in which State level deviates from National level. The economic analysis for instance has been based upon Kerala itself, because this can be seen as a unique own identity that can easily be distinguished from the national economic development. The SSI policy however is mainly described on a national level.

2.2.1 Political environment

In the political environment I will be looking at two aspects that influence the SSI. Firstly the general political climate, which has an important influence on the economic and social environment. Secondly, the specific SSI policies will be described.

Kerala distinguishes itself from the Indian policy in various ways. Kerala has an active political society compared to the rest of India, there is a high degree of political activism. (GoK, 2005) Since the formation of Kerala in 1956, no single party has been able to form a Government of its own. Two coalitions have been running the State. One of these two is led by the Indian National Congress, the other is led by the Communist Party of India (Marxist). Kerala's economy and society operates under welfare based democratic socialist principles. (source GoK, 2005) Socialism is based on the idea that the economy and means of production should be in the hands of ordinary working people. (Edelstein, 2000) The substance of democratic socialism is that in all aspects of society and economy, the population is in control through some type of democratic system. Since 2000, the state has liberalized the economy by allowing greater participation by the free market and foreign direct investment. (GoK, 2005) However, the period before 2000 is of great influence, there are still many government organizations working in the SSI field. In Kerala the agenda for industrial development is set largely by public government institutions, public R&D institutions and powerful social groups. Government operates in the filed of SSI mainly supply driven. They invest in SSI and set up organizations for the development of SSI. However, these are determined from a democratic point of view so that investment is mainly made in education and institutions. Because of this, policies don't really live up to the wishes of the SSI themselves. The policies are not demand driven, but supply driven. As a result, the prevailing economic climate stays behind of the entrepreneurial development. (Mathew, 2004).

The second aspect, which has a more direct influence on the SSI in Kerala, are the national specific policies. Initiatives for generating employment, production and income for SSI in India had a special place in developmental policy over the years. (Kawadia, 2005) A significant aspect of Indian SSI policy is the reservation of products to be produced by the SSI sector. The Reservation Policy has two goals, 1) to ensure increased production of consumer goods in the small scale sector, and 2) to expand employment opportunities by setting up SSI. The idea behind this policy is that SSI are needed to enable economic growth and provide employment. SSI are needed for a harmonious way of growth for the industrial sector; the central government believed that without SSI**,** only really big industrial monopolies would emerge with bad conditions for the environment and employment. The idea was that SSI are needed to serve the people by protecting their jobs and for a more equitable division of many resources. Another reason to protect SSI was to maintain their viability and strength to simplify the problem of unemployment. This policy of reservation is often criticized, because these measurements have created severe distortions in the

market. They have helped firms in Kerala to exist without an explicit need to be as efficient as possible. (Morris, 2001) However, since 2001**,** the government has been steadily ticking off products from the reserved list. The latest data show that the list of items meant for exclusive production by SSI has come down from 836 items in 2001 to 114 at 2007. This indicates that almost 90% of items from the reserved category can now be domestically manufactured by the large, medium or the small scale industry. (SIDO, 2007)

2.2.2 Economical Environment

For a long time, Kerala has been known amongst scientists as a land with a 'paradox of social development and economic backwardness'. Since the founding in 1956, Kerala has been running behind on the other states when it comes to terms of per capita GDP[4]. However, in Kerala the human standard of living is very high compared to the rest of India. This can be seen in the Human Development Index[5], on which Kerala has the highest score in all of India and has a similar score to other developed countries. (GoK, 2005). This Human Development is the subject for the next subsection. However, in this section I want to discuss what the present economic state is and what influence this has on the SSI. The reforms of 1991 are of great influence on the Indian economy and thus also of Kerala. The economic liberalization in 1991, initiated by the Indian Prime Minister at the time, P. V. Narasimha Rao and his finance minister Manmohan Singh, is important in recent Indian economic history. The economic reforms contained, for instance, the removal of control on industrial investment and on imports. The reforms opened energy and telecommunication sectors for private investment (domestic and foreign).The reforms reduced import tariffs and made the rupee convertible for current account transactions. (Panagariya, 2002).

After a period in which the development measured in GDP per capita was running behind compared to India, Kerala went through a big economic growth in the period from 1988 to 2003, both in regard to ten years earlier, and to the growth in all of India. With this, the growth of the Net State Domestic Product (NSDP)[6] is almost equal in comparison to India (see table 1a).

Table 1A; Sectoral Growth Rate of Net State Domestic Product (1993-1994 Prices) over the period of 1987-88 to 2002-03

Sector	Kerala	All India
Primary Sector	2.90	3.47
Secondary	6.13	6.53
Tertiary Sector	7.55	7.48
All Sectors combined	5.79	5.98
Per Capita GDP	5.03	4.01

Source: CSO, National Account Statistics

[4] The gross domestic product (GDP) or gross domestic income (GDI) is one of the measures of national income and output for a given country's economy. GDP is defined as the total market value of all final goods and services produced within the country in a given period of time (usually a calendar year). It is also considered the sum of value added at every stage of production (the intermediate stages) of all final goods and services produced within a country in a given period of time, and it is given a money value. (Wikipedia, accesed on 5th of June)

[5] The Human Development Index (HDI) is an index combining normalized measures of life expectancy, literacy, educational attainment, and GDP per capita for countries worldwide. (UNDP)

[6] Net State Domestic Product, the total value of all the goods and services produced inside the state Kerala minus depreciation on a country's capital goods over a certain period. (GoK, 2005)

The growth per sector contributed to the overall growth rate shows that the industrial secondary sector contributes less to the growth of the NSDP in the period 1983 to 2000.
In this period, employment share increased by 27 per cent, income share fell by 24 per cent. The conventional growth transformation, which is from the agricultural sector to the industrial sector and then to the tertiary sector, has not taken place in Kerala. This is evident as the relative shares of the three sectors, in both income and employment, on an average, show that the tertiary sector has been the major contributor followed by the primary sector. (GoK, 2005) (see table 1b)

Table 1b; Structural Transformation of the Kerala Economy as Seen Through Sectoral Shares of Income and Employment

Sector	1983		2000	
	Income	Employment	Income	Employment
Primary Sector	35	50	26	32
Secondary Sector	25	22	19	28
Tertiary Sector	40	28	55	40

Source: CSO, National Account Statistics

The industrial sector and thus the SSI do not have a leading role in the economy of Kerala when it comes to contributing to the growth of the economy and income. [7] Since 1983 the industrial sector has started playing a bigger part in providing employment. It is unclear what the exact contribution is of SSI in the industrial sector, and what the SSI contribute to the growth of the economy. What we do know is that the SSI functions within an economy in which the service sector has a dominant role.
The State has a high level of unemployment. Unemployment defined as a proportion of the number of employed in the labor force, was 19.2 per cent. (Zhachariah, 2004) Significantly, most of the unemployed are young, unmarried and educated. According to Zacharia there is hardly any unemployment among those with less than primary education. In Kerala, manual labour is associated with low status and hence people with education are reluctant to do it. Shortage of labour is particularly high in agriculture. Many Keralan people are able to find work in other Indian states, the Middle East, and the US. The money they send back home, remittance, is important for the Keralan economy and growth. However, only estimations about the amount of remittance are made. Other aspect that influence SSI is that labour is, as said before, highly organized and consequently wage levels are comparatively higher than in other States. (GoK, 2005)

2.2.3 Social Environment

Kerala's achievements in terms of some of the basic indicators of human development are high compared to India. The life expectancy at birth is 73 years in Kerala, much higher then in the rest of India with 59 years. Further, Kerala is much ahead of other Indian States in providing elementary education. In Kerala almost 95% of literacy is achieved, compared to 65% in India (Census Report GoK, 2006)

[7] The growth of the economy is mainly influenced by the growth of the tertiary sector, which accounts for more than 50 per cent of the NSDP's growth. Besides that, the service sector voor absorbs a major share 40 per cent of the work force. (GoK, 2005)

In her demographic development, Kerala has transformed from high birth rates and high death rates to low birth rates and low death rates[8]. Kerala has an almost stable young age dependent population, increasing working age population and older population.
This shift in the composition of the population has various consequences. Limited opportunity for employment in the local economy has result in people migrating to other countries where employment opportunities are greater. Close to 2.73 of the 35 million people of Kerala are emigrants and return emigrants as of 2004. Migration of labour from Kerala has contributed to interacting with people from different countries and cultures. Migrated people have worked with more modern technologies, organization and management. Emigrants have the possibility of enhancing one's standard of life in Kerala, and they have a 'demonstration effect' on others. (Zhachariah, 2004) This way the modernization and technology brought by emigrants have facilitated adaptation of technology in the local economy. This technology is described in the next subsection.

2.2.4 Technological Environment

In this paragraph, the technological environment of the SSI in Kerala is described. This will be done by looking at the availability of electricity, telephone density and the use of internet. This will be followed by a description of how the industrial sector has developed from a technological point of view. About 85 per cent of the households in Kerala have electricity at present; however the reliability of the connections is far from satisfactory, with frequent blackouts and brownouts. (GoK, 2005)
In Kerala mobile telephones have taken over fixed-line telephones. As of December 2006, Kerala is the only state with a two-digit telephone density at 10.95 in rural areas. In urban Kerala, there are more than 91 phones for every 100 population. Overall in Kerala, the teledensity is at 31.73. The teledensity of India was 16.83. (Departement of Telecommunications, 2007)
There is a relatively high intensity of computers in Kerala and the Internet has penetrated into traditional telecommunications. By late 2000, there were approximately 50,000 Internet connections in the state, ranking it eighth among Indian states. (more up to date data has not been found) (Departement of Telecommunications, 2007) There is a high PC penetration in social life. (GoK, 2005) State policy is that every primary school has at least one computer.
In the previous paragraph the influence of organized labour and remittance is described. Remittance has influenced the Keralan economy by an increase in demand, especially for non-food items. However, according to a study done by the Centre for Development, (Zhachariah, 2004), the productive sectors of the Keralan economy could not utilize investment in the savings generated from the emigrants. This has influence on the technological development of industries. The power of the organized labour aborted the transition to a technologically more productive industrial sector. Institutional power of labor (in terms of early and high level of unionization) stood to drive away most of Kerala's indigenous labor-intensive industries, such as coir processing/manufacturing, cashew processing and tile manufacturing. This background of inability of the productive sectors forms the reason as to why the tertiary sector flourished more than the secondary industrial sector. (Zhachariah, 2004)

There is a high familiarity with technological means and sufficient expendable income for the Keralan inhabitants. At the same time, it is evident that due to high wage-costs and fear for losing

[8] This is often called demographic transition, when the economiy develops itsself from a pre-industrial to a developped industrialized economy.

jobs in the communist oriented politics, innovation in the industrial sector stays behind. What exactly is understood by innovation is topic of the next sub-section.

2.3. Innovatie

In this paragraph, literature on innovation will be discussed. First of all, the origin of the concept of innovation. Subsequently I will discuss the role that innovation has had in different economic growth models, and subsequently I will discuss how innovation on firm level is described.

2.3.1. The concept of innovation

The Austrian economist Schumpeter (1934) is the instigator of the idea of innovation and creative destruction. He defined innovation as "to create or use something new". This always goes together with the loss of old products and processes, Schumpeter calls this creative destruction. Schumpeter considered that the term innovation fits into five categories;

- Introduction of a new product or a qualitative change of an existing product;
- Process innovation which is new for a business sector;
- Opening of a new market;
- Development of new resources;
- Change in the organization and management.

Schumpeter argued that innovations act as catalysts in the economic process of 'creative destruction'. The process of creative destruction leads to economic growth and structural change. An innovation firm undercuts the market of some existing group of producers by producing and marketing a new product or process. Non-innovating firms are eventually forced to imitate the innovation or face bankruptcy. As the innovation is adopted by more and more imitators, output expands and the innovator's initial profits are bid away as the price falls to a competitive level. In the case of a major innovation[9], such as electricity or the automobile, the original new productive activity induces the development of many others, by creating new demands and altering the costs of producers in other sectors of the economy. Thus, it gives rise to important structural changes in the economy, as well as to growth in the total volume of output. Since Schumpeter first formulated in 1942 this model**,** it has remained the basis for most writing on the role of innovations in economic development. In Appendix 1 the role of innovation in different economic growth theories is described.

2.3.2 Innovation at firm level

In this paragraph**,** innovation is discussed on firm level. This will show that there are several ways of looking at innovation. In economic research on innovation at firm level**,** two main approaches can be identified. The "subject approach" and the "object approach" (Archibugi and Pianta 1996). In the "object approach"**,** individual examples of innovation become the analytical unit and in the "subject approach" emphasis is placed on the inputs and outputs of the process of innovation.

The OECD is an institution that does a lot of empirical research on innovation. A part of their research is a good example of the object approach. The OECD concentrates on two of Schumpeter's categories: new and improved products and processes, with the minimum entry set

[9] Schumpeter recognized two degrees of innovations; radical and incremental innovations. Radical innovations are innovations that have a huge impact on the environment and the society. Incremental innovations contribute and lead to continuous changing in small steps

as “new to the firm”. The OECD defines innovation as the implementation of a significant new product or the implementation of a significant new production process. (OECD, 1996, page 10) This definition is widely known as technological product and process innovation, TPP-innovation. Only two of Schumpeter’s points are mentioned, and only technological innovations are involved. OECD’s definition is often used in scientific literature.
The process of innovation is also studied and an example of the subject approach. Innovation is not seen as a static activity; it is a continuous process. Studying innovation as a process gives insight in how innovations occur and which powers influence the innovativeness of a firm. A model developed by Kline and Rosenberg, 1986, is an example of how the process of innovation is examined. The model conceptualizes innovation in terms of interaction between market opportunities and the firm’s knowledge base.

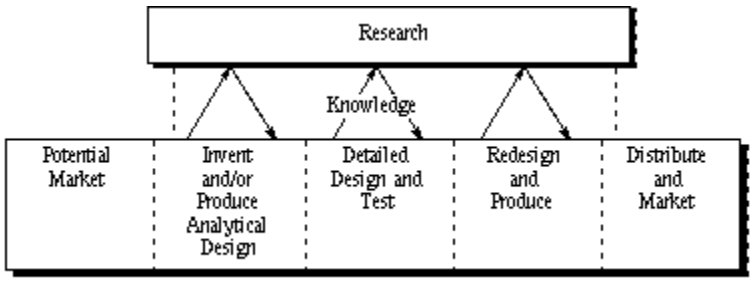

Figure 1 Chain-Link Model Innovation
Source; Kline, S.J. and N. Rosenberg (1986)

This model has the objective of capturing the process and to offer a way of collecting data about the innovation process. (OECD, 1996) The two approaches to study innovation at firm level have been described. Both approaches describe the concept of innovation to capture the technological change in a firm. The main advantage of the object approach is that it provides a direct description of technical characteristics of technological progress. The main advantage of the subject approach is that it offers a better understanding of the significance and usefulness of innovation to its users. However**,** problems in the use and interpretation of these approaches are identified. Especially the use of these approaches in the context of developing countries is criticized. The criticisms argue as follows;

- Schumpeter's theory of creative destruction must be analyzed in the historical context on which it occurred. Schumpeter himself wrote that his analysis of economic development was based on the experience of rapid industrial growth in the capitalist societies. (Europe and North America during the nineteenth and early twentieth centuries). (Schumpeter, 1934) So, it requires modification if it is to be applied in other contexts. In particular, the kinds of change in technology and the organizations characteristics of Western industrial economies could be different in other contexts. That underlying social and economic conditions are different are different is one of Schumpeter issues, however they have not been taken serious in further research (Berry, 1974)
- In the study of developing economies writers assume that no important innovations have been initiated by producers. Others have concluded that most of the new products and processes adopted in developing economies in the 20th century have been introduced and carried out by

foreign entrepreneurs. Developing countries have been 'imitators' of foreign innovations. However, this analysis of technological change in developing countries doesn't take into account that innovations are not shared easily among firms. Moreover, innovations are not easily shared among firms from different nations.

- Furthermore, this analysis does not take into account that firms in developing countries also need to know that new technologies exist at all. Transfer requires learning because most technologies are difficult to use because of tacit knowledge. To gain mastery of a new technology requires investment and skills by the receiving firm. Firms have their own technological progress building upon their own efforts, experiences and skills. So, in the context of developing countries**,** it is not only the initiation of innovations that is important**,** but the capabilities to master an innovation as well.

The three points have argued for a different approach to study innovation in the context of developing countries. To summarize the above arguments 1) the historical context is important to analyze the technological change of a firm, and 2) new technologies aren't easily shared among firms and the efforts to master new technologies are important to analyze technological change in developing countries. Lall argues that technological change in developing countries should be analyzed as a continuous process to absorb or create technical knowledge, determined partly by external inputs and partly by past accumulation of skills and knowledge. (Lall, 1992) Then, innovation can be taken to include all efforts toward technological mastery, adaptation of the technology to new conditions and improvements in the technology. (Lall, 1992) Innovation is defined as the adoption of a technology that is new to the adopting organization, to adapt a technology to new conditions, to improve technologies slightly or significantly.

2.3.3 Firm Capabilities and economic growth

In traditional approaches to analyse economic growth the way to explain productivity growth at the firm level is a production function. (more on economic growth theories in Appendix 1) A production function can be defined as the specification of the minimum input requirements needed to produce designated quantities of output, given available technology. By assuming that the maximum output technologically possible from a given set of inputs is achieved, economists using a production function in analysis**,** are abstracting away from the engineering and managerial problems inherently associated with a particular production process. In traditional approaches to analyze economic growth**,** innovation is assumed as movement of the production function itself**,** rather than along it.

In contrast to the analysis just mentioned, the evolutionary approach explains economic growth with use of the concept of Firm Capabilities. To create value and gain a competitive edge, a firm uses a whole bundle of specific capabilities. Firm–specific, mostly intangible assets are considered to be the firm's capabilities. They are dynamic and the result of strategic decisions in the past, and represent the resources to create more assets in the future. Asset accumulation enables a firm to change restrictions with respect to technology. This accumulation process is path–dependent, and due this process important differences among firms occur. (Foss, 1997) So, in this assignment**,** innovation is discussed and studied on firm level.

2.3.4 Firm Technological Capabilities

Lall defines *Investment capabilities as* the skills needed to identify, prepare, obtain technology for, design, construct, equip, staff, and commission a new facility (or expansion). They determine the capital costs of the project, the appropriateness of the scale, product mix, technology and

equipment selected, and the understanding gained by the operating firm of the basic technologies involved (which, in turn, affect the efficiency with which it later operates the facility).” (Lall, 1992, page 168)” The investment capabilities described by Lall are those skills which lead to the establishment of the enterprise. There is not a narrow definition of access to financial resources. These require skills to carry out feasibility studies as well as technological knowledge (prior knowledge on product and process) (Clancy, 2001)

Lall defines “***Production capabilities*** range from basic skills such as quality control, operation, and maintenance, to more advanced ones such as adaptation, improvement or equipment “stretching,” to the most demanding ones of research, design, and innovation. They cover both process and product technologies as well as the monitoring and control functions included under industrial engineering. The skills involved determine not only how well given technologies are operated and improved, but also how well in-house efforts are utilized to absorb technologies bought or imitated from other firms.” (Lall, 1992, page 168)

*“**Linkage capabilities*** are the skills needed to transmit information, skills and technology to, and receive them from, component or raw material suppliers, subcontractors, consultants, service firms, and technology institutions. Such linkages affect not only the productive efficiency of the enterprise (allowing it to specialize more fully) but also the diffusion of technology through the economy and the deepening of the industrial structure, both essential to industrial development. The significance of extra market linkages in promoting productivity increase is well recognized in the literature on developed countries.” (Lall, 1992, page 168)

2.4. Concluding remarks.

In this chapter, the environment of the SSI in Kerala is described. This forms the social imbedding of the case studies. From that, it becomes evident that there is great potential for economic growth, thanks to the presence of a strongly developed human capital, presence and familiarity with technological means and sufficient expendable income for the Keralan inhabitants. At the same time, it is evident that due to high wage-costs and fear for losing jobs in the communist oriented politics, the industrial growth stays behind.

The literature on innovation gives a scientific ground for the research methodology. From this we can see that innovation in developing countries needs to be seen as an incremental process to adopt new technologies. Firm technological capabilities are necessary for this. The research methodology is the subject for the next chapter.

3. Methodology

In this chapter, the methodology is discussed. First of all, what kind of methodology is used for this research, and why this particular methodology is chosen. Subsequently, how innovation can be measured and recognized. In the third paragraph, I will describe how the research took place.

3.1 Case Study Research as a research strategy

In this paragraph I will explain what kind of methodology is used for this research, and why this particular methodology is chosen.

3.1.1 Case Studies as a research strategy

The particular approach to the research adopted here is taken because of a gap in the existing research into domestic oriented SSI in Kerala. The reason to accomplish case study research is that there is little empirical research on innovation in SSI in Kerala. Besides that, I would like to create insight in the capabilities that can be recognized in Kerala, and the influence that these have on the SSI. These capabilities become visible when put to practice, thus they are studied that way.

The case study done for one of the two SSI is of explanatory kind. An explanatory case study allows the researcher to factually record and draw interferences. The researcher constructs a story to illustrate a certain point of view and offer details of the reasons for the event or the concepts behind them. This sort of case can provide an explanation (Yin, 2003) Explanatory cases that are concerned with providing accurate events and explanations. The cases are more general and descriptive and use an assortment of information. Often, the goal is to provide an adequate explanation by comparing the facts of the case with several competing theories and frameworks. (Yin, 2003). For case studies**,** five components of a research design are especially important; 1) a study's question, 2) its propositions, 3) it units of analysis, 4) the logic linking the data to the propositions and 5) the criteria for interpreting the findings. These five components are discussed below.

3.1.2 Research design

The following questions will be answered by means of the two case studies;

- *Which types of technological capabilities are existent in this SSI?*
- *What is the influence of the development of these Technological Capabilities on these SSI?*
- *What are barriers for these SSI to innovate?*

The two units studied are small firms. These small firms were both situated in Kerala, a state of India. This is for practical reasons. Selection of cases to be studied was found through discussion with the people of Small Industries Development Organisation (SIDO). They have good insights in the SSI landscape of Kerala and the researcher advised me two cases to study. Two single cases are insufficient to draw strong conclusions and to generalize on. Lack of time has been the reason to explore just two cases.

Yin stated that case study research is a difficult thing to do. (Yin, 2003) There are several limitations and difficulties on this kind of research. Case Study research could be disputed, because by not having different sources of information, research could undermine the confidence

of the conclusions. A finding of conclusion in a case study is likely to be much more convincing and accurate if it is based on several different sources of information. (Yin, 2003) In the cases studied, the sources are multiple but most of them were from inside the organization. Weak points in the analysis are the lack of quantitative data and the fact that only a few interviews have been done. In the next paragraph I will describe how innovation is recognized.

Different sources are used to study the case of Hykon;

- a personal visit to Hykon personal,
- an open-ended interview with Christo George, manager and owner of Hykon,
- an interview with the manager of the R&D unit,
- interview with three workers of Hykon,
- promotion material,
- documents on history about Hykon.

Different sources are used to study the case of Pilots India.

- a personal visit to Pilots India with obeservations
- an open ended interview with Sheen Anthony, Chairman and Managing Director
- an open ended interview with the father of Sheen Anthony, founder of Pilots India
- interview with two workers of Hykon,
- website of Pilots India

3.2 Measuring innovation

To understand and measure innovation at the level of firms, different methods and indicators are used. (see Appendix 2 for a description of different indicators and ways of measuring innovation with their advantages and shortcomings) To study innovation in Kerala, the concept of "firm technological capabilities" (FTC) is used. The concept of FTC is used because the analysis of technology and technological change in developing countries should take into account that innovations are not shared easily among firms, and should be analysed in the historical context on which it occurred. Lall argues that technological change is analysed as a continuous process to absorb or create technical knowledge, determined partly by external inputs and partly by past accumulation of skills and knowledge. Innovation in this assignment is taken, to include all efforts toward technological mastery, adaptation of the technology to new condition and improvements in the technology. FTC correspond to a wide range of skills and knowledge, necessary to render effective the effort of the firm towards technological mastery, adoption of the technology to new conditions and improvement in the technology (either slight or significant) (Lall 1992, James and Romijn 1997). In this paragraph**,** the concept of FTC is worked out in more detail. Different categorizations are made for different contexts and settings. The categorization used for this assignment is of Lall. This categorisation is used because it also helps to recognise FTC in SSI. It gives clear skills that can be shown by case study research.
Lall categorizes FTC by a matrix of the major technical functions involved and is shown in Table 1 (Lall, 1992). The columns set out the major FTC by function, the rows by degree of complexity or difficulty. Lall distinguishes capabilities; the degrees of complexity which Lall describes are;

1) basic; simple and routine (experience-based) accumulated experience of problem solving. This could be named as innovation through learning by doing
2) intermediate; adaptive and duplicative (search-based) and aided by external inputs. Innovation through import of technology.

3) advanced; innovative, risky (research-based) or formal research effort. Innovation through formal R&D.

Table 2 Matrix of technological capabilities

		Investment		Production			Linkage
Degree of complexity		**Pre-investment**	**Project execution**	**Process engineering**	**Product engineering**	**Industrial engineering**	**Linkages within economy**
Basic	Simple, routine (Experience-based)	Prefeasibility and feasibility studies; site selection; scheduling of investment	Civil construction; ancillary services; equipment erection; commissioning	Debugging; balancing; quality control preventive maintenance; assimilation of process technology	Assimilation of product design; minor adaptation to market needs	Work flow; scheduling; time motion studies; inventory control	Local procurement of goods and services; information exchange with suppliers
Intermediate	Adaptive, duplicative (Search-based)	Search for technology source; negotiation of contracts; bargaining suitable terms; info. Systems	Equipment procurement; detailed engineering; training and recruitment of skilled personnel	Equipment stretching; process adaptation and cost saving; licensing new technology	Product quality improvement; licensing and assimilating new imported product technology	Monitoring productivity; improved coordination	Technology transfer of local suppliers; coordinated design; S&T links
Advanced	Innovative, risky (Research-based)		Basic process design; equipment design and supply	In-house process innovation; basic research	In-house product innovation; basic research		Turnkey capability; cooperative R&D; licensing own technology to others

Source: Lall, 1992

3.3. Account of the course of the research.

Here, I will describe how the research in the two cases gained form, and the possibilities that I came across in this process. Data was collected through visits to the firms and by open interviews in the period between September 2005 and March 2006. The visits and interviews took place within the firms themselves. The appointments were made over the telephone. The researcher says to have felt welcome; in both case studies consent was given for the research immediately, and it was insisted that we visit as soon as possible.

It was made clear from the beginning that the research was being done by a student from the Netherlands. Possibly, this made it particularly special for the employees. During the research period I was treated with great respect. Employees were impressed and upon my arrival, they laid their work aside. The great difference in culture and background between the researcher and the case study may have lead to answers, interviews and presented data that are slightly influenced.

In society of India the cast system is often understood as important influence in daily live. The caste system is a social system where people are ranked into groups. The caste is a group whose members are restricted in their degree of social participation and choice of occupation. However, in Kerala caste barriers have mostly broken down, especially in urban areas. So, in this research the cast system is not taken in to account and is not experienced as influence on innovation in both SSI.

During the visits, available documents about the firms were asked for and provided by the management. The cases were studied by asking people who work for the firms and by the provided documents from inside the two firms. In both cases, documents were provided by the staff. Because of this, the provided documents were selective. However, it did provide insight in the organisation itself. Little tangible, testable data was given on the financial situation.

While visiting both the firms, there where interviews with at least four people working at different levels in the firm. It was proven to be quite difficult to interview the staff due to translation problems. The language that was used to communicate in was English. In one case, Hykon, the entrepreneur took on the roll of interpreter. During the research I was also given a tour so that the interview could be linked with a visual observation, giving a more complete picture. During the visits, detailed notes of all answers and observations were made. Interviews have been worked out almost literally, right after the visit and based upon the notes that had been made.

4. Cases

In this chapter, the two cases that form the root of this research are discussed. The two SSI from the case studies are both situated in Kerala. From the description of the cases, it becomes clear which innovation processes can be recognized in this SSI, and what their influence is on the development of the SSI.
In the first three paragraphs, Hykon is described. Paragraph one consists of a brief introduction is to the Hykon case. In 4.2, the FTC of Hykon is described. In 4.3, the innovation processes of Hykon are analyzed. In the second three paragraphs, a description of Pilots India is given in the same manor. Paragraph 4.4 is a brief description of Pilots India, 4.5 describes the FTC and 4.6 the analysis.

4.1. Hykon India

In this paragraph**,** a description of Hykon India in the State Kerala is given. The SIDO sees Hykon as a model for other firms and recommended this firm by the researcher to study. They produce a highly advanced product for the internal Keralan market.
Hykon India started in 1991. The firm was set up with the initiative of Christo George. He established Hykon Electronics Systems at Ollur, in the Trichur district of Kerala. The firm started here because this was George native place and he wanted to live close to relatives. The firm started with only five employees, and only one product was in production – the electronic inverter[10] with new digital technology. These electronic inverters are called UPS. Uninterruptible power supplies (UPS) sit between a wall outlet or power strip and an electronic device to provide power conditioning, back-up protection and distribution for electronic equipment loads and to prevent power disturbances (outages, sags, surges, spikes, noise, etc.) from affecting the performance and life of the electronic device and vital data. (Global Spec, 2006)
It was Mr. George's strong believe that this product would work; it was a new product in this market. Frequent power failures in Kerala are the reason for the high demand of this product. It's very useful to take care of light, fan loads and other applications during short cuts. Technology for this product came from a R&D institute from the government. Christo George is an Electronics and Communications Engineer. The knowledge gained from Christo George's education made him think about new opportunities and he saw the potential of digital technology for electricity supply. He saw potential in the market and wanted to introduce this new product. He told that his family and friends supported him. So, he had to succeed, and it was his dream to work as an independent entrepreneur. He wanted to live close to his family, and jobs are not easy to get in Kerala.
First range of product was the electronic inverter. A combination of different technologies made this product unique, but combining them was difficult and a reason to do a lot of trial and error. He studied on this topic by himself, and with his companions he pioneered the way of setting up a firm. He faced lots of difficulties to find funding and he describes the process of starting up as

[10] Inverters are a system which converts DC power (Battery) into AC (Mains) Inverters are mainly used to produce 230V AC from a Battery of 12/24Volts. Simple inverters find applications in automotives like bus, truck etc for running TV and other appliances. This type of inverters can be used to connect to a battery in a car to produce 230V when going for an outing. This type will not have a battery charger or automatic changeovers. The inverters with automatic changeovers and battery chargers are mainly used in houses to have a back up at the time of power cuts or during power failures.

being very difficult but adventurous. Finally, with funding of friends and family, he established the firm with just 5 employees.
After this, he was encouraged by the success of the first range of products. His firm was growing and new opportunities through new business contacts came. Newly hired employees were mainly high-educated (at least bachelor degree) and experienced people gave further inputs to new development and products. For example, Christo George told that he went to the house of the already retired R.V Achnuthan. Christo George knew Achnuthan had experience in the global field. Achnuthan worked as a salesman for Siemens and earned his degree in French. So, he begged him to join the firm and give Christo advice. Nowadays, Achnuthan is working three hours a day to give advices. He was the major force of setting up the R&D department and awareness of new technologies. Since eight years now, Research and Development is organized as a separate section. R&D section has five projects a year. Each project consists of developing a new product by including a new technology. These technologies aren't developed in Hykon itself, there are mainly based on existing knowledge and science. Feedback form customers, market research and the Internet, are the main idea generators for new products and processes. The process of studying, doing research, developing, drawing and finally building a prototype will not necessary end in a product that enters the market. On an average, only one complete new product will make its presence in the market field. The firm now has staff strength of 25 employees. The introduction of this new kind of inverters was very successful. Slowly, through market surveys, research, innovation and development, the product range has grown to over 30 products. Over the years, Hykon introduced several new products. The product range has grown to over 30 products, for example; UPS, Inverters, Servo Stabilizers, Solar water Heater and Solar inverters, Software development, Web designing, Medical and Business Transcription, Electronic choke, lighting fixtures

4.2. Technological Capabilities within Hykon India.

Hykon India shows that it masters several FTC. They have developed several new products and they have adapted technologies to the local needs. They used information from R&D from government institutions and they have successfully made use of this information for developing new products. For example, the development of their first product, the UPC, is mainly due the help and information and help of the governmental institution. It is remarkable that Hykon serve especially the internal Indian market, since especially export and competition of the world market is often reason to innovate.
The *investment capabilities* described by Lall are those skills which lead to the establishment of the enterprise rather than a narrow definition of access to financial resources. These require management skills (to carry out feasibility studies for example) as well as technological knowledge (prior knowledge on product and process) (Clancy, 2001) Researcher has seen evidence for several feasibility studies for several products. The R&D department has to produce five new products each year or develop product improvements. However, on average one on five reaches the market. Before Hykon is introducing a new product to the market, feasibility has taken place. By the employment of Achnuthan, who worked as a salesman for Siemens, the awareness of new technologies and business opportunities is large. With the technical training of George to convert the possibilities and implement techniques into new products, Achnuthan has visibility on the possibility with its commercial context of putting the product in the market.
Production capabilities range from basic skills such as quality control, operation, and maintenance, to more advanced ones such as adaptation, improvement or equipment "stretching,"

to the most demanding ones of research, design, and innovation. Three different categories are distinguished by Lall; process engineering, product engineering and industrial engineering (also see table 1 page 28) Process engineering within Hykon is especially present at the lowest level of complexity; "learning by doing". By the control on the shop floor the process is watched carefully. High-educated supervisors educate employees at daily basis and function at trouble-shooters. Process engineering at higher level of complexity (search-based) is at Hykon present as well. The research in the R&D department has been mainly aimed at improvement of products and not particularly on the process of production. Many products are now made by one employee on the whole, only testing the product happens in a separate step.
Product engineering capabilities are recognized as well. At several levels on different products, improvements are introduced. The researcher saw that ideas by employees about products improvements, for example improvements regarding the place of wire connections and the placement of intern components of the product, is passed on by supervisors to the R&D department. They showed how internet, customers and consumers are source for improvements and the development of new products. For example**,** an employee on the R&D department showed the researcher proudly an internet page with different high-tech products which are inspiring him. The introduction and development of solar-energy products was initiated by Hykons customers. Within the R&D department several projects are passed through each year. Within a period of 15 years, 30 new products have been developed and have been introduced on the market. However, there is little attention on workflow scheduling. Scheduling is only on products and sales on weekly basis. The inventory controls were managed on ad hoc basis: only in case raw materials were out of stock, new material is ordered, sometimes inferior material was used.
Linkage capabilities are the skills needed to transmit information, skills and technology to, and receive them from, component or raw material suppliers, subcontractors, consultants, service firms, and technology institutions. Hykon is well bedded in their local community; this is not surprising since Hykon is mainly financed by family. George has friends and family connections in Cochin and surrounding**,** which are important for his business. He knew several people at ISOD. Many high-trained young people, with minimum bachelor degree in engineering, are working at Hykon.

4.3. Concluding Analysis Hykon

Hykon is a case in which high grade technological products are produced within a domestic oriented SSI. Existing techniques are used in products for the local market.
In the description of this case, I will point out that on all three levels, capabilities on learning by doing level are present in particular. The structure of feasibility studies and the set up of a R&D department are important investment capabilities.
The production capabilities on learning by doing level are well developed due to an open attitude towards improvements. Products are continuously under further development by production staff and the R&D department. These capabilities particularly aim for the development of the products themselves, and not as much for the development of the production process. A lot of products lend themselves to be made in several steps; for example the housing, wiring, finishing and testing of the product. For Hykon however, this is not the case, even though this method seems more efficient for the production of various similar products.

The linkage capabilities are mainly combined in the person George. He has contact with clients and suppliers. The first product he started to produce together with others was produced with the help of governmental knowledge. The Technological Firm Capabilities of Hykon are highly developed for a domestic oriented SSI. All of these FTC have helped them to introduce and master new products. The connection between FTC and the development of Hykon is strong. The extant capabilities at the beginning of Hykon, anchored in the person George, have brought on a development in new products and growth of the SSI. Since the establishment of Hykon, there is presumed to be an interaction between FTC and the growth of Hykon. On the one hand, Hykon's growth in terms of products in production, the number of staff members and financial growth have resulted in more available FTC for Hykon. For example, employees bring in new information and knowledge, and with this knowledge, more could be organized and structured in the introduction of new products. On the other hand, the FTC brought on Hykon's growth. Examples in this case are hiring of new workers in order to produce more, investing in new products by feasibility studies and the continuous improving of products have resulted in a higher quality and a growing consuming market.
Hykon has a positive influence on the economy of Kerala. Hykon offers jobs for high-educated workers. There is not much work in Kerala for high-educated workers, so Hykon is a well know employer. The products that Hykon delivers are of great importance on the local market. Problems with power-cuts are prevented by converters.

4.4. The case of Pilots India

Second case is the case of Pilots India. Pilots India produces Food Processing and size Reduction Technology. Pilots India is situated in Kallettumkara Trichur (Kerala) and has introduced several new products in their firm. The case of Pilots India is included because of the recommendation by the SIDO. Pilots India was established in 1988. After Sheen Anthony had finished his engineering study his interest was to renovate all kinds of technical equipment. Together with his father he repaired all kinds of machinery for family and friends. His father motivated him to start a small firm to earn a living. In the beginning it was just for family and friends. He also tried to simplify the way of cooking for his mother by making equipment to help his mother with her cooking activities. In Kerala, cooking is done with ingredients that have not been processed before use. They are ingredients that come straight from the fields to the market. These are then prepared by the housewife. People also often go out to eat.

He didn't change the cooking process itself; he just developed equipment. This is to protect the taste and smell of the food. Since then, he developed more and more different equipment. Demand was rising without any organized marketing. Nowadays, Pilots India has variety of equipment. Examples of these products are the Pulveriser, fruit pulper, Rice Mill and Washing Machine. Surprisingly, Pilots India doesn't have organized and structural innovative activities. They introduce several new products a year, but all are developed by the working personnel and Sheen Anthony himself. Anthony is initiator of new products. "Trying to understand new techniques and to see what they are useful for, is what I like to do the most". Main innovative activities are done by the director himself. In contact with his customers and personnel**,** he tries to find out what kind of improvements and new products are needed. Most of the time, this demand for new products results in the incremental development of products. Together with the engineering staff**,** he discusses the possibilities of new techniques and improvement. This collaboration with his engineers is important. He tries to stimulate them to improve products and to think about new products. This is all done informally. There is no R&D budget and there is no

specially hired person to develop new products. The outcomes of the innovative activities are the introduction of new products and improved products. 40% of their products have changed over the last year, and every year 10% of their products are completely new. Two products are patented by the government of India. Main reason for innovative activities is market demand. There is constant change in Reason for innovation from customers, the entrepreneur himself, and new customer demand.

4.5. Technological Capabilities within Pilots India

Investment Capabilities in form of feasibility studies are not found in Pilots India. Products are developed on the basis of new questions and findings of the staff. Sale of the product to a customer is sufficient to develop a new product or a new application of a product. This is not directly profitable, taken into account that there are many products of which some are sold badly. In the interview, it also becomes clear that in the surroundings of Sheen Anthony, it is suggested to pay more attention to profitability instead of development of new products. Nevertheless, Pilots India has produced more than 50 different products in the 20 years that they exist.

Production Capabilities are located on especially the lowest level of complexity. The manner of innovating and developing products is not institutionalized, but a manner of daily work. The products which are developed are initiated by own ideas and initiatives of the shop floor employees. Attention is paid to what the customer wants and to what the shop floor comes forward with, to build the product more efficiently. This indicates both process engineering and product engineering. Work flow scheduling happens on a weekly basis. The nature of the products is that these are made on customer demand, not on stock, and that this is difficult to plan.

Linkages within economy are a strength for Pilots India. Contact with customers and suppliers in particular. The contact with the customer is the most important source of new ideas. Moreover, Pilots India takes care of a large part of implementation of the machines which they sell, by imparting technical knowledge training to the customers. Therefore, they ensure development or mastery of a new technology to their customers. This is an important service moreover, which is linked to the products, and produces important information for product improvement for Pilots India.

4.6. Concluding Analysis Pilots India

The Technological Capabilities of Pilots India are mainly on the level of ‘learning by doing’. The investment capabilities, production capabilities and connections within the economy to Pilots India, could be labeled as weak. These are weak because the qualities haven’t been institutionalized in twenty years, and they are still dependant on the owner.

The link between FTC and the development of Pilots India can particularly be seen in the development of new products. This has brought on a growth in terms of products in production and the number of employees.

5. Conclusions and Recommendations

In this chapter, I will discuss the conclusions made with reference to the two cases, and thus I will answer the main question. *What type of innovation processes in SSI exist in Kerala, and what is their contribution to economic development?* Furthermore, I will give the SSI organization SIDO pointers for further scientific research on innovation in SSI.

5.1 Conclusions

The following research question has been answered in this report.

What type of innovation processes in SSI exist in Kerala, and what is their contribution to economic development?

First of all I have defined SSI in the Indian context as an industrial undertaking in which the investment in fixed assets in plant and machinery whether held on ownership terms or lease or on hire purchase does not exceed Rs 10 million, equivalent 175 thousand euro (exchange rate April 2007).

5.1.1 SSI and Innovation in the Economy of Kerala

What is the political, economical, social and technological context of SSI in Kerala? Various positive factors in Kerala make the development of SSI and FTC within these SSI possible. There are enough highly-educated workers and government institutions have been set up to support SSI. Besides that, there is sufficient expendable income amongst the population to ensure a good consuming market. There are however also a number of important barriers for SSI in Kerala in order to come to the development of FTC. The wage levels are high and labour is very organised. It has become evident out of the two case studies that it is difficult to receive funding and suppord from the government. In conclusion, it is evident that there is potential for the development of FTC in Kerala. However, the government and the social situation provide hardly any stimulation towards development and innovation. For the two SSI in this research, the international trade doesn't either.

5.1.2 Innovation in SSI

In this research, what is meant by the term innovation? In the thesis it has become evident that several definitions can be distinguished for the word innovation. The case studies in both SSI oriented on the domestic market, support the idea that developing countries it should be taking into account that innovations are not easily shared amongst firms, and that an analysis needs to be made in the historical contact on which it occurred. In both cases, the products that are produced are strongly regionally determined: for Hykon, the converter is based particularly on the precarious supply of electricity, and for Pilots India, the products are linked to the traditional ways of food preparation in Kerala. What can also be seen in the two cases is that the developing products call for a very specific knowledge that is developed in the SSI themselves. Adapting to the wishes of the customers also happens in the SSI themselves. This also supports the adoption of new technologies, as it is a continuous process of absorbing or creating technical knowledge, determined partially by external inputs and partially by past accumulation of skills and knowledge. Looking at to the two cases, with the perspective of FTC, produces a clearer picture of how innovations arise and which strengths lay behind it. FTC's correspond to a wide range of

skills and knowledge, necessary to effectively render the effort of the firm towards technological mastery, adoption of the technology to new conditions and improvement in the technology (either slight or significant) (Lall 1992, James and Romijn 1997). We see a high degree of development in the FTC in some area's in the two cases studies. The two FTC's that are distinguished in these two SSI will be discussed in the next paragraph. The strength of FTC is that we pay more attention to the activities which take place. These find their embeddings in their context. This way, local history and history is taken in consideration. Thus, the term innovation gains form and becomes more understood within a country and within a culture. Innovation as a statically scientific functional term which presumes that introduction of new processes and products do no right to the daily reality. In daily reality, new processes and products have preceded a lot of small steps in a forward direction, along with a complete development and a lot of failed attempts. These difficulties of adoption and mastery of new technologies are relevant. Out of both cases it has also become evident that; the introduction of new products and techniques is a process. This process begins with an idea and follows a path through gaining information, trying out ideas, discovering possibilities, schooling people for production, etc. This process is relevant for SSI. The extent to which this process is mastered has turned out to be a factor of success in the introduction of new products.

5.1.3 Different kinds of technological Capabilities

Lall distinguishes the three different kinds of capabilities, investment capabilities, production capabilities and linkage capabilities. *"Investment capabilities* are the skills needed to identify, prepare, obtain technology for, design, construct, equip, staff, and commission a new facility (or expansion)." (Lall, 1992, page 168)"

In both of the two cases, it can be stated that the investment capabilities have been developed, however, they are not equally strong on each level and generally they are not very organized and structured. Hykon and Pilots India are both capable of assessing whether a new product is remunerative. This capability can be seen in the new development of products and the conscious choosing processes that are used. The development of new products is based upon either wishes of the client (Pilots India), or based upon new found chances. The investment capabilities for Hykon are anchored in the way of organizing, more so than for Pilots India. The development of new products is visibly present, in a separate room, and is done by a set group op people.

In both cases, we don't see it in the development of new production processes. The in-house processes are relatively labour intensive. In both cases, they work with basic tools. (of which a welder can be considered the most advanced tool). These findings correspond with the findings of Romijn (Romijn, 1997). Improvements should be made on the products themselves. There is not much interest for the development of better internal processes and skills for production. *"Production capabilities* range from basic skills such as quality control, operation, and maintenance, to more advanced ones such as adaptation, improvement or equipment "stretching," to the most demanding ones of research, design, and innovation." (Lall, 1992, page 168) The two cases differ from each other when it comes to presence of production capabilities. For Pilots India, production capabilities are practically absent. Quality control is done based upon daily problem solving; products are simply tested just before delivering them. Hykon has much developed these capabilities much farther, and has also institutionalized them. Products are checked in a special manner and the daily direction gives on the job training and supervises the working method.

"*Linkage capabilities* are the skills needed to transmit information, skills and technology, and to receive them from component or raw material suppliers, subcontractors, consultants, service firms, and technology institutions." (Lall, 1992, page 168) In both cases, family and friends are considered an important source of information. The two cases have been perfectly imbedded in the local area. The attitude towards this local area is serviceable and open. Wishes and tips from clients are realized in the products. Here too, it is evident that this concerns the actual products more than it concerns processes.
In the Hykon case, the information for the converter comes from the government institution. Out of this information, it becomes evident that in the Keralan economy and within Hykon's capabilities, there are possibilities for innovation. This does however seem to be an acceptation to the rule, as information turns out to be very difficult to get your hands on, and there is no commercial perspective from government institutions. In conclusion; with the capabilities that have been made visible, it can be presumed within reason that the SSI in Kerala have sufficient capabilities to innovate, although these capabilities are on learning by doing level.

5.1.4 Innovation and the Economy of Kerala

Both cases have shown that they possess various capabilities to make relatively advanced products and take new products into production. How does this influence the firms and the economy of Kerala? From the two case studies, within reason the careful conclusion can be made that there are SSI in Kerala with sufficient capabilities to innovate. These capabilities may be on learning by doing level in particular, but in daily reality this often turns out to be sufficient to make adoption of new products and techniques possible. Within reason, it may also be concluded that there is a link between the presence of FTC and various economic factors. There is a positive connection between innovation that takes place on learning by doing level within the two SSI and the;

- Growth and success of the SSI
- The introduction of new products
- The creating of jobs for the highly-educated.

In the next paragraph, it is discussed where we *can* find important stimulation for the development of FTC.

5.1.5 Role of the manager

What stimulates domestic oriented SSI to innovate? From the case studies, it turns out that the manager and the owner of the SSI are an important stimulating factor. The entrepreneur George plays an important role in guaranteeing and stimulating FTC in Hykon. George has integrated many of these capacities. He has technical knowledge thanks to his education, and he knows how to translate them into end-products. He saw the business and commercial possibilities of the converter, which is an example of his business capabilities. Much of the same could be said about the role of the entrepreneur Sheen Anthony. He himself is the founder of the organization and he considers it as a continuation of his hobby. This drive to develop new products lays in the culture of Pilots India. However, Anthony's commercial thinking is less developed, which can be seen in the fact that he gives little value to keeping track of data of several products and periods. Anthony's skill en hobby mainly aims for the technique of the new products and not so much for the affectivity of the organization. FTC in small firms differs from FTC in large firms**,** in the

sense that they are much more centered around the individual entrepreneur or manager. Innovations are often initiatives of entrepreneurs and scientific researchers. (Hyvarinen, 1991) The manager is seen more as a boss by his few workers because communication is direct and the organization structure is more flat in SSI. Managers in SSI are more important than in large firms**,** or even the only investors in the firm, which explains their strong influence. (Hyvarinen, 1991) The influence of management attitude on the technological capabilities has been discussed in earlier research on SSI in India. (Clancy, 2002) Clancy stated that learning by doing could be difficult if the people who are learning and doing are not in the position to influence the innovation process. The fact that in this culture, one doesn't just contribute ideas and suggestions to the manager could be of bad influence on the development of FTC.
In the two cases, it is clear that in Kerala, managers and owners can be of positive influence. A manager with an open and positive attitude in the innovation process has great influence on the time and the quality in which this process is solemnized.

5.2. Recommendations for SIDO

SIDO is a government institution that aims to help along the development of SSI. The two case studies and the literature shine light on barriers that make development on the FTC front difficult. Recommendations are made for this. The SIDO receives advice on the best ways at current to help the SSI in their development.
Kerala is a special situation. The wage levels are high in comparison to other states. This is due to the high level of education amongst the people and the strongly organized labour. Thus it is very important for SIDO to determine their course of action while taking this situation into consideration. In order to create jobs that suit the education level, production levels in the SSI need to be raised; higher production levels require more skilled labour. Because of this, it is necessary to make good use of the people's capabilities.
Up until now, SIDO has mainly focused on creating new jobs by establishing new SSI, and protecting existing SSI. This way, new jobs may be created, but these jobs aren't necessarily appealing to the unemployed who are often highly-educated. Jobs that newly established SSI's have to offer, often don't meet the aspirations and possibilities of highly-educated workers.
Hykon and Pilots India show that by production of advanced products, highly-educated workers are also hired. These SSI are established and managed by ambitious engineers. Particularly this potential group of highly-educated workers should receive all possible support and means for the establishment of an SSI. Helping the lower-educated by providing them with courses and hereby bringing new SSI to life, leads to many weak SSI. Particularly the highly-educated potential managers with capacity can provide Kerala with employment and bring on growth in the industrial sector.
This way, SIDO should go from supply-oriented to demand-oriented service. At this point, there is a lot of knowledge about products and techniques. This knowledge in particular is present under beginning entrepreneurs. In the two cases, it has become evident that there is a need for financial support and help with the financial household. For both cases, business education is more important than technological education. My advice to SIDO is to aim for the manager potential and offer supporting question-oriented business courses.

6. Reflection on Doing Research on SSI and FTC

In this final section**,** the focus is on how innovation in SSI in India should be studied and measured. Since the late 1970s literature on technology, development and innovation has emphasized the acquisition of technological capability in developing countries as a crucial determinant of successful industrialization. (Romijn, 1997) Many of these researches are directed at the level of a country, so far there has been little research done on firm basis. However, also a number of detailed firm-level case studies have been done in several African and Latin-American countries. (for example: see Katz, 1987; Lall, 1987) These studies have showed that the development of local skills and knowledge is necessary to effectively assimilate technology, adapt it to local conditions, and to create new technology locally. Still, the neoclassical way of understanding innovation is very popular and is still the basis for policy making. Romijn (1997) argues that an important reason for this has to do with the fact that its findings are still almost exclusively based on qualitative evidence. "This lack of rigor leaves it open to criticisms of subjectivity and the risk of inappropriate generalizations across different firms, industries, countries and historical periods. It also does not provide a sound enough basis for the design of appropriate policies aimed at stimulating technological learning in firms. There is still no suitable set of indicators by which capability at the firm level can be measured more or less objectively, and which could serve as a basis for a systematic assessment of the alleged contribution of this variable to productivity increase and growth. The concept of technological effort is quite vague and unclear and there are no acceptable measures for it. " (Romijn, 1997, page. 360) However, the lack of quantitative measurement and testing does not undermine the validity of the results achieved by the studies so far, but it certainly reduces their usefulness.

In this last section I argue for a quantitative way of measuring FTC in SSI. Qualitative measuring has proof that FTC is a very suitable concept to understand innovation and economic growth in developing countries. These qualitative methods to study FTC are useful when to understand the cultural (or sub cultural) context in which innovation occurs, how activities and capabilities relate to these FTC, and how these activities and capabilities result and relate to firms characteristics and results. However, there is still a lack of quantitative research on FTC in developing countries and in SSI in particular. Romijn (1997) states that there is still no suitable set of indicators by which capability at the firm level can be measured more or less objectively, and which could serve as a basis for a systematic assessment of the alleged contribution of this variable to productivity increase and growth. The same situation obtains with respect to the technological activities that are believed to play such an important part in its emergence. In Appendix 3 a quantitative way of measuring FTC based on the matrix of technological capabilities by Lall is developed.

In appendix 4 the quantitative way of measuring FTC is tested on the case of Hykon. The method of research produces a better and well-organized insight of the case of Hykon. The way the results of the research have been presented seem better compared with other cases. A vaster definition of FTC seems necessary to make the quantification more easily and more unambiguous. The exploratory variables are quantifiable and seem clearly of influence on the FTC. The quantifiability of it is sometimes disputable. However, the given exploratory variables seem a first good starting point to make FTC in SSI quantifiable. What now still rests to stipulate the impact and success of this method is a large-scale research. In what by means of the outcomes, regression analysis should be done as well.

7. References

- Acs, Zoltan. J; and Audretsch David, B; 1991. *R&D, Firm Size, and Innovative Activity* in Zoltan J. Acs and David B. Audretsch, eds., *Innovation and Technological Change: An International Comparison*, New York, NY: Harvester Wheatsheaf.
- Amara, N., Landry, R., Becheikh, N., Ouimet, M., (2004). "*What Factors Drive Radical Innovations in Traditional Manufacturing Industries?*" DRUID Summer Conference, 14–16 June, Copenhagen, Denmark 2004.
- Asian Development Bank, (2007) "*Country Strategy and Program Update (2007–2009) India"* www.adb.com.
- Archibugi D and Pianta M. (1996) "*Innovation surveys and patents as technology indicators: the State of the Art*" in Innovation, Patents and Technological Strategies, OECD.
- Archibugi, D., Sirilli, G., (2001). *"The direct measurement of technological innovation in business."* In: European Commission (Eurostat) (Ed.), Innovation and Enterprise Creation: Statistics and Indicators. European Commission.
- Bayineni, S., (2004) *"The Role and Performance of Small-scale Industries in Indian Economy"* The ICFAI Journal of Managerial Economics. August 2004, pages 66-72
- Berry Sara S. (1974) "*The Concept of Innovation and the History of Cocoa Farming in Western Nigeria"* Journal of African history, Volume: 15 Issue: 1 (1974), pp: 83-95
- Bowonder, B. and Miyake, T. (1988). *"Measuring Innovation of an Industry: An Analysis of the Electronics Industry in India, Japan and Korea*" Science and Public Policy. 15. 279–303.
- Clancy, J. S. (2001) *"Barriers to innovation in the briquetting industry in India."* Journal of Science, Technology and Society, 6(2), 329-357.
- Cohen, Wesley, M. & Levinthal, Daniel A. (1990) "*Absorptive Capacity: A New Perspective on Learning and Innovation"*, ASQ, 35, 128-152.
- Cunningham, J. Barton, (2004), *"Case study principles for different types of cases"*, Quality and Quantity, Springer Netherlands, Volume 31, Number 4/ November, 1997
- Department of telecommunication Economic research Unit (2002), *"Indian telecommunication Statistics 2007"* New Delhi: Department of telecommunicatiosn, Government of India
- Economy Watch, (2005) "*Indian Economy Overview, The Three Sectors of Indian Economy"* Compare Infobase Private Limited, New Delhi, India, www.economywatch.com, accessed 25 April 2005
- Edelstein, J, (2000) *"Social Democracy Versus Revolutionary Democratic Socialism"* The Alternative Orange. September 13, revision 2, Vol. 2 No. 3 Syracuse University.
- Flor, M.L., Oltra, M.J., (2004). "*Identification of innovating firms through technological innovation indicators: an application to the Spanish ceramic tile industry*". Research Policy 33, 323–336.
- Foss, N. (1997) "*The Classical Theory of Production and the Capabilities View of the Firm*" Journal of Economic Studies, 24 (4-5).

- Freeman, C; and Soete, L; (1999). *The economics of Industrial Innovation.* Third Edition, Pinters, London.
- Geertz, Clifford. (1973) *"Thick Description: Toward an Interpretive Theory of Culture"*. In The Interpretation of Cultures: Selected Essays. New York: Basic Books.
- Global Spec. Website URL http://electronic-components.globalspec.com/ accesed on 12-1-2006
- Government of India, (2005) "*Economic Survey 2004-2005"* New Delhi: GOI Press.
- Government of India, (2005) "*Economic Survey 2004-2005"* Ministry of Finance and Company Affairs, Economic Division, New Delhi.
- Government of Kerala, (2005), "*Human Development Report Kerala 2005"* Prepared by the Centre for Development Studies, Published by State Planning Board
- Hyvarinen, L. (1991). "Innovativeness and its indicators in Small and Medium Sized Industrial Enterprises"' International Small business Journal, vol 9 No 1. pp 6-79
- James J. and Romijn H. (1997) "*The Determinants of Technological Capability: A cross-country Analysis"*. Oxford Development Studies, Vol 25, No.1, pp 189-205
- Kacker, S, (2005) "*Overcoming Barriers to Innovation for Indian SMEs"* Joint Secretary, Government of India, Ministry Small Scale Industries, New Delhi
- Kamien, M.I. and Schwarz, N.L. (1982) "*Market Structure and Innovation"*, Cambridge: Cambridge University Press.
- Kawadia, G, (2005) *Growth Trends and Performance of Small Scale Industries in India,* The ICFAI University Press
- Katz, J., (1987) "*Technology Generation in Latin American Manufacturing Industries"* Houndmills: Macmillan.
- Kirit Parikh, S, and Radhakrishna, R; (2005) "*Indian Development Report 2005"* New Delhi, Oxford University Press.
- Kline, S.J. and Rosenberg, N; (1986) *"An Overview of Innovation"*, in Landau, R. and N. Rosenberg (eds.), The Positive Sum Strategy. Harnessing Technology for Economic Growth, National Academy Press, Washington, DC
- Kleinknecht, A.H. and J.O.N. Reijnen (1991) "*More Evidence on the Undercounting of Small Firm R&D*", Research Policy, Vol. 20, pp579-587.
- Kleinknecht, A., Van Montfort, K., Brouwer, E., (2002). "*The non-trivial choice between innovation indicators.*" Economics of Innovation and New Technology 11 (2), 109–121.
- Kumar, V, Kumar U, and A. Persaud (1999) *"Building technological capability through importing technology: the case of Indonesian manufacturing industry"* Journal of Technology Transfer 24, pp. 81–96

- Lall, S., (1987) "*Learning to Industrialize. The Acquisition of Technological Capability by India"* Houndmills: Macmillan.
- Lall, S., (1992), *"Technological Capabilities and Industrialization"*. World Development, Vol 20. pp 165- 186
- Lall S (1993), *"Understanding Technology Development"* Development and Change, Vol 24, pp 719-753
- Lall. S., (2000), '*The Technological Structure and Performance of Developing Country Manufactured Exports, 1985-1998*', Queen Elizabeth House Working Paper Series, No. 44, University of Oxford.
- Lucas, R. E., (1988), *"On the mechanics of economic development.*" Journal of Monetary Economics 22: 3 - 42.
- Mathew, P.M. (2004), *"Business Development Services for Small Enterprises: A Regional Study"* SIDO
- Michie, J., (1998). *"Introduction. The Internationalization of the innovation process"*. International Journal of the Economics of Business 5 (3), 261–277.
- Ministry of Small Scale Industries, (2002) "*Final Results- Third All India Census of Small Scale Industries 2001-2002"* Government of India.
- Morris, S. e.o, (2001). "*The Growth and Transformation of Small Firms in India"* Oxford University, Oxford University Press, New Delhi.
- NSSO, National Sample Survey Organization, (2000) "*Employment and unemployment situation among social groups in India 1999-2000*", Round 550th, India, National Sample Survey.
- Nelson, R. (1998) *"The Agenda for Growth Theory: A Different Point of View"*, Cambridge Journal of Economics, 22.
- Nooteboom, B. (1994) "*Innovation and diffusion in Small firms; Theory and evidence*" Small Business Economics 6, pp327-347
- OECD (1996) *"Oslo Manual, The Measurement of Scientific and technological Activities*", European Commission Eurostat
- Panagariya, Arvind, (2002) **"**India's Economic Reforms. What Has Been Accomplished? What Remains to Be Done?" Asian Development Bank.
- Ramasastry, A.S and Krishnaswamy, K.N. (1979) *Transfer, Innovationand development of Technology.* Department of Industrial Management, Indian Instirtue of Science, Bangalore.
- Rebelo, S., (1991) "*Long-Run Policy Analysis and Long-Run Growth*". Journal of Political Economy 99: 500 - 521.
- Rizzoni, A. (1991) *"Technological Innovation andSmall Firms; A Taxanomy"* International Small Business Journal.
- Rogers, E. M., (1983) *"The Diffusion of innovations*" Third Edition, New York: Macmillan, The Free Press.

- Romijn, H; (1997) *"Acquisition of Technological Capability in Development: A Quantitative Case Study of Pakistan's Capital Goods*", Sector World Development, Vol. 25, No. 3, 359-311
- Romer, P. M., (1986) "*Increasing returns and long-run growth*". Journal of Political Economy 94: 1002 - 1037.
- Rothwell, R. and Dodgson, M. (1994) "*Innovation and Size of Firm"*, in The Handbook of Industrial Innovation, Editors M. Dodgson and R. Rothwell, Aldershot Hants: Edward Elgar, pp310-324.
- R.U.P.E., Research Unit for Political Economy, (2005) "*Global Power, Client State, India's Place in the US Strategic Order"* Aspects of India's Economy, No. 41
- Schumpeter, Joseph A. (1934) "*The Theory of Economic Development"*. Cambridge: Harvard University Press. New York: Oxford University Press, 1961.
- SIDO (1999) "*Annual Report 1998-1999"* Ministry of Small Scale Industries, Government of India, New Delhi
- SIDO (2002) "*Annual Report 2001-2002"* Ministry of Small Scale Industries, Government of India, New Delhi
- SIDO (2007) "*http://www.smallindustryindia.com/"* accessed on 25 April 2007. Ministry of Small Scale Industries, Government of India, New Delhi
- Srinivasan, T. N. (2003) ***"****Indian Economic Reforms: A Stocktaking"* as SCID Working Paper No. 190.
- Stewart, F., S. Lall and S. Wangwe, (1992) "***Alternative Development Strategies in Sub-Saharan Africa"*** Houndmills: Macmillan.
- United Nations Statistics Division (1993) "*System of National Accounts"*. Series F, No. 2, Rev. 4, United Nations publication Sales.
- Yin Robert K. (2003) *"Case Study Research"*, SAGE publications, Thousand Oaks, London, New Delhi.
- Zachariah, K C, B A Prakash and S Irudaya Rajan. 2004. 'Indian Workers in UAE: Employment, Wages and Working Conditions', Economic and Political Weekly, No. 22, May 29 2004, Pp.2227-2234.
- Zhachariah, K. C. and Rajan, S. I. (2004) Gulf Revisited: Economic Consequences of Emigration from Kerala, Working Paper No. 363, Centre for Development Studies, Thiruvananthapuram.

Appendix 1 Innovation in economic growth theories

The growth of an economy as a whole is one of the fundamental questions of economics. Robert Solow developed in the 1950s the neo-classical growth model. He made the assumption that countries use their resources efficiently and that the return on capital investments are diminishing. Increasing capital relative to labour creates economic growth, since people can be more productive if they are given more capital. One of the predictions he made was, that because of diminishing returns of capital, economies will reach a point where increase in capital will not create economic growth anymore. The model also notes that an economy can overcome this point and continue growing by inventing new technology that allows production with fewer resources. The model assumes technological progress and innovations. This technological progress is not included in this model. This excluding of technological progress is called "exogenizing" technology from the model. Innovations don't have a central place in Solow's growth model. And, as a result of assuming technological progress, neo-classical models cut back on government intervention in industry. A drawback of Solow's model, is the assumptions that the rate of technical change is the same across nations; measurement has shown Solow's assumption to be incorrect. (Romer, 1986)

A group of models that emerged in the 1980s explain long-term economic growth endogenously. Influential endogenous growth models are that of Romer (1986), Lucas (1988), and Rebelo (1991). In an economic model, an endogenous change comes from inside the model and is explained by the model itself. These models include technological progress. Since the 80s models emerge where the technological progress is endogenous to the model. Output and productivity growth do not rely on exogenous technical progress. In these models, it is assumed that new products or new processes are generated by investment in R&D and human capital. Thus, these models treat R&D as an entrepreneurial activity. New processes and products are used as inputs in the production of final goods. Firms and individuals have an incentive to invent in order to exploit an advantage over their competitors. So, they create an advantage by improving their own productivity. In contrast to the older neoclassical growth theory, endogenous growth theory argues that policy measures regarding research and development, can have an impact on the long-run growth rate of an economy. This theory is attentive to policy measures that can influence the innovativeness of a nation. (Romer, 1986)

Nelson argues (1998) that the basic assumptions of neoclassical growth theory inherently limit the ability of models within that theory to cast light on economic growth as it has been experienced. This holds for 'the new' endogenous-growth theory as well as the older neo-classical growth theory. Nelson proposes that for understanding economic growth, a growth theory needs the following elements:

1) the possibility that technological development could be analyzed as an essentially difficult process; with much uncertainty and which is context and path-independent

(2) incorporation of a firm-level theory in which firm capabilities and differences across firms are central elements; and

(3) inclusion of a framework of institutions that contributes to an explanation of cross–country differences in economic growth.

The evolution theory offers a grip on how to study and describe innovation at firm level. The proportion between the concept of innovation and the evolutionary theory is discussed in paragraph 2.3.2

Appendix 2 Innovation Measurement

This Appendix is describing a review of empirical articles and research on innovation in the SSI sector in India. The examination of the articles included in our review showed that innovation was measured in various ways. As we will see, they are not based on the concept of FTC. This paragraph describes the problems with other measures than with the concept of FTC. In the next chapter a way is explored in which the concept of FTC could be used in research in qualitative and quantitative ways. In all kind of research, innovation is understood as a complex, diversified activity with many interacting components, and sources of data need to reflect this (OECD, 1997).

2.1 Indirect indicators of innovation: R&D and Patents

Traditionally, innovation has often been measured by using two *indirect indicators*: research and development (R&D) and patent data. However, R&D and patent data have been shown to have many shortcomings; R&D represents an input to the innovation process which does not necessarily lead to technologically new or improved products and/or processes (Flor and Oltra, 2004; Kleinknecht et al., 2002). Thus, R&D data would seem to be an over-estimated measure of innovation since it includes aborted R&D efforts. Moreover, all innovations are not necessarily 'simmered' in R&D laboratories (Michie, 1998). Innovations can emerge in response to a specific problem or quite simply following a clever idea that the innovator suddenly had. In this case, measuring innovation by using R&D data will underestimate the phenomenon. Moreover, it is noteworthy that R&D data used as an innovation indicator tends to favour large firms compared to SSI**,** due to the fact that SSI R&D efforts are often informal (Acs and Audretsch, 1991; Kleinknecht et al., 2002)

As for patent data, it measures inventions rather than innovation (Flor and Oltra, 2004; OECD, 1997). Measuring the new introduced products or products by using patents as indicator**,** one other problem occur. The high cost of meeting complex regulations and the lack of knowledge about patent procedures are major barriers. Large firms are able to spread their costs, defend patents and hire specialist. It is not plausible that innovative behaviour of SSI is measurable by patents. Given that all innovations are not necessarily patented, patent data is thus a distorted measurement of innovation.

These limitations have not however prevented R&D and patent data from being used in various studies; examples of these kinds of research and data in the field of SSI are from the government Department of Science and Technology. They provide data on India on R&D expenditure and patents of the Indian economy. The government department is single provider of periodical data on R&D and patent of SSI. The National Council of Applied Economic Research has done once only an extensive study in this area. It gives an estimation of the total R&D expenditure and number of patents in the SSI sector in the period from 1999 till 2001.

2.2 Direct indicators of Innovation

So**,** as to deal with the shortcomings of measuring innovation indirectly, more direct indicators are used to measure innovation. The main indicators are: (1) innovation count, and (2) firm-based surveys. Innovation count consists in collecting information on innovations from various sources such as new product/process announcements, specialized journals, databases, etc. The second measurement consists of surveys carried out with companies.

The firm-based survey approach is becoming the standard method of collecting direct information on innovation because of in particular to endeavours by the OECD to standardize the methods used and the information collected in such surveys (Archibugi and Sirilli, 2001). Direct measures of innovation also have some disadvantages. Innovation count tends, in practice, to favour radical innovations over incremental ones (OECD, 1997) and product over process innovations (Kleinknecht et al., 2002). This approach excludes unsuccessful innovations, thereby preventing any comparative analysis of success and failure. Researchers have to be experts on their field of study to judge what should be understand as an innovation in a special industry. This needs much expertise and makes studies difficult to compare and distribute to other industries and research areas.

For firm-based surveys**,** a major disadvantage is that the significance and the representativeness of the results depend widely on the answer rates (Archibugi and Sirilli, 2001). These surveys are based on the methodological guidelines of the Oslo Manual**,** which measures newness by asking questions. (for example: 'During the last three years, did your business unit introduce any new or significantly improved products onto the market?') Such empirical results are less and less effective because they suggest that all innovations are the same and that most firms innovate, thus providing limited pertinent knowledge for decision-making. It is therefore important to upgrade this approach by introducing indicators assessing the degree of newness or innovativeness rather than measuring whether firms have innovated or not. (Amara et al., 2004)

2.3 Explanatory variables of innovation.

Explanatory variables of the innovative behaviour of firms have been considered by different researchers. These are subdivided in two kinds of variables: (1) results concerning the internal determinants of innovation, and (2) those specific to the contextual determinants.

Identifying the distinguishing characteristics of highly innovative companies at the micro/firm-level has been the aim of organizational theorists. The contingency theory states that an organization is above all an adaptive system which evolves by reacting to its environment. Environment has a determining impact on firms' strategies, structuring and behaviour. Details about which variables are used in all kinds of research are tabled in table 3.

Good example of the use of internal and external variables by studying innovation is study of the National Council of Applied Economic Research; internal variables (nature of the product, size of the firm, age of the firm, composition of work force) as well as external factors (competition, infrastructural environment) are analysed as factors influencing innovation in small firms.

Table 3 Main disadvantages of innovation indicators

Indicators		**Disadvantages**
Indirect measures	R&D	R&D activities are an input to the innovation process
		All innovations do not necessarily stem from R&D
		There is a tendency to favour large companies over SSI
	Patents	Patents measure invention rather than innovation
		Propensity to patent differs across sectors
		Not all innovations are patented

Direct measures	Innovation count (object approach)	There is a tendency to privilege major (product) innovations as opposed to minor (process) ones
		Excludes unsuccessful innovations
		Must appeal to a panel of experts to evaluate the innovations (practical difficulty/subjectivity)
	Firm-based surveys (subject approach)	The significance and representativeness of the results depend on the response rate
		Is an unqualified dichotomous measure of innovation
Source; Amara et al. 2004		

Appendix 3 Measuring FTC in a quantitative way.

For setting up a measuring instrument of FTC in a quantitative manner, I make use of the matrix of technological capabilities of Lall. This matrix and the study of Romijn (1997) have been the basis for this paragraph.

The central aim of this methodological instrument is to explain the differences in capabilitie levels observed is a sample of SSI in a certain area through variations in a set or explanatory variables that are expected to be potentially important mechanisims in learning and innovation. Furthermore, this methodological tool can provide insight in how several capabilities relate to each other by regression analyses. The capabilties and the different components are reflected in the following tables.

Investment Capabilities
- Pre-investment *Table 4a*
- Project Execution *Table 4b*

Production Capabilities
- Process Engineering *Table 5a*
- Product Engineering *Table 5b*
- Industrial Engineering *Table 5c*

Linkage Capabilities
- Linkage Within economy *Table 6*

The exploratory variables are described after the tables with in it the capabilities and are based on earlier studies and the two case studies.

Table 4A Classification System Investment Capabilities; Pre-investment				
	Capability	**Definition**	**Scales**	**Grading**
Learning-by-doing, Simple:	Pre-feasibility and feasibility studies	A detailed investigation and analysis of factors influencing the project to determine if the project is viable, such as type of structure, the sources and availability of funding, and availability of utilities are examined and weighed against the financial return expected.	0-3	0; no feasibility studies. 1: poor feasibility studies 2: Qualitative: formal, detailed and structured feasibilities studies. 3: more than five qualitative feasibilities studies a year.
	Site Selection	Site selection is the process by which a SSI analyzes the merits of prospective locations in which the firm potentially intends to locate.	0-2	0: no conscious site selection process at the start of the SSI 1: conscious site selection process at the start of the SSI with relative simple and basic selection criteria. 2: formal, detailed, and conscious site selection process at the start of the SSI with relative extensive selection criteria.
	Scheduling of investment	Scheduling involves taking decisions regarding the allocation of available financial resources to jobs, activities, tasks or customers over time. Thus, investment scheduling results in a schedule of what is to be done, when, by whom and with what equipment based on financial recourses.	0-3	0: No scheduling of investment 1: Scheduling only on ad hoc basis or poor quality. 2: Scheduling on project basis with different time periods. 3: Monthly detailed and high quality investment scheduling
Import of technology Search Based	Search for technology Source	An investigation of different suppliers of technologies and Negotiation of Contracts	0-2	0: Only investigation on suppliers within ones own acquaintances. 1: Investigation of suppliers through easy available information sources without targeted investigation and negotiation. 2: Investigation of suppliers through available information sources with detailed and targeted investigation and negotiation.

Table 4B Classification System Investment Capabilities; Project execution				
	Capability	**Definition**	**Scales**	**Grading**
Learning-by-doing, Simple:	Commissioning	The procedure by which a completed building or manufacturing/industrial process is tested to be in operable condition (the condition is rendered by the plan and design function).	0-3	0: No testing procedure 1: Testing on the job 2: Planned testing procedure. 3: Detailed and planned testing procedure with certifying procedure.
Import of technology Search Based:	Equipment Procurement	Procurement of equipment (simple machines) which typically provides a mechanical advantage in accomplishing a physical task.	0-2	0: Procurement only on bases of problem solving 1: Procurement of equipment on active basis. 2: Frequent search and procurement of equipment
	Training and recruitment of skilled personnel	Planned activities leading to skilled behaviour of personnel and planned recruitment of skilled new personnel	0-2	0: No training 1: Planned recruitment of skilled new personnel or planned training activities 2: both planned skilled recruitment and planned training activities
Formal R&D Research-Based	Basic process design	Involves specifying all practices needed, flowcharting, rationalisation and error prevention	0-4	0: No basic process design +1 specifying all practices needed, +1 flowcharting, +1 rationalisation +1and error prevention
	Equipment design and supply	Designing and building new equipment based on the requirements of a new developed process or product	0-2	0: no design of new equipment 1: design of new equipment 2: design and building of new equipment

Table 5A Classification System Production Capabilities; Process Engineering				
	Capability	**Definition**	**Scales**	**Grading**
Learning-by-doing, Simple:	Debugging and balancing	The act of attempting to determine the cause of the symptoms of malfunctions detected by testing	0-2	0: only problem solving 1: active debugging procedures 2: debugging and balancing procedures
	Process Quality Control	A standard against which process conditions can be compared on quality	0-2	0: No organized quality control 1: Quality control on ad hoc basis 2: Quality control on regular basis
Import of technology Search Based:	Process Adaptation and cost saving	Any change in the structure or function of process to reproduce more effectively	0-2	0: No cost saving or process adaptation 1: Poor understanding of process adaptation and cost savings 2: Organized process adaptation and cost savings
	Licensing new technology	Business arrangement with a firm with proprietary rights over certain technology in return for specified royalties or other payment.	0-2	0: No licensing 1: Licensing of one process 2: Licensing of more than one process
Formal R&D Research-Based	In-house process innovation	Process innovations developed within a firm Itself (innovation is understood a the development of a new process)	0-2	0: No process innovations 1: Unstructured innovation activities 2: Structural innovation activities in house
	Basic Research	Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying phenomena and observable facts, without any particular application or use in view.	0-1	0: No basic research on processes 1: Basic research on processes

Table 5B Classification System Production Capabilities; Product Engineering				
	Capability	**Definition**	**Scales**	**Grading**
Learning-by-doing, Simple:	Assimilation of product design	Process whereby new ideas and experiences are fitted into previously existing product designs	0-2	0: standard product design with no changes over the last two years 1: Product design which changes by implementation of new ideas of employees 2: Structured design assimilation
	Minor adaptation to market needs	Any change in the structure or function of process that that is initiated by market needs	0-2	0: standard product design with no changes over the last two years 1: Product design which changes based on market needs 2: Structured design assimilation
Import of technology Search Based:	Product Quality Improvement	Measures undertaken in order to increase quality of products with the purpose of achieving additional benefits for the customer and the organisation	0-2	0: No organized quality control 1: Quality control on ad hoc basis 2: Quality control on regular basis
	Licensing and assimilating new imported product technology	Business arrangement in which the manufacturer grants permission of a product to manufacture that product (or make use of that proprietary material) in return for specified royalties or other payment.	0-2	0: No licensing 1: Licensing of one product 2: Licensing of more than one product
Formal R&D Research-Based	In-house product innovation	Product innovations developed within a firm Itself (innovation is understood as the development of a new product for the firm)	0-2	0: No product innovations 1: Unstructured innovation activities 2: Structural innovation activities in house
	Basic Research	Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying phenomena and observable facts, without any particular application or use in view.	0-1	0: No basic research on processes 1: Basic research on processes

Table 5C Classification System Production Capabilities; Industrial Engineering				
	Capability	**Definition**	**Scales**	**Grading**
Learning-by-doing, Simple:	Work flow scheduling	The process of inventorying, analyzing, and developing a records retention and disposition schedule which contains series descriptions, retention a graphic representation of the flow of work in a process and its related sub processes; including specific activities, information dependencies, and the sequence of decisions and activities	0-4	0: now workflow activities +1: Workflow of the work in process +1: workflow of the work in progress and sub processes. +1:Including specific activities, information dependencies, +1 the sequence of decisions and activities
	Time Motion Studies	A time and motion study would be used to reduce the number of motions in performing a task in order to increase productivity.	0-1	0: No motion studies 1: Motion studies
	Inventory Control	Supervision of the supply and storage and accessibility of items in order to insure an adequate supply without excessive oversupply	0-2	0: no inventory control +1 supply and storage control of raw material +1 supply and storage control of end products.
Import of technology Search Based:	Monitoring productivity	Regular and systematic collection and analysis of information to measure productivity	0-2	0: No monitoring productivity 1: Regular collection of information to measure production 2: regular and systematic analysis of information about productivity

Table 6 Classification System Linkage Capabilities; Linkage within the economy				
	Capability	**Definition**	**Scales**	**Grading**
Learning-by-doing, Simple:	Local Procurement of goods and services	This covers all activities that involve buying, contracting, purchasing, sourcing or tendering within local environment	0-2	0: Procurement of goods and services with only one suppliers within a radius of 10 km 1: Procurement of goods and services with 2 till 5 suppliers within a radius of 10 km 2: Procurement of goods and services with more than 5 suppliers within a radius of 10 km
	Information exchange with Suppliers	Hand over and receive information about processes and products with suppliers and customers another	0-2	0: No information exchange 1: Information exchange on unstructured basis 2: Information exchange on structured basis
Import of technology Search Based:	Coordinated design	Inclined to work together with another or others for a product or system design that can be plugged in, turned on, and operated with little or no additional configuring due cooperation with each other.	0-2	0: No coordinated design 1: Coordinated design once 2: Coordinated design in more than single case
Formal R&D Research-Based	Cooperative R&D	Research and development – all activities related to the evolution of new products and services inclined to work together with another or others for a common purpose	0-1	0: No coordinated R&D activities 1: Coordinated R&D activities
	Licensing own Technology to others	Business arrangement in which the manufacturer grants permission of a product to manufacture that product (or make use of that proprietary material) in return for specified royalties or other payment.	0-1	0: No product or process licensing 1: Product or process licensing

After the different FTC are described in the preceding tables, the exploratory variables will be described. Received literature about capability building served as important sources of information about the nature of possibly important activities and determinants through which technological capabilities are acquired.

a) General Education
b) Formal Technical and Business Education
c) Prior Working Experience of the owner manager
d) External Technical or Business assistance
e) Age of Firm

A) General education of the owner manager is supposed as an important factor to influence FTC in a positive way. As said before; the culture inside SSI in development countries in India did not lend itself to junior staff members contributing ideas or suggestions, particularly if they lay outside areas of their direct responsibilities. A SSI often employs junior family members or even workers who are better educated than the owner, but it is clearly the latter who makes the major decisions about assimilation of new product technology, incorporation of improvements, and investment in new machine tools, and so on. (Clancy, 2001) Hence, a study of SSI should not necessary consider the extent to which general education is present among other actors within the sample firms.

Education helps the entrepreneur to understand new information that could help him to develop higher technological capabilities. Education and literacy opens up a wide number of channels through which new technological knowledge can be obtained. Literature about the diffusion and adoption of innovations has shown that education may affect people's attitudes in favour of early adoption of new technology (Rogers, 1983 in Romijn, 1997). Education level could be measured by an interval variable defined as the number of completed years of non-technical education obtained by the owner-manager.

B) Formal technical and business education is considered so important for the emergence of FTC. It is important to distinguish this type of technical education from general education because the effects of formal technical education is likely to be more direct. Furthermore, the effects on formal technical education is likely to have special effects on Production Capabilities. (Table 5a, 5b, 5c) Technical courses would presumably impart knowledge and skills that can be readily applied. For example, one might expect a course in technical drawing or production methods to have a direct impact on the firm's ability to import a new product technology successfully.

The level of technical education could be measured at the highest level present in the firm as a whole. Unlike with general education, it is supposed as not appropriate to consider the technical education of the owner/managers alone. This is because their managers have less opportunity to attend a technical training course or college themselves; it seems more likely that the owner hires workers for technical knowledge and advices on technological areas.

To scale the different education levels on a combination of course length and the level of education, could be as follows for Indian SSI:

level 0: No formal technical education at all.

level 1: Below-matriculation vocational training. This is entirely practical in content.

level 2: Post-matriculation vocational training. This could impart some basic theoretical knowledge in addition to practical skills training.

level 3: Post-matriculation three-year engineering college education. This is a broad, technical education leading to the diploma of "associate engineer," more or less equivalent to FSC (Faculty of Science) level. About 60% of the course content is theoretical, the rest practical.
level 4: Post-matriculation four-year BTech, BSc, or MSc. These are the highest possible forms of engineering education. The BTech is somewhat more advanced than the three-year polytechnic education in electrical, mechanical and automobile engineering, taking four years. A BSc in engineering also takes four years to complete, but it is more theoretical than the BTech. An MSc takes another two years after the BSc.

C) Prior working experience of the owner manager is supposed to have an important influence on the existence of FTC. The consciousness of other techniques and working methods is supposed to have influence on the urge for the owner to develop new FTC. Prior experience in SSI by the owner-manager should be included as an explanatory variable of capability because it apparently serves an important purpose in transmitting basic practical working and production skills. Ideally, one would measure the extent to which the experience was actually relevant to the technical tasks currently undertaken, but it could be difficult to quantify this aspect. In case it's difficult to quantify this aspect, it could be possible to quantify the number of years, different kinds of companies etc. In the worst case, one could decide to use a simple binary (yes/no) variable.

D) External technical assistance and information is of importance because SSI have limited resources to generate new information internally. SSI are therefore more depending on their environment of technical assistance and information. SSI in developed countries reflects a general acceptance of the idea that successful firms acquire information from their environment and somehow translate this into viable business opportunities. A suitable approximate measure of the extent of external information could be the number of different information channels used, because SSI that were most active searchers appeared to use a larger number of different channels for obtaining possibly relevant information than others. Informal channels, such as discussions with family, customers, suppliers, and competitors, and examination of competitors' products when they are on public display, are part of the normal business routine. Other information channels are internet, magazines, scientific publication and so on. For example, the use of internet is a widespread phenomenon in India, however in the two cases which described the use of internet, it is not found as a way of searching for new techniques. New technical knowledge and information obtained through institutional technical assistance could presumably play an important role in upgrading a firm's technological capability. The underlying assumption is that the more information and assistance channels a firm uses, the greater the effect is likely to be on its technological capability.

F) Age of firm may be expected to be an important explanatory variable of capability in so far as capability is a function of accumulated experience or "learning- by-doing". Efficiencies in firms emerge because of the increasing experience of individuals. Furthermore, efficiencies and development of FTC emerge because those who make up the firm get used to working with one another and learn to function as a team.
Data analysis by means of the previous directives through regression analysis can produce insight in how different FTC relate to each other. Moreover, it gives insight in how far external variables can practise on this influence. This information is useful to map out how FTC develop and to what extent FTC are represented at a certain SSI in a certain region. Governments and interested

authorities can find useful information and sub structuring out of this for interventions in the economical climate.

Appendix 4 Example of Quantifying FTC for the Case of Hykon

An example of the quantitative manner of the research of FTC is given in this paragraph. By means of the earlier described case of Hykon India, the tables to describe FTC quantifiable are given hereby. By means of one case it is impossible to make a quantitative analysis as for example a regression analysis. More cases are needed for this.

Table 7A Classification System Investment Capabilities; Pre-investment Hykon				
	Capability	**Grading**	**Hykon Score**	**Justification**
Learning-by-doing, Simple:	Pre-feasibility and feasibility studies	0; no feasibility studies. 1: poor feasibility studies 2: Qualitative: formal, detailed and structured feasibilities studies. 3: more than five qualitative feasibilities studies a year.	3	Qualitative Feasibilities studies of several new products are made. Every year one of five new products reaches the market. In the development of new products**,** a report with possibilities, financial return as well as possibilities to produce the products is made. Christo George, together with the R&D manager decides which products are introduced to the market.
	Site Selection	0: no conscious site selection process at the start of the SSI 1: conscious site selection process at the start of the SSI with relative simple and basic selection criteria. 2: formal, detailed, and conscious site selection process at the start of the SSI with relative extensive selection criteria.	1	The selection criteria for the site of Hykon were the availability and distance from family. The place isn't nearby researches, suppliers and employees, and customers.
	Scheduling of investment	0: No scheduling of investment 1: Scheduling only on ad hoc basis or poor quality. 2: Scheduling on project basis with different time periods. 3: Monthly detailed and high quality investment scheduling	1	Financial resources aren't an important decision criteria and only scheduled with the introduction of new products. The work schedules are based on availability of resources and personnel. Financial resources are scheduled only at the introduction of a new product. Investment scheduling based on bank loans aren't necessary, because bank loans are minimal. Hykon was financed in the beginning by family. Since the successful introduction of the converter, financial resources weren't leading in the decision making of the development of products and processes.
Import of technology Search Based	Search for technology Source	0: Only investigation on suppliers within ones own acquaintances. 1: Investigation of suppliers through easy available information sources without targeted investigation and negotiation. 2: Investigation of suppliers through available information sources with detailed and targeted investigation and negotiation.	0	Suppliers of technology are acquaintances of Christo George. Technology search is often done, only this search is for technology and not for suppliers. Technology is copied or developed further for own products of Hykon, suppliers of technology are in the and technology are all in he circle of acquaintances

Table 7B Classification System Investment Capabilities; Project execution Hykon				
	Capability	**Grading**	**Hykon Score**	**Justification**
Learning-by-doing, Simple:	Commissioning	0: No testing procedure 1: Testing on the job 2: Planned testing procedure. 3: Detailed and planned testing procedure with certifying procedure.	2	Products and processes to produce new products are tested in the R&D department. Before a product is taking in to production a prototype is built and tested.
Import of technology Search Based:	Equipment Procurement	0: Procurement only on bases of problem solving 1: Procurement of equipment on active basis. 2: Frequent search and procurement of equipment	?	Not clear ; during the research the way in which the equipment is done isn't sure.
	Training and recruitment of skilled personnel	0: No training 1: Planned recruitment of skilled new personnel or planned training activities 2: both planned skilled recruitment and planned training activities	1	Recruitment and training of new employees is organized. Once in service employees aren't trained anymore.
Formal R&D Research-Based	Basic process design	0: No basic process design +1 specifying all practices needed, +1 flowcharting, +1 rationalisation +1and error prevention	1	Single Products are made basically by one employee in complete. The practises needed are specified and orders. However, there's now flowcharting of rationalisation of the process.
	Equipment design and supply	0: no design of new equipment 1: design of new equipment 2: design and building of new equipment	0	Equipment isn't designed within Hykon

Table 8A Classification System Production Capabilities; Process Engineering Hykon				
	Capability	**Grading**	**Hykon Score**	**Justification**
Learning-by-doing, Simple:	Debugging and balancing	0: only problem-solving 1: active debugging procedures 2: debugging and balancing procedures	2	In the testing face of a new product**,** there is a phase of debugging and balancing. In this phase**,** several tests are done to guarantee the solidity and efficiency of the products.
	Process Quality Control	0: No organized quality control 1: Quality control on ad hoc basis 2: Quality control on regular basis	0	No organized quality control of the process
Import of technology Search Based:	Process Adaptation and cost saving	0: No cost saving or process adaptation 1: Poor understanding of process adaptation and cost savings 2: Organized process adaptation and cost savings	0	Process adaptation isn't seen by Hykon.
	Licensing new technology	0: No licensing 1: Licensing of one process 2: Licensing of more than one process	0	No licensing of technology
Formal R&D Research-Based	In-house process innovation	0: No process innovations 1: Unstructured innovation activities 2: Structural innovation activities in house	0	No in-house process innovation
	Basic Research	0: No basic research on processes 1: Basic research on processes	0	No basic research

Table 8B Classification System Production Capabilities; Product Engineering Hykon				
	Capability	**Grading**	**Hykon Score**	**Justification**
Learning-by-doing, Simple:	Assimilation of product design	0: standard product design with no changes over the last two years 1: Product design which changes by implementation of new ideas of employees 2: Structured design assimilation	1	Employees with ideas about how the product has to produce are shared with others and the R&D department.
	Minor adaptation to market needs	0: standard product design with no changes over the last two years 1: Product design which changes based on market needs 2: Structured design assimilation	1	Market needs expresses by customers, for example the introduction of converters for solar energy, have influenced the products designs.
Import of technology Search Based:	Product Quality Improvement	0: No organized quality control 1: Quality control on ad hoc basis 2: Quality control on regular basis	2	Each single product is controlled before leaving the company of Hykon by a quality assurance person.
	Licensing and assimilating new imported product technology	0: No licensing 1: Licensing of one product 2: Licensing of more than one product	0	Several products are introduced based on knowledge of other institutions. These products are however not licensed
Formal R&D Research-Based	In-house product innovation	0: No product innovations 1: Unstructured innovation activities 2: Structural innovation activities in house	2	In the R&D department innovation in terms of the introduction of new products is on structural bases.
	Basic Research	0: No basic research on processes 1: Basic research on processes	0	No basic research is done.

Table 8C Classification System Production Capabilities; Industrial Engineering Hykon				
	Capability	**Grading**	**Hykon Score**	**Justification**
Learning-by-doing, Simple:	Work flow scheduling	0: now workflow activities +1: Workflow of the work in process +1: workflow of the work in progress and sub processes. +1:Including specific activities, information dependencies, +1 the sequence of decisions and activities	1	The workflow of products in process is monitored. There is information available about how many products are in process and in what time they should be ready. Further detailed information isn't available about the work flow.
	Time Motion Studies	0: No motion studies 1: Motion studies	0	No motion studies are found.
	Inventory Control	0: no inventory control +1 supply and storage control of raw material +1 supply and storage control of end products.	1	The inventory control is only on raw materials.
Import of technology Search Based:	Monitoring productivity	0: No monitoring productivity 1: Regular collection of information to measure production 2: regular and systematic analysis of information about productivity	1	Te production rates and efficiency is collected and for Christo George important information. Based on this information he is able to see how much efficient and effective the production of personnel is.

Table 9 Classification System Linkage Capabilities; Linkage within the economy Hykon				
	Capability	**Grading**	**Hykon Score**	**Justification**
Learning-by-doing, Simple:	Local Procurement of goods and services	0: Procurement of goods and services with only one suppliers within a radius of 10 km 1: Procurement of goods and services with 2 till 5 suppliers within a radius of 10 km 2: Procurement of goods and services with more than 5 suppliers within a radius of 10 km	2	Goods and services are bought in the neighbourhood. Bank services, food, equipment and raw material are bought by local suppliers
	Information exchange with Suppliers	0: No information exchange 1: Information exchange on unstructured basis 2: Information exchange on structured basis	1	Suppliers are sometimes invited to see the company by delivery of materials. In this process information about needed materials and processes is exchanged.
Import of technology Search Based:	Coordinated design	0: No coordinated design 1: Coordinated design once 2: Coordinated design in more than single case	0	No coordinated design is found
Formal R&D Research-Based	Cooperative R&D	0: No coordinated R&D activities 1: Coordinated R&D activities	0	There were no coordinated R&D activities found
	Licensing own Technology to others	0: No product or process licensing 1: Product or process licensing	0	Hykon doesn't license there products of processes.

Table 10 Classification of FTC: Hykon			
Table	**Capabilities**	**Possible score**	**Total score Hykon**
Table 7A	Investment Capabilities; Pre-investment	10	5
Table 7B	Investment Capabilities; Project execution	13	4
Table 8A	Production Capabilities; Process Engineering	11	2
Table 8B	Production Capabilities; Process Engineering	11	6
Table 8C	Production Capabilities; Process Engineering	9	3
Table 9	Linkage Capabilities	8	3

Exploratory variables

A) General education of the owner manager is supposed as an important factor to influence FTC in a positive way. Education level could be measured by an interval variable defined as the number of completed years of non-technical education obtained by the owner-manager. The number of completed years of education of Christo George is 13 (2 years in-house education at younger age, 6 years of college, 5 years high school).

B) Formal technical and business education is considered so important for the emergence of FTC. The level of technical education could be measured at the highest level present in the firm as a whole. To scale the different education levels on a combination of course length and the level of education is as follows for Hykon; Christo George does have the highest education of Hykon: level 3. Christo had a post-matriculation three-year engineering college education.

C) Prior working experience of the owner manager is supposed to have an important influence on the existence of FTC. Christo George hasn't had much working experience before he started Hykon. After his technical education, he had some experience at the SSI of his father. This was a small shop in electric equipment.

D) External technical assistance and information is of importance because SSI have limited resources to generate new information internally. In case of Hykon, the presence of Achnuthan was an important source of information; Achnuthan worked as a salesman for Siemens and earned his degree in French. He was for example the major force of setting up the R&D department and awareness of new technologies.

F) Age of firm may be expected to be an important explanatory variable of capability in so far as capability is a function of accumulated experience or "learning- by-doing". The age of Hykon is 17 years