Globalisation of Innovation in Danish Agro-food MNEs

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[1] In the Description of Work the title of D5.1 is "The strategies of EU and Southern MNC's for offoshore producing innovation".

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Introduction

This report is based on the firm-level research undertaken for the Work Package 5 (WP5) of the INGINEUS project. By taking a micro-level perspective this report aims to contribute to our understanding of the transition from global production networks (GPN) to global innovation networks (GIN). Specifically, it aims to provide an-depth understanding of the international R&D strategies of both EU and Southern MNEs. This is achieved by analysing the micro-level determinants of the strategy of MNEs to offshore outsourcing knowledge intensive activities and the role of institutional frameworks in this decision. It also sheds light on how MNEs balance between technological access objectives and the managerial complexities of internationalising technological activity. The empirical evidence is based on the interviews undertaken at the headquarters (HQ) and at the R&D centres overseas of several MNEs in the three different sectors: ICT, Automobiles and Agro-Food.

This report is structured as follows: In the initial part, it primarily deals with the analysis of the empirical evidence based on the EU MNEs and their innovation activities undertaken at their R&D subsidiaries located in the Emerging Markets. Part I presents a comprehensive research paper that provides a conceptual framework to explain the underlying dynamics in the relation between the innovation strategies undertaken at the EU MNE's R&D subsidiaries located in Emerging Markets, the host country institutional frameworks in which it is embedded, and the extent of their integration in GIN. A further dynamic element is introduced by tracing the evolution in the kind of activities that are undertaken in the R&D centre and in their market orientation over time.

While the Part II deals with detailed case studies of selected EU MNEs and their innovation strategies in overseas locations. The case studies of Southern MNEs are also presented. The format for presenting the cases on three areas: R&D Organisation, R&D Management and R&D Strategies of MNEs, brings together the evidence in a structured way. Moreover, in the Agro-Food sector, all four MNEs interviewed were Danish MNEs, who were among the top players in the sector in Denmark. This allowed us to have a comparative insight into the R&D internationalisation in the Danish Agro-Food. Firstly, it identified the specific factors that influence Danish Agro-Food MNE's strategic decisions on the kind of activities internationalized and the location that is most appropriate for such activities. It also provided an understanding of:

- what leads Danish MNEs to decide *when* and *where* global organization of production in global production networks (GPNs) is not sufficient by itself and consequently to start explore and exploit globally distributed resources;
- under what conditions they decide to upgrade to global innovation networks (GINs);
- whether a decision to widen and/or deepen a GIN is based on considerations that have nothing to do with previous production.

Research methodology

A qualitative research methodology is employed based on in-depth case studies of some world's leading MNEs in the three sectors of ICT, Automotive and Agro-Food. The selection of the MNEs for detailed analysis was based on the fact that they represented one of the leading players in the respective industry, in terms of market share and in terms of being one of the largest employers in

the country. They are also the leading R&D spenders. For example, Ericsson, Philips and Volvo, with a annual R&D spending of EUR 2.4 billion, EUR 1.6 billion and EUR 1.5 billion, respectively, are the leading R&D performing MNEs in their respective sectors in the EU [2]. One other criterion was that the MNE selected were the ones with R&D activities in overseas markets (matched cases). In all the EU cases in our sample, MNEs had established R&D subsidiaries in the Emerging Markets and were involved in innovation activities, undertaking functions such as research, process development and product development, including molecule mapping, engineering, system integration, design, etc.

In total 15 EU MNEs and 2 Southern MNEs were interviewed. The list of EU MNEs interviewed is presented in Table I. The matched EU cases where possible in 4 out of 6 firms in ICT, and in all 4 firms in Auto sector (see Table I). However, for the Agro-Food, this was possible only in the case of the 2 biotechnology firms (Danisco and Novozymes) out of 4 companies. In the ICT sector, insights were gained from 2 Southern MNEs based in Estonia as well. These Southern cases were however interviewed in the HQ alone.

Table I: List of EU MNEs interviewed

	India	*China*	*Brazil*	*South Africa*	*HQ*
ICT					
NSN	y	y	n	n	y
Philips	y	y	n	n	y
Ericsson	y	y	n	y	y
Alcatel	y	y	n	n	n
ST Microelectronics	y	n	n	n	n
Infineon	y	n	n	n	n
Agro-Food					
Novozymes	y	y	n	n	y
Danisco	n	y	n	y	y
Company III	n	n	n	n	y
Company IV	n	n	n	n	y
Automobile and Parts					
Volvo	y	n	n	n	y
Bosch	y	n	y	n	y
Continental	y	y	n	n	y
Fiat	n	n	y	n	y
Autoliv	n	y	n	n	y
Total					
15 MNEs	10	8	2	2	12

Data Collection

[1] http://iri.jrc.ec.europa.eu/research/scoreboard_2010.htm

The initial strategy was to undertake interviews for each MNE at their head quarters (HQ) and at their R&D subsidiaries in overseas markets. This would provide us with matched cases, where two different perspectives, the HQ perspectives and R&D subsidiary perspectives can be enabled for each MNE. In accordance, at the HQ locations, the interviews were carried out with the top management personnel with responsibility for global R&D strategies and for implementing them (Chief Technology Officer, Global Development Head, Senior VP for Emerging Markets R&D etc). The HQ interviews covered the MNE's R&D landscape and enabled a good perspective on their corporate R&D strategies in the well established markets in the West and in Emerging Markets. The information on the corporate R&D strategies with respect to Emerging Markets included the general R&D strategy in specific locations and not to do with their activities within the R&D centre alone.

The interviews at the R&D Centres in Emerging Markets were undertaken with the Head of R&D centre in India, China, South Africa and Brazil. This provided an understanding of the activities and agenda of the R&D centre there and to present the global innovation links and specific locational advantages in these regions. For example in Fiat since we have insights on the activities/agenda of its 3 R&D subsidiaries in Brazil, it is able to provide evidence on the emergence of Brazil as an important location that is rapidly getting integrated in Fiat's global innovation networks.

As is evident in the Table, in the case of EU MNEs, the interviews are undertaken at both the MNE HQ and at their R&D subsidiaries in at least one Emerging Market location. Further, in 8 cases it enabled the comparison of the insights in more than two contexts, i.e., interviews at HQ, and in two emerging market locations. This is complimented by a database that was created for each of the MNEs providing detailed data collected from the corporate websites and press releases. The data for the case studies were thus collected in 3 phases. In phase 1, an interview guideline template questionnaire constructed in order to be used in the interviews with MNE's R&D subsidiaries. Based on the preliminary insights from these interviews, further interviews were carried out at the HQ. In the third phase the gathering of the background information on firms were undertaken. By carrying out this phase towards the end it proved extremely useful in comparing the insights got from the different interview perspective to the MNE's corporate strategies mentioned on the websites. This enabled us to validate the data gathered in the different contexts, thus allowing us to check its credibility and its robustness. This approach in data collection thus facilitated a more thorough understanding into the nature and characteristics of the underlying process.

Part I: MNE's innovation strategies in emerging markets, their integration in MNE's Global Innovation Networks & host institutional factors - a dynamic perspective

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1. Abstract

This paper focuses on the innovation strategies of EU MNEs undertaken in Emerging Markets. It draws on case studies of 15 EU MNEs with R&D centres located in India, China, Brazil and South Africa. These companies are amongst the leading R&D spenders in the following sectors: ICT, Automobiles, and Agro-Food. The conceptual framework developed here identifies specific patterns and dynamics with respect to the innovation strategies undertaken at the R&D centre, and in its integration in the MNE's global innovation links (GIN), in the context of the host institutional factors. The distinctive feature is that it provided a framework to position the different innovation strategies pursued by MNEs at the R&D facilities in Emerging Markets. It was possible to distinguish 5 innovation strategies. These strategies fit on a continuum which displays increasing innovation capability, greater integration into the MNE's GIN and local embeddedness. These strategies also lie on a continuum with respect to the relevance of market driven and supply driven institutional determinants. These innovation strategies are not mutually exclusive as some R&D facilities simultaneously pursue a number of these innovation strategies at their host locations.

Our results show that the R&D centre's innovation capability advancement and the strengthening of the host institutional frameworks have happened hand-in-hand. These innovation strategies are not static either, but evolve in relation to the MNEs previous engagement in the host market, and are based on experiences of their interaction with different institutions in the host system of innovation. Despite the different ways in which they have evolved, a trend towards greater integration into the MNE's GIN and greater local embededdness is apparent. Further, it also highlights distinctive features across sectors. By focussing on the specific factors (human resources, IPR, public institutes, market and competition), this paper contributes to our understanding of the role of institutional frameworks.

2. Introduction

This paper focuses on the knowledge creating activities of EU MNEs in Emerging Markets. The main aim is to improve our understanding of innovation strategies of firms with regard to their R&D facilities in Emerging Markets. We see such strategies as resulting from the dynamic interplay between the host institutional factors in which a centre is embedded and the extent of its integration in the MNE's global innovation networks (GIN). A further dynamic element is introduced by tracing the evolution in the kind of activities that are undertaken in the centre and in their market orientation over time. This paper is based on insights from case studies of R&D centres of 15 EU-

based MNEs located in India, China, Brazil and South Africa. These companies are amongst the leading R&D spenders in the following sectors: ICT, Automobiles and Agro-Food.

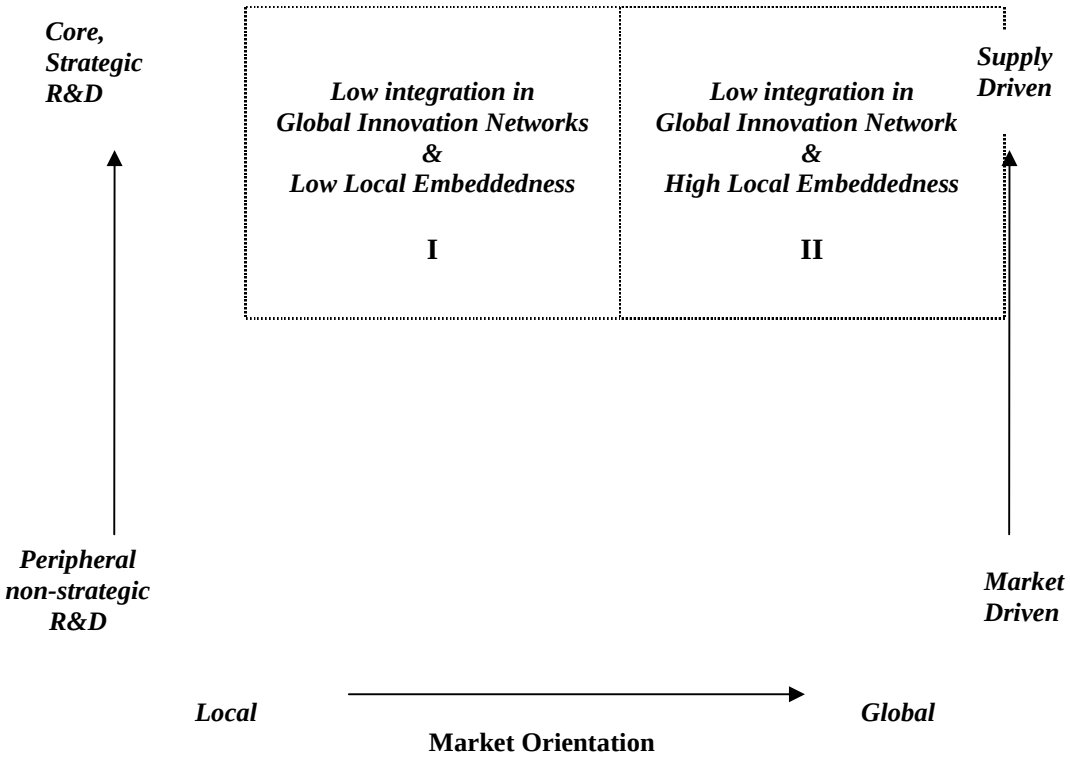
The conceptual framework presented in this paper attempts to identify the patterns and dynamics with respect to how the institutional strengths and weaknesses of emerging countries interact with the innovation strategies undertaken at the R&D facility within these countries, the extent of their integration into global innovation networks and their local embededdness (see Figure I below). The underlying rationale is that a holistic approach is imperative in order to explain such innovation strategies. Such an approach has to take into account the host institutional determinants, the level of R&D capability at the R&D centre, and its market orientation. Further, we emphasise that any analytic perspective has to consider the interactions and the resulting synergies between these dimensions over time in order to provide a good understanding of the emerging patterns and dynamics with respect to the extent of integration in GIN and local embeddeddness.

Figure I present our conceptual framework. The first point to note is that the extent of integration in the MNE's global innovation network and the extent of local embeddeddness are quite low if the local subsidiary undertakes peripheral and non-strategic routine type of R&D, mainly catering for the local market (cell 1). The figure also shows that the extent of integration in the MNE's global innovation network and the extent of local embeddeddness increases when the level of innovation capabilities of the R&D subsidiary is high and it has a global market orientation (cell IV). However, a greater integration in the global innovation network does not always coincide with the greater local embeddeddness, as is the case in cells II and III. The precise position of the R&D subsidiary in this diagram is influenced by the host region's supply factors such as the local technical/scientific skills and the competence of the supplier and science base. The relevance of market factors such as the local demand for low cost products and the flexibility in operations to meet those demands are also important, as are the internal demands from MNE's various business units. The host government incentives and national priority on undertaking certain kinds of technology development also have a role to play.

Figure 1[3]: Innovation strategies at the R&D centres in host locations - a conceptual framework

Some integration in Global Innovation Networks & High Local Embeddedness **III**	***High integration in Global Innovation Networks & High Local Embeddedness*** **IV**

[3] Conceptual Framework produced by the author by drawing on research undertaken for INGINEUS project.



The main distinctive feature is that the Figure I provide a framework to position the different innovation strategies pursued by MNEs at the R&D facilities in Emerging Markets. Thereby it tries to capture the underlying dynamics in the interaction between the different dimensions effecting the pace and direction of globalisation of innovation. This framework has also enabled us to highlight any distinctive features across sectors, with respect to the innovations strategies of the R&D centres, the location specific institutional factors and in the characteristics of innovation networks.

The rest of the paper is structured as follows: Section 2 presents empirical background and contributions from the literature. Section 3 deals with the research methodology. Section 4 discusses the empirical evidence. In Section 4.1, it will analyse the different innovation strategies evidenced at the R&D facilities in Emerging Markets within the conceptual framework discussed above. Section 4.2 examines the specific host institutional frameworks that have influenced the MNE's innovation strategies in ICT, Automobiles and Agro-Food sectors. Section 4.3 provides insights into how the MNE's innovation strategies impact upon the host institutional factors. The paper contributes to the advancement of our understanding of the role of institutional frameworks by focussing on the specific factors such as human resources, IPR regime, public institutes, market and competition. Section 5 presents the main conclusions.

3. Institutional frameworks and its interaction with MNE's innovation strategies

Globalization of innovative activities in general, and R&D in particular, has increasingly become the centre of attention amongst policy makers and academics. It is not a new phenomenon as the first major academic studies on the subject began appearing more than 20 years ago (for a summary of this early work see Granstrand et. al. (1992)). The main conclusion of this early work was that the world's largest R&D spending firms tend to locate a vast proportion of their innovative activities at home, close to the location of their headquarters (Patel and Pavitt, 1991; Gassmann, and von Zedtwitz, 1999). Past understanding of the globalisation of innovation activities stems from the analysis of two strategies for R&D FDI: the knowledge exploiting and knowledge augmenting strategies (Patel and Vega, 1999; Dunning and Narula, 1995; Kuemmerle, 1997*)*. These strategies have been analysed as a function of different levels of technology capabilities of the MNEs, its home country and the host country. These studies have noted the strong influence of national innovation systems on the technological and innovation activities of MNEs (Pavitt and Patel, 1999; Patel and Vega, 1999; Le Bas and Sierra, 2002).

In general, the knowledge augmenting (or sometime referred to as the home based augmenting) strategies are associated with locations in advanced countries, where the primary motivation is to tap into the science and technology base in foreign centres of excellence. The underlying rationale is that MNEs internationalise R&D to monitor new technological developments and generate new technologies and products from locations abroad (Cantwel, 1995; Kuemmerle, 1997). Such activities are concentrated in the few locations that can provide the advanced resources and institutions and that display continued commitment to improving their technological competitiveness position (Jones & Teegen, 2003). This literature suggests that the 'parent corporation continues to serve as the most active creator and diffuser of knowledge within the corporation' (Gupta and Govindarajan, 2000, p. 490).

However, when it comes to discussing the capabilities in Emerging Markets, the literature has largely centred around, the exploitation of existing technology developed at the home base (Dunning and Narula, 1995; Kuemmerle, 1999; Ernst, 2002; UNCTAD, 2006). Part of this argument rests on the premise that emerging countries such as India and China are characterised by weaker IPR compared to advanced economies, hence the R&D activities of foreign MNEs undertaken in subsidiaries tend to be different from the activities undertaken at home. Despite the weaker IPR regimes some of the most innovative MNEs are increasingly setting up foreign R&D affiliates in these countries. In trying to explain this, 'UNCTAD and OECD studies have found that these R&D activities often focus on developing technologies that typically need to be used in combination with other complementary technologies. In the absence of the latter, local technology leakage does not pose a major threat' (OECD, 2008, p.45). Empirical evidence from China suggests that strong internal linkages among technologies can allow firms to generate value from their overseas R&D even in the absence of strong IPR protection (Zhao, 2006). Studies show that provided that the R&D centres are wholly-owned, they are able to protect knowledge and prevent unwanted technology transfer, as the tendency for full ownership is positively related to the technological sensitiveness of MNE's business field (Gassmann and Han, 2004; China S&T Statistics, 2003). Many innovative ICT firms in the San Francisco Bay Area follow a hybrid model, utilizing both their own R&D centres particularly where intellectual property is a concern and extensive partnerships with one or more Indian majors.

Based on the studies that have focussed on the R&D internationalisation in Emerging Markets, it can be said that in general there is a lack of consensus in the literature with respect to the kind of R&D activities that the firms internationalise in such countries. One view is that innovation activities in foreign R&D centres are only concerned with local product adaptation through intensive cooperation with customers and suppliers. Previous empirical evidence has suggested that a large part of MNE's R&D activities in China is market driven and development oriented rather than research oriented. For example two-thirds of MNE's R&D alliances in China between 1995 and 2000 are development oriented (Li and Zhong, 2003). Further studies have argued that the likelihood of establishing a local development unit increases if a given firm's business requires local product adaptation and intensive customer cooperation (von Zedtwitz and Gassmann, 2002). Another view is that innovation activity of MNE's can best be described as global generation of innovations, i.e., innovations are conceived on a global scale from the moment of inception in an inter-play between R&D and innovative activities in both the home and the host countries (Archibugi and Iammarino, 2002). This is partially supported by cases of US companies such as Cisco and Intel. Cisco's second global headquarters is setup in Bangalore to leverage India's engineering resources and develop products for Indian and other emerging economy markets. In the case of Intel, product development accounts for 65% of activity in India and has recently begun designing products in India aimed at developing country markets.

The vast literature has provided us with a clear understanding that the precise features of a host country needed to attract R&D depend on the industry and activity involved (UNCTAD, 2005). However, identifying the precise features that are present in healthy institutional environments is a challenge. Even harder is the task to specify the genesis and underpinnings of healthy institutions (Mudambi and Navarra, 2002). Evidence based on the foreign R&D activities of US MNEs found that country-level investments that support institutions conducive to economic development and scientific output generate a munificent environment for R&D (Doh et al., 2005). Further, political stability with low risk of change, low corruption and IP rights protection were important as well. The increasing role displayed by R&D affiliates located in a host country in the generation of new technology is in accordance with the comparative advantage in innovation of that country (Papanastassiou and Pearce, 1997; Cantwell, 1995). Both the availability of scientists, technologists and engineers and the future human resource capabilities are important factor in the location decision (Taggart, 1991; Voelker and Stead, 1999). Higher educational system is seen to be a major factor (Papanastassiou, 1997; Kuemmerle, 1999).

The drawing power of institutions is shown to be highly contextual (Dunning and Zhang, 2008). In new technology industries, the availability of R&D personnel and low costs of doing R&D in India have been identified as the primary drivers, whereas in conventional technology industries the primary factor is proximity to manufacturing and to the Indian market (Reddy, 2000). In certain sectors such as biotechnology there is a greater role for public research institutes engaged in basic research. The relevance of an efficient IPR system is also critical for this sector. In general, IP protection is more relevant for asset augmenting FDI strategies compared to efficiency seeking FDI strategies where fiscal incentives are rather more relevant. However, it is shown that for latecomer countries, copying and reverse engineering have historically been a vital source of learning and upgrading (Lall, 2003).

Governments are shown to have a twofold influence. They primarily affect the climate for innovation and the local linkages between science and technology in the host country. They also initiate specific policy measures that have an influence on the upgrading of the R&D activities of the affiliates. But such specific investment incentives have only an incremental rather than primary

effect on R&D locations (Cantwell and Mudambi, 2000). An empirical study comparing the R&D collaboration with public knowledge institutions in small advanced economies finds that Finland has a relatively high share of innovating firms involved in such R&D compared to Netherlands (van Beers et al., 2008). This they attribute to Finnish policy-induced collaborations, linking innovating firms to domestic public knowledge institutional structure more effectively than Dutch innovation policies. In the Netherlands the focus of policies is more on financial instruments like tax credits that address firm's production costs than on improving collaboration (van Beers et al., 2008).

4. Data gathering and methodology

The empirical evidence is gathered from case studies of 15 EU-based MNEs with R&D facilities in India, China, Brazil and South Africa. These MNEs belong to the following sectors: ICT, Automobiles and Agro-Food. The selection of the EU MNEs was based on the fact that they were amongst the leading players in their respective sectors both in terms of market share and in terms of being large employers in their home countries. They are also amongst the leading R&D spenders in the EU. Another criterion for selection was whether the MNE had established R&D and innovation activities in India, China, Brazil and South Africa.

The data gathering was facilitated by means of semi-structured interviews undertaken at the R&D centres of the EU MNEs in India, China, Brazil and South Africa. In total, interviews were undertaken at 22 R&D facilities in the Emerging Markets between March 2010 and April 2011. The person interviewed was the head of R&D centre. A four page structured questionnaire comprising 23 questions were used as an interview guideline. There are 4 sections in the questionnaire, the first of which captures information about the R&D in the company as a whole. The second and third sections are devoted to the activities of the R&D centre and on it external links, respectively. The centre's structure and relationship with HQ and other R&D centres of the company are captured in the final section. The instrument was constructed in such a way that the template for interview guidelines used at the Indian R&D facility could be used in China, South Africa and Brazil with only minor modifications.

The empirical evidence gathered provided important insights into the changes in the agenda of the R&D centre in the host location over time. As well as providing comparable data on MNE's R&D activities from a host institutional perspective. The initial strategy was to undertake interviews for each MNE in at least two Emerging Markets. In relation to the ICT MNEs we were able to secure interviews in 2 different locations in Emerging Markets, in 4 out of 6 firms. However, this proved to be too difficult as shown in Table I. For example in the case of Infineon and ST Microelectronics it was only possible to interview the head of R&D centre in India. For the Agro-Food, this was possible only in the case of the 2 biotechnology firms (Danisco and Novozymes) out of 4 companies and in the case of Automotive industry 2 out of 5.

Table I: MNEs interviewed at R&D centres in emerging markets

	India	*China*	*Brazil*	*South Africa*
ICT				
NSN	y	y	n	n
Philips	y	y	n	n
Ericsson	y	y	n	y
Alcatel	y	y	n	n
ST Microelectronics	y	n	n	n
Infineon	y	n	n	n
Agro-Food				
Novozymes	y	y	n	n
Danisco	n	y	n	y
Company III	n	n	n	n
Company IV	n	n	n	n
Automobile and Parts				
Volvo	y	n	n	n
Bosch	y	n	y	n
Continental	y	y	n	n
Fiat	n	n	y	n
Autoliv	n	y	n	n
Total				
15 MNEs	10	8	2	2

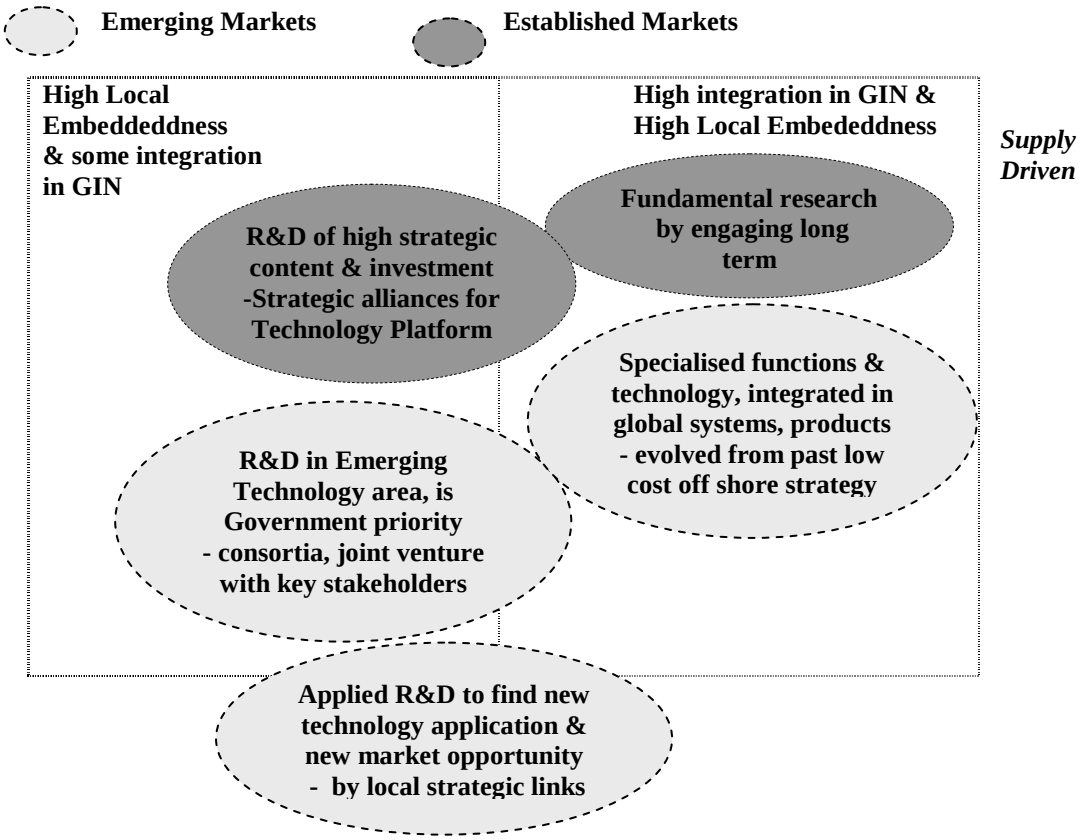
5. Discussion

Our results show that the EU MNEs in general, regardless of the sectors they belong to, resort to multiple innovation strategies simultaneously at their host locations in Emerging Markets. Hence to regard innovation activities undertaken at the Design Centres, R&D centres, Technical centres, and Centres of Excellence located in the Emerging Markets as pure development activities would be ill conceived. While the innovation capabilities of all these centres transcend the low level, peripheral kind of tasks, they have not yet advanced to the level of fundamental research or core R&D with high strategic content. For example in our case studies the generation of common technology platforms for the entire company, research into new materials that can potentially generate high value and strong IPs, and other critical functions involving substantially high investments are mostly confined to the home country locations of the MNEs and do not feature in the innovation activities undertaken at any of these centres.

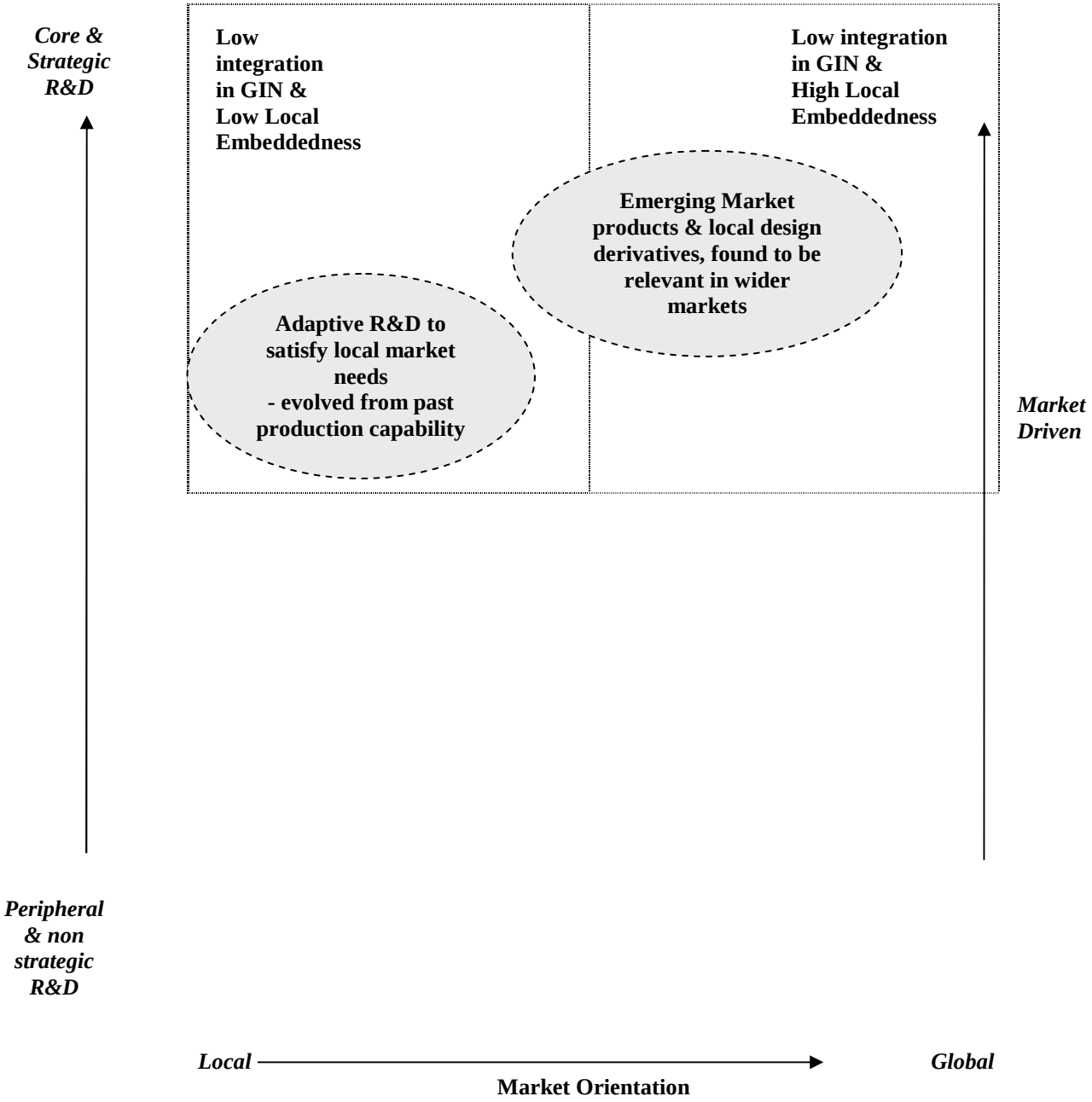
Drawing on the insights from the MNE's innovation activities overseas, it was possible to distinguish 7 innovation strategies by analysing the level of innovation and the degree of market orientation, within a host institutional context. As shown in Figure II, these innovation strategies fit on a continuum which displays increasing innovation capability and greater integration into the MNE's global innovation networks and local embeddedness. Out of the possible 7 innovation

strategies identified, only 5 innovation strategies featured at the Emerging Market R&D facilities in our sample. These innovation strategies are not mutually exclusive, as is explained in the sections below. Some R&D facilities simultaneously pursue a number of these innovation strategies. Since the focus of the paper is on the innovation activities of the EU MNEs in Emerging Markets, the rest of the discussion will concentrate on the 5 innovation strategies identified in Emerging Markets.

Figure II[4]: Dynamics in the Interaction between the: Innovation Strategies at R&D Centres in Host Location, Host Institutional Factors in which it is embedded & their Extent of Integration in MNE's GIN



[4] Conceptual Framework constructed by the author based on empirical evidence drawn from case studies of EU MNEs with R&D facilities in Emerging Markets, undertaken for the INGINEUS project.



5.1 Analysing the innovation strategies at the R&D centres in emerging markets

Based on the conceptual framework outlined earlier (Figure I), it was possible to identify specific patterns and dynamics of innovation strategies at R&D centre and its integration in the MNE's global innovation links in the context of the host institutional factors. At one extreme is the *Adaptive R&D* strategy that is strictly market driven and where R&D is mainly exploitative, where there is low level of integration in GIN. At the other end is the strategy involving supply driven and explorative R&D, which relies on *Specialised technology capabilities* that are part of a system and which are integrated in global products and solutions. In between these two extreme are three

further innovation strategies: the *R&D on Emerging Market products and technology*; the *Applied R&D for the generation of new technology applications and to find new market opportunities*; and the R&D on *Emerging Technology area that are government priority in the host country*.

Figure II manifests a varying degree of local embeddedness across the five types of MNE strategies as a function of the strength and weakness of the host institutions in the local system of innovation. In relation to the *Adaptive R&D* strategy, the activities are mostly undertaken internally and the local links which are mainly with the suppliers and customers are weak. In this case the local supplier links are mostly outsourcing relationships introduced as a cost-saving measure and the customer links are mainly to get the market input and customer feedback. In the intermediate strategies, there is greater embeddedness in the local networks. For the *R&D on Emerging Technology area that is government priority of host country* and in the case of *Applied R&D*, the local partner inputs are critical. Here the R&D facilities are involved in formal long-term collaborations, joint projects, joint ventures, and research consortia. For the R&D strategy to come up with *Emerging Market products and technology*, the local informal links are important as well.

Our case studies show that the specific innovation strategies pursued depends on the kind of opportunities and the various operational and managerial difficulties arising from the institutional strengths and weakness in the host system of innovation. As shown in Figure II, the five strategies lie on a continuum with respect to the relevance of supply driven and market driven institutional factors. For example, the centres with *Specialised technology capabilities* are part of a system and hence integrated in global products and solutions. They are primarily skills driven and engage in upgrading their innovation capabilities, through in-house training to develop specialised expertise and provide external training to local universities. The emphasis is also on developing various ways to integrate the specialised functions and technologies in the global systems, products and solutions. This is evidenced here, in most of the ICT R&D centres with system integration capabilities, in the Auto R&D centres undertaking automotive engineering services, and the specialised centres for Biotechnology such as those specialising in protein engineering capabilities.

On the other hand, in the case of *Adaptive R&D* the centres are purely market-driven. This is the case for Ericsson China R&D Institute, where the localisation of existing products and technologies to meet the demands for emerging countries has been high on the agenda. Almost all (90%) of the operations at this centre are to cater for local specific requirements that are very different from those of the markets in the developed countries. In such market driven centres the most pertinent capabilities are those related to undertaking advanced development in-house as well as networking to foster local collaboration with providers of such capabilities. The *Applied R&D* strategy equally emphasises creative ways to open up new market opportunities, signalling that demand considerations are becoming more important over time reflecting the prospects of large and growing markets. Undertaking innovation activity near the market is considered essential to translate the distinct local demand in concise form, and to provide alternative technology solutions in the wake of specific technology constraints and regulatory requirements.

While in the case of centres engaged in *R&D in Emerging Technology areas that have been identified as government priority in host location*, the institutional factor most relevant is the government support. The emphasis is on mobilising local networks and setting up of research consortia in order to help establish an institutional infrastructure in the host system of innovation that is conducive for such activities. This is evidenced from the research undertaken by Fiat and Bosch on flexi-fuel technologies in Brazil, Novozymes on second generation bio-fuel for the Chinese market, and the development of a different mobile technology standard in the case of NSN in China.

5.1.1 Evolution of the innovation strategies and their integration in MNE's GIN

The 5 different innovation strategies identified are not static, but evolve in relation to the MNE's previous engagement in the host market, and are based on experiences of their interaction with different institutions in the host system of innovation. Some facilities have engaged over a long period in the host location and have been involved in continuously upgrading the capability at the R&D facility. This is because their initial strategy was solely determined by the availability of low cost skills rather than on accessing advanced specialised competences. These centres have now accumulated specialised technology capabilities, with some attaining the status of an excellence centre which are recognised by the entire organisation.

The search for global efficiency has driven the concentration of these specialised functions to a single location thereby reducing duplication. These centres do not cater for local demand but contribute to the parent company's global product development. For example, the ST Microelectronics set up a design centre in India in 1995 which initially undertook characterization, design layout, work on libraries etc. As the workforce became more experienced, the centre has advanced to designing full chips and complete systems (set top boxes). As a consequence 15% of all VLSI design and software activities at ST Microelectronics were carried out in India in 2007, making it the largest design centre outside Europe contributing to one of its lead technologies. This process is also evidenced in a number of Auto R&D centres. For example when the Bosch centre in India (Robert Bosch Engineering and Business Solutions) was setup it only undertook embedded software development but it gradually moved up the value chain so that today its activities encompass complete product design i.e., electronic design, hardware design, software design and integration.

In certain other cases the evolution was a gradual one, from being a support centre for local production activities to undertaking adaptive R&D, to being fully responsible for developing certain Emerging Market products and innovation with a global mandate. The Infineon Design centre in Bangalore was set up in 1997 as essentially a resource augmentation centre. Over the years it has consolidated its position in the company by acquiring greater knowledge and getting more involved in the product roadmap and project management. Recently, the centre has advanced further by assuming complete product development responsibilities, involving the management of global teams.

Some centres are involved in simultaneously developing products for the Emerging Markets and undertaking specialised functions for the company as a whole. This is seen in our Biotechnology MNEs (Novozymes centre in India), in ICT (Alactel centre in India, the Philips centre in China) and in Auto (Bosch centre in India). To illustrate, the Volvo centre in India is developing products for the emerging markets at the same time as providing specialised software and engineering functions for the company's other business areas. The centre has gradually evolved from a strategy based on local supplier sourcing and purchasing to developing Emerging Markets products.

In some cases the local R&D facilities have evolved from simply monitoring local technology trends to undertaking Applied R&D. Over time, the significance of engaging in local and global networks in order to open up new market opportunities became apparent to the managers of such R&D centres. They now engage with a broader base of potential clients in order to identify new applications based on existing technology. R&D activities of Ericsson and NSN in China and that of Philips in India provide examples from ICT sector. Similar activities are evidenced in Auto manufacture (Fiat) and Auto component supplier activities (Bosch) in Brazil. In Biotechnology,

MNEs aims to develop new application of enzymes in sectors beyond food and agriculture. For this the local collaboration is with global players producing rubber products, textiles, detergents etc.

The discussion above highlights the fact that in most cases strategies have followed an evolutionary path. However, there are exceptions where a company has pursued a more opportunistic strategy. For example, the R&D capability at Novozymes site in India was rapidly upgraded by acquiring complimentary expertise and specialised technology knowledge in surface enzymes, and is now the centre of excellence for wine and juice R&D. This can also be said about the extent of the integration of different R&D centres into the MNE's global innovation networks. There are a variety of ways in which such integration take place. In certain cases it has followed an evolutionary trajectory, where the integration was gradual, from being loosely engaged in production networks into a greater integration in the global innovation networks of the parent company, in line with the accumulation of innovation capabilities at the R&D centre over many years. Whereas, in other cases, the integration was more rapid, resulting from the acquisition of local companies with specialised capabilities that are complimentary to the strengths at home.

5.1.2 General findings based on the analysis of the 5 innovation strategies

Despite the different ways in which the five innovation strategies have evolved, a trend towards greater integration into the parent global innovation network and a greater degree of local embededdness is clearly apparent. The Bosch case illustrates this. Being a global Auto component supplier, Bosch has R&D facilities in lead markets by following its customers, the global Auto manufacturers with aggressive expansion plans in high growth markets. The activities undertaken at its Development centre in Brazil focuses on developing local products such as fuel systems (diesel, gasoline and ethanol), brake systems and chassis and automotive electronics. This centre also contributes to the development of flex-fuel engines, which use ethanol as fuel and hence has become a competence centre in flex-fuel technology and the World Engineering Centre for specific products. Internal links with the parent and the interaction with global engineering development teams played a crucial role in enhancing the local innovation capabilities, so are its external links with local engineering teams of the manufacturers like Fiat, for upgrading its capabilities.

The strategic factors in host Emerging countries for undertaking R&D includes the availability of skills, market, presence of research institutes, and government-led initiatives, confirming past research (Demirbag and Glaister, 2010). However, a combination of these market-driven and supply-driven factors is relevant for the intermediate innovation strategies in our framework. Only the two extreme innovation strategies are driven by strategic factors such as market and skills alone. In our biotechnology sample for example, the strategic motives for pursuing the innovation strategies at the R&D centers in India are driven by the need to access advanced level skills and scientific expertise in certain areas, and to develop enzymes closer to the market. In the Fiat and Bosch cases, the main motive in Brazil was to develop closer to market and to take advantage of the government initiatives in areas of priority (bio-fuel using ethanol). Further, cost is not seen to be that important. However, cost seems to matter for the functions outsourced to Contract Research Organizations (CRO). The discussion below focuses on these institutional factors with the aim of highlighting any sectoral differences.

5.2 Institutional factors and sectoral differences

5.2.1 Human resources

The availability of large pool of well-qualified scientists and engineers is one of the key factors. In ICT and Auto, the MNEs looking to expand and scale up the engineering and other specialised functions in the medium to long term, are able to create the critical mass. For example, NSN's R&D facility in China grew from under 500 staff to 3000 staff in just 3 years. The host locations also offer the flexibility of operations. EU MNEs in our sample looking to deal with the peaks and troughs of the business cycle was able to rapidly upscale and downscale their activities by outsourcing to local specialised technology and service providers. For example, the Continental centre in India has developed strong linkages with local suppliers of software services.

Despite this, MNEs face many challenges such as the disparity in the quality of skills, retention of key personnel, the need to invest heavily in upgrading innovation capabilities and to overcome the cultural differences. The recruitment of experienced mangers for more important roles such as to lead and manage projects, is a severe challenge across all sectors. Most MNEs try and overcome this by recruiting a growing number of expatriates (scientists in senior roles) returning home. For example, many R&D centres in China employs a similar strategy of recruiting Chinese scientists who are expatriates. However, some of the challenges are much more critical in specific sectors. The retention of skills is a greater challenge at the R&D centres in ICT, compared to Biotechnology and Auto. Whereas, it is harder to find skilled people for specific functions in Auto MNEs. The Continental R&D centre head in India found it difficult to recruit people with a good understanding of the combustion process in a cylinder of an engine, which is essential when developing car engines. According to the head of the R&D centre in India:

> *'… there is Tata and Mahindra and few others but it's not comparable to what is done in Europe or the US today. And so the number of experts for real combustion processes, exhausts, after treatment process, they are not there. So the core development is initiated in Europe or in the United States ... then our Indian team is either supporting the core development, or applying it now to Tata and other projects locally.'*

5.2.2 IPR Regime

MNEs employ many ways to overcome the threat from weaker IP protection at their R&D centres in Emerging Markets. Generally, the innovation activities that are critical for the competitiveness of the company are undertaken in-house. It is the non-core and support functions that are outsourced to specialised technology suppliers & service providers in the host locations. Furthermore, most of the local collaborative projects on emerging technology areas involve pre-competitive research. However, the weak IP regime is stalling the progress in upgrading the innovation of the R&D centre only in some cases. MNEs across sectors approach this differently depending on the extent of the threat of weak IP regime. For example, Novozymes found the retention of key skills a greater challenge than the retention of its formal and informal IP in India.

5.2.3 Public research institutes

The cooperation with universities and research institutes is regarded as an important means to access the complementary technology and resources. Despite this there are differences in the underlying

motives for collaboration across the sectors. In the ICT sector, the university links are primarily to ensure a steady supply of engineering skills. Whereas, in the case of Biotechnology the MNEs emphasise on connecting with the developments in basic research. In the Auto sector, the local linkages are mostly with suppliers (in the case of Auto manufacturers) and customers (in the case of Auto suppliers). In the ICT sector, some centres have research collaboration with premier institutes in field of computer science and networking. This is the case of Alcatel's research facility in India. Similarly, ST Microelectronics centre has dedicated laboratories at premier research institutes such as India Institute of Science (IISc) and India Institute of Technology (IIT). In Ericsson's centre in China the university collaborations involve sponsoring of research projects at the universities. Whereas, in most other cases it is to source talent as seen for Ericsson's centre in India. This is also evident in the case of Fiat centre in Brazil, where the university links are mainly for recruitment and training, joint research links is not evident. More long term and extensive research collaborations are evident in the case of Biotechnology R&D centres in China. According to the Biotechnology MNE's R&D manager in China:

> "*In addition to having access to highly educated staff and first class universities, we also find a mature biotechnology network in China, which we can use to continually enhance our advantages in the field of enzyme discovery and protein engineering*"

5.2.4 Markets and competition

For the MNEs in our sample, the emerging economies provide great market opportunities due to the high growth in domestic demand and due to the escalating income level. In order to tap into the rural and low-income market segment that are at the bottom of the pyramid, the MNEs in the business of mobile technology and services perceive immense potential in developing socially applicable applications such as emergency services, tele-medicines, e-learning, micro-finance. The development of these applications is by partnering with the domestic informal institutions who closely engages with this segment of the population. Ericsson's innovation activities in South Africa provide one of several such examples. Another driving factor is the development of local standards in these markets. The MNEs in the business of wireless and wire line technology infrastructure, finds it important to collaborate with the telecom operators and service providers. The Alcatel's Bell Labs facility in India partners closely with Alcatel-Lucent customers as they deploy new technologies such as cellular data and low-cost networking to address their most challenging problems. The Alcatel facility in China collaborates with major telecoms operators such as China Telecom and China Mobile.

However, the sales prospects in the market need to be large enough to justify the R&D activities in host locations. This is the case with Novozymes, where its R&D centres are set up only in markets with sales potential. The two Biotechnology MNEs in our sample supplies enzymes and other bio-ingredients to global players. The localisation needs of their international customers are the main reason for undertaking local R&D. It is seen that Alcatel undertakes extensive localisation at their R&D centre in China unlike in India mainly because, according to the R&D manger:

> '*India is still not a major customer for ALU, in comparison to China. Installations in India are 2G. There are teams that support the legacy installations (such as the E10 switches). Focus on India is on voice, the 3G licenses have not been given out by the Government, whereas, China is already 4G and by virtue of being a major customer also has a much bigger R&D.*'

Similarly, in the Auto sector, component suppliers such as Autoliv and Continental, established R&D centers in China mainly to be present in one of the largest automotive markets in the world, close to the growing R&D presence of major international car manufacturers in that location. This is also the driver of Bosch centre in Brazil. A number of Auto R&D centers are catering for the demand for low cost products and technologies, by undertaking localisation of existing products and technologies involving re-engineering, cheaper design implementations and other adaptations. The Autoliv facility in India plays a critical role in its overall effort to improve safety for small cars, while the Fiat centre in Brazil undertakes R&D to cater for the specific demands for the flexi-fuel and locker technologies in automobiles. The rationale was that the differential local unique demands on products, such as smaller engine for smaller cars, could not be easily met by the high specification products used in high-end cars that are available for the EU market. Further, the Auto MNE responds to demands from the local OEMs for rapid solutions to the problems encountered in production engineering. Additionally, when the centers were set up, the Indian market was of little importance to Auto component suppliers, but recently supplying the Indian OEMs has increased in importance. Hence, in Continental, certain business units have started to collaborate and to provide consultancy services to local auto manufacturers such as Mahindra and Tata.

5.3 Impact of MNE innovation strategies upon institutions in the host system of innovation

In many of our cases, the innovation strategies have impacted upon the institutional frameworks in host emerging countries, where the MNE's subsidiary innovation agenda and the strengthening of certain aspects of the host institutional frameworks have happened hand-in-hand. Though the weakness of the institutions in these host innovation system poses a constant risk to MNEs trying to increase the scale and scope of innovation activities in the Emerging Markets, the cases demonstrate their direct engagement in strengthening the institutional shortcomings. Some of the roles played by these facilities are presented in the Table II below.

Table II: Engagement at the R&D centre in order to strengthen the host institutional shortcomings

Roles Played	Benefits to the Host Institutions
Skills- Devising specialised courses at universities	Mainly to fill the gap existing in the demand and supply for appropriate skills for specialised functions in the labour market
Entrepreneurial activities such as: - technology-based spin-offs that are no longer core to the company; - option-based alliances with local specialised technology providers; - expertise offered through consultancy.	Encouraging entrepreneurial activity internally, normally transcending the company boundaries and spilling over into the market benefiting the local innovation system.

Transferring best industry practices through its outsourced relationships	Helps to strengthen and empower the local specialised technology and service providers and other actors in the host innovation system
Developing the local supplier base to cater for the MNE's local as well as global markets	This has resulted in world class and highly competitive supplier capabilities locally
Bridging role played by key personnel at these facilities	Mainly advise the government and other local stakeholders on setting up industry regulations and technology standards in emerging areas of mutual interest.

6. Conclusions

This paper draws on the insights from case studies of innovation activities of EU MNEs undertaken at their R&D subsidiaries in Emerging Markets of India, China, South Africa and Brazil. It set out to examine the dynamics in the interplay between the three dimensions determining the pace and direction of globalisation of innovation, *vis.*, the innovation strategies undertaken at MNE's R&D facilities in Emerging Markets, the host institutional factors in which the centre is embedded, and the extent of its integration in the MNE's global innovation networks. The conceptual framework developed in this paper uses a dynamic approach and takes into consideration the interactions and the resulting synergies between these dimensions over time.

Based on the new empirical evidence gathered, 5 different innovation strategies were identified in Emerging Markets depending on the innovation capabilities of the R&D centre and its market orientation, within a host institutional framework. These strategies are not mutually exclusive and lies on continuum of increasing innovation capability, wider market orientation, greater integration into the MNE's global innovation networks and local embeddedness. This enabled us to provide a good understanding of the emerging patterns and dynamics with respect to the extent of integration in global innovation networks and the local embeddeddness.

Our results show that despite the different ways in which these innovation strategies have evolved, a trend towards greater integration into the MNE's global innovation network and a greater degree of local embededdness is clearly apparent. The distinctive features across sectors, with respect to the innovations strategies of the R&D centres, the location specific institutional factors and in the characteristics of innovation networks are highlighted. By focussing on the specific factors such as human resources, IPR regime, public institutes, market and competition, this paper contributes to our understanding of the role of institutional frameworks. It shows that in Emerging Markets the R&D centre's innovation agenda and the strengthening of certain aspects of the host institutional frameworks have happened hand-in-hand.

The results of the paper have important implications for the EU MNEs and for organisations involved in the creation, use and diffusion of innovation. The globally networked nature of innovation means that it has implications for organisations from both developed and developing countries engaged in attempting to integrate the widely dispersed international innovation networks. By considering the specific comparative advantages and innovation strategies in India, China, South

Africa and Brazil, it has highlighted the policy areas that need to be addressed to strengthen the institutional framework for fostering innovation with the involvement of MNEs.

Firstly, the MNEs involved in new technology based products and processes innovation require knowledge inputs from multiple fields. It is important to mobilise both market-related inputs as well as specialised technical knowledge in order to successfully innovate. It is become evident that such new and complimentary knowledge are increasingly being sourced from Emerging Markets, residing within various informal and formal institutions in the host NIS.

Secondly, in industries characterised by compressed product life cycles and increasing speed to market, as well as in the industries facing market saturation in established economies, the high growth markets in India, China, Brazil etc. are very attractive. In these locations however, it is required to undertake innovations that are different from the innovations undertaken at home (and in established markets) to succeed in these markets. In order to undertake R&D on Emerging Markets products and technology, the institutional strengths at home locations and the existing research facilities in the Europe and the US are increasingly found to be unsuitable and out of touch with the specific knowledge requirements and the essential market feedback.

In the R&D facilities in Emerging Markets, such research can be undertaken in close interaction with the market and can facilitate frequent exchanges with the key stakeholders involved in the development of the technology and innovative solutions. Moreover, the conditions are most suitable for enabling them to simultaneously introduce the resulting innovations in all other markets if it is found relevant. The countries such as India and China combine enormous market potential with a large pool of well-qualified scientists and engineers. One specific location advantage is that it is able to provide the flexibility, which is important to undertake innovation activities efficiently and to sustain higher returns to R&D investments.

In recent years the MNEs have focussed on developing low cost products in Emerging markets as a competitive strategy rather than competing with the expensive and ill-adapted European products. The attractiveness of vast and untapped market potential combined with the presence of essential elements in the host innovation system conductive for undertaking R&D have encouraged MNEs to do applied R&D to find new technology applications and to create new market opportunities. The presence of large international suppliers and customers, premier research institutes with world-wide recognition, presence of low cost service providers, system integrators, contract research organisations, as well as the presence of specialised technology and service providers in the region have been the main factors.

Moreover, the government in these countries has recently prioritised key emerging technology areas as a means to increase the competitiveness of national industries. This provides the EU MNEs, an opportunity to contribute not just in technology development by benefiting from the public funding and support, but also in establishing appropriate industry regulations and technology standards and in strengthening the institutional framework for undertaking innovative activities in general. The latter is imperative for MNEs pursuing an Emerging Market innovation strategy as a means to have the competitive edge and to succeed in a toughening global competition.

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Part II - A: Evidence from the EU MNEs in the sectors: ICT, automotive, agro-food

Part II presents the case studies of selected EU and Southern MNEs in the three sectors: ICT, Auto and Agro-Food. It will initially delve into the MNE's important R&D locations world-wide, the rationale behind setting up the R&D/design/technical centres in host locations, and the kind of research activity performed at the HQ and those at overseas locations. Deep insights are also provided with regards to the organisational and managerial challenges in a number of areas of innovative activity of MNEs, and on the managerial process devised to efficiently manage this. It focuses on the following areas:

- *knowledge* which includes the integration of globally sourced knowledge from both within the enterprise and from external sources, the intra-organisational and external innovation collaborations, the upgrading of the technological capabilities as well as the managerial skills at its overseas locations etc;
- *organisation* which includes organisational mechanisms for the coordination of widely dispersed R&D units, how strategic control at the HQ locations versus autonomy in decision making at dispersed R&D locations is done; and
- *institutional* dynamics driving the specific R&D strategy such as the availability of skills, the centres of technology excellence, market competition, government incentives, and the quality of local institutions such as IP regulations, etc.

The evidence from the EU MNEs is presented first in Section A. The Agro-Food sector is presented first followed by the cases from ICT (Philips, Nokia Siemens Network) and Auto sector (Volvo AB and Fiat). Since the four MNEs in the Agro-Food sector are all Danish MNEs, it enabled us to undertake a comparative analysis within the realm of the Danish Agro-Food valley. Two of the MNEs interviewed in the Danish Food Sector (Company III and Company IV[5]), were rather less internationalised in terms of R&D. Hence, these MNEs are not discussed in detail. This followed by the evidence based on the Southern MNEs in Section B. It includes the insights from the two cases in the ICT sector drawn from the two MNEs based in Estonia.

[5] Not the real name of the companies.

Globalisation of innovation in Danish agro-food MNEs

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1. Introduction

The Danish Agro-Food industry is the third largest food cluster in the EU and is known as the Agro-Food Valley (European Cluster Authority, 2010; Hansen, 2009). It accounts for approximately 20% of the Danish exports, with Europe being the main destination (64%). Although this sector is generally perceived as low tech, the Danish Agro-Food industry comprises of some of the most innovative companies in Denmark. Policy initiatives for the sector include a cluster specific policy targeting areas like: enhancing the innovation in the sector, increasing competitiveness of the sector, and strengthening of organic production amongst other things. These initiatives and other regional development schemes have facilitated strong links between the firms and other supporting organizations in the cluster. As a result the firms have extensive collaborations in Denmark, both with horizontal (universities, research institutes) and vertical (supplier, customers) partners (Hansen, 2009).

However, it is seen that the public policy has mainly focused on local cluster, its elements and structure, such as the SME's local networks, the supply-chain, and on exports. The focus was not on the global research activities of the firms in the cluster[1]. Nevertheless, it is common for MNEs engaged in export activity to also engage in some adaptive innovation in host markets. There is also a high degree of vertical collaboration globally. This is because, as part of the industry tradition, where MNEs source extensively from its core suppliers in the value chain, the core supplier tends to follow the MNEs overseas in order to maintain its position as core supplier. The Danish Agro-Food Valley, thus serves as an interesting backdrop for understanding the process of globalization of innovation in MNEs in a traditional sector. This involves the analysis of the following:

- To what extent is the internationalization of R&D activities related to adapting the firm's products to new markets (e.g. enzymes for pasta has to be adapted for use in noodle production in China)?
- To what extent is internationalization of R&D an investment to tap into external knowledge sources and also to integrate new knowledge into the firm?

Theoretically, this links to the concepts of location attractiveness and exploitation and augmentation (Kuemmerle, 1999). Insights from cases were able to provide a greater understanding into the MNE R&D internationalization in this industry by examining how MNEs engage in global innovation, the rationale behind it, and the extent to which outsourcing of R&D follows the geographical patterns of their earlier outsourcing of production. In particular, it provides clarity on the R&D strategies and determinants of Agro-Food MNEs for outsourcing R&D to emerging countries in the South (China, India and South Africa). Interesting insights on international research links of the firms are also reported in the cases by examining whether innovation takes place in new types of networks.

The four cases discussed here represent two distinct types of MNEs in two segments of firms that dominate the Danish Agro-Food industry:

- Biotech related firms engaged in the production and development of ingredients, enzymes etc. for the food industry; and the
- End-market firms whose strategies relate to the expansion of market beyond the Danish and European economy.

Companies I and II are typical of firms in the biotech-related segment, the producers of ingredients who have globalised their innovation strategies over the last decade and have made inroads as significant players in the global biotech industry. They engage in basic research as well as in the development of new products and have relatively high R&D intensity compared to that for the industry in general[6]. In 2009, Company I spend over 6% of its turnover on R&D, and for Company II it was 14.3 %. Both these companies are highly innovative with a large number of patents[7]. Denmark being a small country, the limited market size is not sufficient to finance such high R&D investments. Rather, it needs a global market presence and this requires a global outlook for innovation as well.

Company III and IV are typical of the second type, the more traditional companies such as meat producers, dairy producers and breweries that have internationalized their innovation activities only to a limited extent. They focus predominantly on their production and undertakes innovation for adapting products to cater for local markets For example, Company IV is a cooperative company owned by farmers and their innovation are related to process and to marketing their products. In order to serve the host market they also focus on upgrading the local producers to become their core suppliers.

2. Internationalization of R&D in agro-food MNEs - comparative insights

The Agro-Food market is characterized by a high degree of diversity in tastes, textures, raw produce, and quality, depending on the regions. Therefore MNEs serving global markets need to engage in some development of their products specifically for the local demand, in order to use local raw materials, and to meet local standards, norms and other conditions. All 4 MNEs were engaged in product development for local markets engaging mostly with their suppliers and customers while establishing collaboration in innovation. Hence the level of internationalization of their suppliers and/or customers determines their global agenda. For instance, company II is a core supplier of ingredients to the lead players in the Food industry and hence it adapts products to the specificities in local tastes in the market of the lead firm.

The primary drivers of internationalization of R&D are however, seen to differ for the two groups. For the two MNEs (Companies I and II) involved in research and in the development of new products, the main driver of internationalization is to access scientific knowledge and to locate in centers of excellence. These MNEs also engage in research on developing new types of products with new raw materials. Therefore they need to engage with how these raw materials have been used in their locations. They also internationalize to seek supplementary skills, specialists input etc., having re-organized their R&D into 'global operations' where, the innovation projects require

[6]In Agro-Food Industry the average is approximately 2 % of turnover, Statistics Denmark 2010

[7] Company I and Company II had 39 and 62 Danish patents in the period 2004-2008 respectively, Ministry of Science and Technology 2010.

specialized inputs that are undertaken in certain R&D locations. This also includes collaboration with very specialized research institutions on codified tasks such as molecular mapping.

Thus for the MNEs in biotech-related area, the drivers for internationalization of innovation are both exploitation and exploration; however the internationalization comes with a cost of increased coordination and communication. This explains why Company III and IV are not involved in global generation of innovation. Their products are for the end-market consumers and are relatively standardized (beer and dairy). The type of innovation undertaken by these two MNEs are related to expanding the consumer group and their market position, hence internationalization relate more to setting-up production near large markets like China, to develop new varieties (e.g. functional dairy with vitamins, special beer for women), or to prolong the shelf-life of their products (packaging). For these two MNEs innovation collaboration seems to take place predominantly with universities in Denmark and involves different types of jointly funded university research.

On comparing the level of integration in global innovation networks, in order to create a typology, it is categorized into three dimensions: 'global', 'innovation' and 'network', as presented in the Table. The rational for this is that, MNEs tend to engage more or less globally; internationalize more or less innovative activities; and engage more or less in an innovation network.

Table I: Typology of Global Innovation Networks

	Global	**Innovation**	**Network**
High	World wide (G)	Exploration (Research related) (I)	Beyond the value chain (N)
Low	Denmark/Europe (g)	Exploitation (Development related) (i)	Within value chain (n)

In the table below the four case companies are listed. Capital letter indicates a 'high' in the three dimensions while lower case letter indication means 'low'. In some cases the MNE is involved in both high and low as in the case of Company I, it engages in innovation of both types: exploitation (low) as well as exploration (high). In this instance the 'i' will be a capital I. This is done in order to show the most GIN'ned parts of their networks, hence the largest letter is reported.

Table II: Cases and the typology of Global Innovation Networks

	Global (G / g)	**Innovation (I / i)**	**Network (N / n)**
Company I **GIN**	5 large R&D platforms in Europe, US, China - R&D satellite set up in South Africa	Future oriented, new to the world innovation. - 6 % of turnover into R&D	Development: customers - 10% of R&D spending outside the company (universities)
Company II **GIN**	R&D projects managed globally -10 R&D locations	Bio-tech -14 % of turnover into	Collaborations: - with firms in China, - universities in

	spanning 5 continents	R&D	Bangalore - universities in Denmark
Company III **giN**	Sample collections globally - R&D at HQ in Denmark	Marketing driven research - Focus on end-customer	University collaborations - A high number of co-sponsored professors, PhDs and post docs in Denmark
Company IV **gi/IN**	6 R&D centres in Europe	R&D is pre-dominantly market oriented - Some research into milk-genome	Public research funding University partners - 10-15% of R&D budget is spent externally

It is evident from the table that only two of these MNEs (Company I and II) engage in GINs having established long-term R&D engagement in India and China, whereas Company III and IV have internationalized their innovation activities to a limited extent and primarily within Europe. The rest of the paper will focus on the R&D Organisation, R&D Management and R&D Strategies in Company I and II, these are MNEs that have established global innovation networks.

2.1 R&D organisation in Company I and Company II

Company I

Company I is a world leader in innovation within its field, with R&D undertaken at its R&D facilities in 8 countries. 54% of employees are placed outside Denmark, and the company serves their customers in 120 countries. The core customers are lead firms within Food sector. Company I performs research into new or advanced ingredients for food production, basically to provide knowledge intensive solutions to its customer's (lead firm) problems. This includes solution for extending the shelf lives of finished food products by introducing certain ingredients to the finished product, such as the extension of the 'best before' date on bread. Therefore there is a strong need for proximity to customers in order to be able to identify potential problems and collaborate on new solutions. This is also the case when these customers engage in new markets and/or new market segments and product types. For example, in order to serve the Chinese market and Chinese customers, there is a need to do research on these projects locally.

Furthermore, in order to be able to engage with the lead firms in different markets, there is a strong need to recruit local experts within specialized segments of the food industry who can provide key inputs on location specific knowledge. As a result there is a strong incentive to establish links to local academic groups and to engage with local firms for their inputs into the innovation process: Thus Company I engage in two kinds of innovation. One is the above-mentioned development and application of enzymes and ingredients to provide solutions to their customers. The other is the

development of new products, (e.g. how to bind oil and water in food products). This later function often implies basic research – e.g. pure chemistry – and requires the skills of specialized scientists.

> '*…all good innovations cannot take place in Denmark…Practically, it is easier to talk with people in Beijing if we have researchers placed there.*'[8]

Both kinds of innovation are highly internationalized and take place in its 5 global R&D sites. However, the two kinds of innovation are organized differently. With regards to the research on new breakthrough products, each R&D projects has the participation of researcher located at all major R&D sites. This principle is primarily to ensure the ability to embrace variety. Thus a small number of researchers (less than 20%) at each of these locations are involved in this kind of work.

> '*We have strong principles for how to organize globally. We have a need to organize globally; in particular as food types and tastes are very regional products. There are huge differences and also similarities*'.

The research kind of innovation is centralized and is coordinated by a 'committee for coordinating innovation'. The Innovation Committee is responsible for collaborating with the central management team and also for allocating funds for projects at the pre-market stages of product innovation. All radical innovation has to be approved by this committee. As part of this centralization of decisions, coordination and priorities in innovation, all 5 research centers have the same structure and project management. Thus even though R&D is undertaken at 5 different R&D centers, it has a high degree of centralization in the management of these centers. Generally, there is greater decentralization when it comes to adapting the products and solutions to cater for the location specific markets

The decision on a new R&D center is based on how conducive the environment is for innovation, the presence of customers, and also on whether the company already has some production in the location and on a sound legal system. In China Company I had some difficulties due to weak IPR system. But this did not prevent it from engaging in R&D in China, instead they invented new ways of doing it. Company I acquired a small research intensive company in South Africa. This was to internalize the firm's strong competencies in the African market and know how about working with local ingredients. Firstly, their knowledge of the local market, food producers, potentially buyers, and their expertise in specialized ingredients such as yeast for low quality wheat etc, was considered vital in order to have a foothold in one of the fastest growing market. The South African firm also had developed a process of identifying customer's problems and solving them faster. This process technology is now being adopted through out Company I.

<u>Company II</u>

Company II has three different types of R&D:

> *'The formula for our success is a good balance between short-term product improvements, mid-term development of new concepts, and long-term radical innovation in our pipeline'*[9].

[8]Interview with the Global Innovation Manager at Company I.
[9] Company II, Annual Report 2009.

Based on the kind of R&D, Company II has different strategies for internationalizing R&D. It has R&D centers abroad, some of them are in Emerging Markets. Some R&D sites evolved from their existing global production network (China) while others are part of a strategy of accessing supplementary knowledge capacities new research areas (India). The latter was performed by a take-over. While in certain other instance it prefers to out sources tasks to external organizations. The main reason to establish R&D in China was related to the first type based on the fact that the use of enzymes and ingredients differ in different settings and there were many innovations regarding applying their products which could no longer be performed in Denmark. China was a priority market 15 years ago and the company was very fast in setting up a R&D facility to meet the local market requirements. Due to its long history in China, the company engages at many different levels also politically, e.g. with the authorities on the development of bio-fuel in close collaboration with two important Chinese state owned enterprises.

> *'We saw the economy booming. This was an early move compared to our competitors but we felt we needed to establish a research center as the production scaled up big-time'*[10].

Whereas, the acquisition of a local player in India relates to the second type. Company II bought the enzyme part of an Indian company, driven mainly to internalise their process technology for internal use. The Indian firm had strong research capabilities into complementary products and also patents within this area. Prior to this take-over Company II only had little production and no research in India. However, in the take-over Company II also took over 150 employees and a research facility which is now turned into a center of excellence within the supplementary product types. Hence, the India site is now a center for excellence for the global R&D operations. The acquisition also enabled the company to establish research links with local academic groups in bio-tech and local firms. This strategy was similar to the one used in the development of research activities within industrial microorganisms, a process that involved six to eight take-overs. This enabled it to enhance its global R&D operations. Company II do not outsource extensively, while production is almost totally integrated with very few exceptions, in R&D there is a slightly more outsourcing. Outsourcing is done in the case of very specialized tasks or to satisfy the need for specialized equipment not available in-house. An example is the 3D models of molecules, developed by universities in US, Korea and Europe with very specialized equipment for these specific tasks. Outsourcing is also undertaken, if it is cheaper and/or better carried out outside the company.

2.2 R&D management- mechanisms for global integration

Company I

An important tool for global integration of innovation is by developing a strong company culture and by facilitating efficient communication.

[10] Interview with the innovation manager at the Company II

> '*This culture is designed for innovation and for encouraging willingness to take risks, curiosity, freedom, trust, networks, supporting entrepreneurs, willingness to change, room for all, open mindedness, and experimenting at all level. We work to make all our employees all over the world feel part of the company. From the top management and downwards, sharing knowledge is a very high priority. We also put success stories on the intra-net to encourage people to do a little extra*'[11].

Company I utilizes advanced ICT to enhance knowledge sharing. This involves common databases, electronic laboratory journals, reports etc. It has developed two unique IT systems, one for knowledge sharing and search, and other is a competence finder. These are embedded in a Google-like search engine allowing internal researchers to explore knowledge capacities across the company platforms. Overall the company puts an effort into developing new methods for pooling knowledge and avoids duplication as much as possible. In order to in-source ideas and develop further the 'good ideas' Company I has appointed 'CreActors', who are professional consultants from within the company. Their role is to assist people anywhere in the company with a good idea and to help them develop it further. The central coordinating body, the Innovation Committee evaluates the ideas and once approved, the future development of the product becomes centrally coordinated. All projects that are of global relevance to the company are prioritized and the team for developing further a particular product consists of people with the relevant expertise located at the different sites. In the selection of locations Company I also consider the quality of local capacities outside the company such as that of the universities and research centers.

Company II

For Company II, internationalization of innovation has been a difficult process and are constantly developing methods for integration, communication, and to reduce duplication of functions at global sites. The organization of R&D in Company II is as centers of excellence within specialized areas. In addition to this there are certain application-related activities for the local and or regional markets at each site. Although, the organization of R&D into centers of excellence is to reduce duplication in R&D at its different sites, it has implications in terms of coordination.

> '*For each new research site it gets more complicated to coordinate from the head quarters. A totally new set of competencies is required from our project managers. It is a huge challenge to operate globally but I see no alternative*'[12].

The integration into its global research strategy was faster in India compared to the R&D centre in China. R&D facility in China evolved from a subsidiary for production, and though the company's engagement in China was a lot earlier (10 years) it has been integrated into the global R&D operations only recently. In India the R&D facility was an existing laboratory with supplementary competencies at the global level. Hence, this immediately became a part of the global R&D operations. As the R&D developed into physical centers of excellence it faced certain logistical problems. One example is the center of excellence in India that develops [wine and juice] products, for which the global marketing department is in Switzerland. Hence, it requires tight coordination of

[11] Interview with the Global Innovation Manager at Company I.
[12] Interview with the Management at the Company II

the R&D strategy with that of the marketing strategy. Movement and circulation of people is how Company II establishes personal networks. Researchers in different sites undertake frequent short-term visits for the purpose of getting people to know each. This makes further communication over phone or online easier.

The projects in Denmark are mostly radical innovation projects, characterized by a need to have a critical mass for early stage development. However, very few projects exclusively involve the central R&D facility in Denmark although half of the R&D personnel are located there. One example is a global project on Bio-ethanol. This is organized as a global R&D project with project members in six countries.

> '*this project team is particularly globalised as we need many specialized people that are not available from one site only*'[13].

The company also emphasises on standard reporting in R&D and has laid down priorities in facilitating mechanisms for global integration. This includes: developing new interactive forums, setting up of Innovation Office to manage front-end pipeline across businesses, a common single database covering all previous databases and local data, the Electronic laboratory notebook to record all experimental work across sites, and working platforms for teams across projects, areas and sites. Besides utilizing many communication tools, Company I also works on creating a common corporate culture. As part of this strategy, movement of people is facilitated to create a good flow in networks.

> '*we develop our employees into dedicated employees, they are Chinese at home but here we are all the same*'[14].

However, Company II still faces cultural barriers when developing a common company culture in some overseas sites.

> '*It is very difficult to export the Scandinavian model which is based on flat company structures and where decisions are taken at the level where it makes sense and rarely at the top-level, hardly any hierarchy and an informal tone. Even after decades in India and China we are still working on this*'[15].

2.3 R&D strategies - enhancing learning, knowledge integration and knowledge sharing

Company I

At Company I, 10 % of R&D spending is placed outside the company. This is mainly spent in collaboration with universities for basic research.

[13] Interview with the Management at the Company II.
[14] Interview with Manager at one of the Company II's sites in China.
[15] Interview with one Scandinavian researcher in Beijing site of Company II.

'*If we have a question say why meat is so easily spoilt, we collaborate with relevant universities to solve this*'[16].

For the development functions and for the application of ingredients to food products, the focus is more internal, and is by recruiting experts from the food industry within potential new markets. Downstream collaboration is very important as the company needs to keep up with the needs of their customers to remain a key supplier. It engages in new ways of learning and in cross-sectoral integration to exploit knowledge in other fields. One way of doing this is by engaging with actors in other areas within the Agro-Food industry. For example, the expertise obtained in natural rubber is now being developed into ingredients for tyre production. This is undertaken jointly with a global lead firm within tyres. In addition to this, the company engages increasingly in other new areas such as bio-fuel (with oil companies), and functional foods (with pharma industry, for people with cardiovascular diseases or weak bones). Company I also engage in knowledge sharing and joint product development with suppliers. One of these is within ice cream where the company has a partnership with a dairy producer and a producer of machinery. These three actors collectively provide full-package solutions for customers who want to engage in production of ice cream. This is also the case with tortillas.

For such development and application for the local markets, research project are generally organized across geographical sites. Each of the locations has experts in specific fields who frequently exchange knowledge. For example in bakery, there are bakery experts in all the regional centers and they have a strong internal professional network, where the bakery experts engage in weekly or monthly phone meetings and meet physically every year to exchange knowledge. This is the case for developing ingredients in ice cream, chocolate, yoghurt etc. Knowledge sharing is considered very important at the same time Company I place experts in almost all research areas at each site.

'*our centers of excellence are virtual centers. They include experts from across the R&D locations*'[17].

The company also tracks new technology developments in the academic research environment. Since 2004, the company offers annual awards for new breakthrough innovations within food and beverages to potential university researchers. These awards allow the company to know of new upcoming technologies and to generate strong links with interesting researchers. Likewise the company has made use of the website 'innosearch' mainly to recruit specialists in specialised fields.

Company II

According to Company II, communication is the most important way for enhancing learning and knowledge integration. Due to the recent developments in ICT, the company has decided that geography cannot be a limiting factor in their global innovation collaborations. Lots of collaboration takes place by mail, phone and via internet tools, such as the electronic laboratory log-book which allows all researchers at any site to access each other's laboratory notes at any time. There is a lot of effort on facilitating communication at all levels. Still, there are language barriers,

[16] Interview with the Global Innovation Manager at Company I.
[17] ibid

particularly in China. In addition to this, the company has had some difficulties in making contracts with Chinese players, and the salaries of researchers is seen to be higher in China than India.. In India, the company had some cultural problems as well, and introduced the 'failure of the month' award for employees who took a risk and failed. This is to emphasis that the company appreciates people taking risks for company rather than not daring to try out an opportunity because of a fear of failing.

Connectivity' is a high priority and Company II collaborates in many different environments to find specialized knowledge, small biotech companies to take over, and for collaboration opportunities with world-class research institutions. The recruitment strategies of Company II also imply integration into local research networks, often within chemical institutions and universities. This is mainly driven by the fact that it is easier to attract world-class researchers to other sites than in Denmark, due to the cultural, language and other barriers (such as the tax level - which according to the company is a major barrier). Company II finds it is much easier to attract people to their sites in US, China, Japan, India and Brazil. In India, IIT and IISc are two premier institutes in the country and Company II finds that it is easier to tap into these resources only if there is a local presence.

Table III: R&D organisation, R&D management & R&D strategies in MNEs in the agro-food sector

	Company I	**Company II**
Global R&D structure and organization	- Less than 20% of research team in the same location as the project leader. - Customer collaboration in development as problem solving and knowledge provider. - Centrally coordinated R&D, Innovation Committee.	- R&D in specialized centers of excellence. - Exploitation: developed from global production to global innovation in China. - Exploration: innovation in new fields in India by acquiring a firm. - Some outsourcing of codified tasks to experts.
Mechanisms for global integration	- Emphasis on culture, designed for innovation. - CreActors harvesting good ideas in the company. - Project teams of experts in each site.	- Effort into exporting the Scandinavian model. - Emphasis on the movement of people and communication tools.
Enhance learning and knowledge integration	- Collaborations with partners in many new areas in the sector (tyres, pharma related). - Virtual centers of excellence. - Tracking new technology developments in universities through award program.	- No geographical limitations for knowledge and learning! - Physical centers of excellence - Recruitment into new networks at new locations.

Going back to the four cases, although being among the Danish lead firms in agro-food, only two of these have engaged in global innovation networks. One explanation here could be the Danish focus on supporting cluster creation and collaboration in Denmark, hence not supported international collaboration. It is difficult for Danish companies that depend on public funding. However, IPR did not seem to be an issue.

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ICT sector

Case I: Philips

Headquartered in the Netherlands, Philips is one of the largest electronics companies in the world with sales of more than €25 billion in 2010. Europe and Emerging Markets both accounted for one-third of the company's total sales, with North America a further 28%. In terms of trends recent years have seen a strong growth in the share of emerging markets and stagnation in Europe and North America. Philips has 119,000 employees in more than 60 countries and approximately 55% are located in mature markets, 45% in emerging markets. Philips operates 3 business divisions: Healthcare, Lighting, and Consumer Lifestyle (formerly consumer electronics). In 2010 Consumer Lifestyle accounted for 35% of total sales, Healthcare 34% and Lighting 31%.

1. R&D organisation

Philips has a strong track record in introducing innovations in a wide range of areas from lamps, radio and television to medical equipment, electric shavers, and semiconductors. Further the company has a strong IP portfolio with over 130,000 patent and design rights. In 2010, the R&D investment amounted to EUR 1.6 billion (6.2% of sales). About half of the total sales are from the sale of new products (48% in 2009 and 52% in 2010). In total there are about 12,000 employed in research, out of which Corporate Technologies employs around one-third and the remaining two-thirds are employed in the three business divisions. *Corporate Technologies* is the corporate body that controls and coordinates the international research activities of Philips. It serves the corporate needs by creating '*synergy between the three sectors, extending the business of these sectors or beyond these sectors*'[18]. It contributes to the development of new markets and products and functions alongside the 3 business sectors. Its function is to leverage company-wide synergies in technology, IP, research, and competencies. It encompasses *Philips Research*, *Applied Technologies*, *IP & Standards* and *Philips incubators*.

Philips Research has over 1,500 researchers employed at 6 laboratories.[19] One of its functions is to create new technologies that support the three business divisions. Another is to develop innovations related to markets that are adjacent to these businesses by supporting technologies that address new markets in line with the strategic direction of the company. The management of Philips Research reports directly to the Global Head of Markets & Innovation. The principle location is at the HQ in Eindhoven employing 1,100 researchers. There are two other laboratories in Europe located at Hamburg (Germany) with 100 employees and Cambridge (UK) employing about 35. Outside Europe there is a laboratory in the US (located in Briarcliff) employing 125 people, another in China (Shanghai) employing 110. In India, Philips Research has about 30 employees located at the Philips Innovation Campus in Bangalore.

[18] Interview with Chief Technology Officer, Royal Philips Electronics, (April 2006 -10), 21st January, 2010.
[19] http://www.research.philips.com/locations/index.html

Philips Applied Technologies is a dedicated contract R&D organisation providing innovation services that include product development, consultancy and manufacturing support.[20] It serves the 3 business sectors of Philips as well as a range of external companies varying from start-ups to market leaders. Philips Applied Technologies has 7 locations in 6 countries, 3 of which are in Europe (Eindhoven, Germany, UK), 2 in Asia (Singapore and India) and 2 in US (Boston and San Jose).[21] It employs 850 technical and business specialists in-house with experience in applying and integrating a wide range of technologies including software, electronics, robotics, precision motion and sensors.

Corporate Technology also deals with creating new intellectual property in strategic areas and supports the development of the Philips IP portfolio. The *Philips Intellectual Property & Standards* collaborates with organizations within Philips and externally with IP offices and government bodies globally. It participates actively in the formulation of formal standards and regulations to maintain favorable conditions for market access for Philips products. Further, it has 3 business incubation units that are part of Corporate Technology.

1.1 R&D in business sectors

In terms of R&D spend, corporate research amounts to only 10% of the Group's total R&D expenditure, whereas, 44% of the total R&D spend is in the Healthcare sector, 23% in Lighting, and 23% in Consumer Lifestyle sector. Healthcare sector has a total of 22 R&D centres worldwide. In Lighting, Philips has set up 3 global R&D centres for lighting electronics, located at Eindhoven, in India and China. The Indian centre was set up in Noida in 2010 and employs 35 engineers and caters for the needs of the Indian market as well as for Asia-Pacific, Europe and North America. Many of the R&D locations house both Corporate Technologies and the 3 sectors. For example, in India at the Philips Innovation Campus, out of a total of 750 people, only 30 researchers work for the Philips Research, the remainder work in sector dedicated R&D.

> '*Not all innovations happen in corporate, new things happen in business sectors as well…three-quarters of the innovation at Philips is happening inside the 3 sectors. There are about 9000 R&D people working globally in the sectors performing all of the running and developing of products in those sectors. They have their entire product development organisation they need to do their businesses.*'[22]

[20] As of January 1, 2011, Philips Applied Technologies (Apptech) activities are re-grouped into two new organizations, Philips Innovation Services and the new Philips Research organization.

[21] http://www.sehta.co.uk/media/files/BenBroers020210.pdf

[22] Interview with Chief Technology Officer, Royal Philips Electronics, (April 2006 -10), 21st January, 2010.

2. R&D strategies and management of globally dispersed innovation activities

2.1 History

The R&D strategies at Philips have undergone major reforms over the years, reflecting the overall changes in the company. The key element of this change was a decentralisation of large parts of R&D to the divisions and business groups. At the same time corporate level research was reorganized into a network of specialised Centres of Excellence. The 6 Philips Research labs were set up in locations that enabled Philips to take advantage of the dynamic national innovation system and by leveraging their strengths these labs were able to develop specialized capabilities (*Reger, 2004*). Philips Research North America was set up in Briarcliff in 1942, to take advantage of the local presence of major companies in the pharmaceutical, biomedical technology, and healthcare, as well as that academic and government healthcare research centers. The centre is involved in global research programs in a number of areas such as Controls, Communication & Healthcare Informatics; Ultrasound, Photonics, etc. Philips Research facility in Hamburg was set up in 1957 because of the excellent scientific infrastructure for the medical industry in the region. In India, the centre in Bangalore was established in 2000 to leverage the local talent and the surrounding innovative hub for IT/electronics related developments. Philips Research UK set up in 2008, is located in the Cambridge science park in order to leverage location specific strengths in terms of scientific skills and research collaborations with some of Europe's largest consultancies and leading universities.

However the emphasis within Philips shifted from being technology-led to more market driven in the early 1990s. This was due in a large part to the growing number of autonomous divisions in global locations which made efficient transfer of research results into marketable products difficult. At the same time there was duplication of activities at the dispersed research centres. Overcoming these difficulties and intense competition pressure in the industry led Philips to a stronger market oriented strategy (*Reger, 2004*). This gave rise to initiatives such as ExperienceLab and SimplicityLabs which are focused on the consumer and driven by the need to include end-user feedback in the research on new concepts and products. The perceived benefits include faster and richer consumer feedback in the early phases of product concept development and greater product adoption.

2.2 Open innovation strategy

Currently the main focus in Philips is to pursue an open innovation strategy to access technology know-how, find new application areas, develop products and solutions, and to commercialise the technology. Currently it has around 100 strategic collaborations with major universities and research institutes. Many of the collaborations are on new areas where very little fundamental knowledge exists. As an example in the case of Magnetic Particle Imaging technology (MPI), collaborations with leading academic medical institutions, industrial partners and governments were crucial in the effective translation of the new imaging concepts into practice. Philips seeks external expertise in order to accelerate the development. An example is the technology platform for DNA/RNA molecular diagnostic testing which was developed by Corporate Technologies. In order

to leverage external expertise future developments and commercialisation of this technology is being undertaken by Biocartis, a molecular diagnostics company based at the Philips High Tech Campus in Eindhoven, with extensive experience in the field. The company also actively participates in large joint technology development projects such as the development of the Blu-ray Disc format. This required the development of the blue laser optical systems, which was jointly developed by Philips, Panasonic, Sony and TDK.

3 Upgrading of the local capabilities at the Philips Innovation Centre, India

The Philips Innovation Centre (PIC) located at Bangalore, India is a global innovation hub for the products and services specialised in software based solutions primarily serving the Philips Consumer Lifestyle and Healthcare business. Out of a total of 750 employees, majority are developing software for Healthcare products, less than 20% are developing software for Lifestyle products, and only about 5% (about 30 people) are involved in developing complete products for emerging markets. In addition to this about 30 dedicated research personnel from the Philips Research are also located here.

> '*Our competences cover the innovation chain: developing new concepts, developing prototypes and development, supported by a patent searching and filing team. Whilst software is our competence area we have extended now into mechanical and electrical. We also have taken complete product ownership for certain products targeted at the Indian market.'*[23]

It was set up in 1992 driven by the need to consolidate the company's growing number of small engineering software operations worldwide and to create a large software centre outside Eindhoven. Gradually this centre has grown to being a central player for the company as a whole by acquiring systems capabilities. The initial strategy was to provide service for other parts of the company involved in global development. Since then it has built-up extensive know-how and expertise in the software engineering and other technology domains to become an integral part of global development within Philips. Lately the centre has taken on special development projects to serve the local market. Part of the reason for this focus on the local market is that Phillips has acquired a number of companies in India in the last two years. These companies were acquired specifically to undertake the value part of the business to develop products that were simple to use and less expensive. The intention is that once such products are developed they can cater for demand in the company's other markets around the world. Currently, there are 200 projects, 90% of these involve product development. Each of these product teams report to an Innovation Manager in the business unit they work for, while the head of PIC reports directly to the Chief Technology Officer. The presence of a small group reporting directly to Corporate Technologies ensures that the developments in India feed in directly to Philips activities worldwide. A number of experienced people from the HQ work at the centre.

> '*The strategic direction of the business is set by the business team, we impact and create value by our contribution in the roadmap and project delivery. We manage the projects*

[23] Interview with Head of PIC, India.

independently but in close collaboration with other teams, as our solutions are to be integrated in the system and must delight our customers[24]*.'*

Case II Nokia Siemens Network (NSN)

Nokia Siemens Networks (NSN), with its HQ in Finland, is among the top players in the telecommunications carrier market. It is a joint venture between the Communications division of Siemens and Nokia's Network Business Group and was formed in April 2007. The company provides a portfolio of mobile, fixed and converged network infrastructure, as well as professional services. NSN has a global presence with operations in 150 countries with over 600 Communications Service Provider as. Its sales were EUR 12.6 billion in 2010. NSN recently realigned its business units into three areas: Business Solutions (BSO), Network Systems (NWS) and Global Services (GS). The NWS is hardware and solution related and BSO provides business services and GS is cross-functional and includes network implementation, consulting and systems integration, care and managed services. In the initial period following the merger, since the two parent companies came in with partially duplicate portfolios, a process of streamlining was done.

1. R&D organisation

NSN has 25 R&D centres globally[25] employing 16,000. Finland and Germany are the main locations employing over 45% of the R&D workforce. Finland has 4 R&D centres and Germany has 6 R&D centres employing 4300 and 3000 employees, respectively. In Europe, Poland is the other major location and employs 1500 people at its Wroclaw site[26]. Outside Europe, the main locations are China, India, and US. Many of NSN's R&D centres are global development centres, serving business units by providing infrastructure, people and resources. For example the centre in Poland is a global software development centre developing solutions and applications for advanced telecom equipment and networks. The Indian centre located in Bangalore is a global software development centre employing 2400 engineers. The GSM-Railway centre in Hungary is a global competence centre for railways communication solutions (800 people). The Hangzhou centre[27] in China has 1600 people mainly developing software. Many other development centres support local product development to address specific market requirements. For example the 3 centres in the US mainly serve business unit needs to cater for the US market. The laboratory in Texas, with 100 employees, drives LTE[28] development to ensure that the unique requirements of operators in North

[24] ibid

[25] Information on the R&D centre location is drawn from the interview with Head of NSN Global Development Center Management & Head of Wroclaw Development Center, Poland, 8th April, 2010

[26] Information on the number of employees at each R&D centre is drawn from the interview with Head of NSN India Development Center, Bangalore, 24th March, 2010.

[27] Information is drawn from the interview with Head of Development Center, Hangzhou, China, April, 2010.

[28] Long Term Evolution (LTE) is the next-generation mobile broadband technology and the evolutionary step from GSM, WCDMA/HSPA/HSPA+, TD-SCDMA, CDMA and WiMAX networks.

America are fully incorporated in products.The Israel development centre evolved following the acquisitions of two local companies and employs 200 people. In Greece, NSN has two Service Core and Applications centers employing 330 people.

2. R&D globalisation strategy

NSN's R&D globalization strategies largely reflect the shift in business focus, from hardware to more of a services and solutions business. Both its parent companies, Siemens and Nokia had a strong hardware business focus. Since the merger NSN has been repositioning in the value chain by expanding the scope of its product offering to include high-value service and software solutions. This is best reflected in the growth of its services business which account for 40% of NSN's revenues. With substantial experience in operating and managing multi-vendor networks, NSN currently holds second position in Services business with a global market share of 21%, behind Ericsson (39% global share). The aim of the company is to achieve the best 'value' out of locating R&D in certain locations.

> '*Value in that sense is not just cost but is considered as a value package, i.e., value in performance, innovation and cost*'[29]

NSN undertake intense research before deciding on future development locations. Usually the decision is based on mixture of innovation capability, flexibility of the workforce and legal framework in host country, as well as cost. At the same time the company monitors the R&D activities of its competitors and other companies in new locations. The location decision is also influenced by the need to have development centres near key markets but this is not an overriding factor. The key factor is to have the right people and the right knowledge for the best price.

The company has been consolidating R&D facilities globally following the merger in 2007. Most of the pre-merger facilities were mostly near the respective HQ locations and in the EU or US. Certain less strategic functions such as system testing were located in the past in smaller centres outside these regions. This has changed dramatically in recent years.

> '*The development was done in Germany and Finland before, today you can say the development is done possibly in Germany, in India and in China to almost equal parts. Let's say in a much bigger proportion than it was before……actually, it doesn't matter where we develop the technology. So even if western customers demand but eastern customers are doing and designing and developing the technology that's perfectly ok. It is the case actually more now*'[30]

This process is not one of transferring existing knowledge functions from established centres in Finland or Germany to new locations but is one of starting new activities in new locations.

> *'In our today's setup there is a certain retentive know how still in our HQ countries but usually about older technologies, for all the new technologies we start the operations not in Finland or Germany anymore but in other locations. If you have GSM technology it is*

[29] Interview with Head of NSN Global Development Center Management & Head of Wroclaw Development Center, Poland, 8th April, 2010
[30] ibid

still very heavily represented in Germany and Finland but 3G, and 4G LTE is taking over so GSM will not be required so much more in the future. So this is a natural tuning down on flow from Germany to the other side.'31

NSN's R&D strategy is focused on developing strong technology platforms and offering a wide set of applications to expand its global customer base. NSN's acquisition of Motorola's network assets (currently undergoing) is aimed to boost its customer base in the US and Japan and to improve technology platforms in CDMA technology areas. In emerging markets, NSN has been involved in the co-evolution of technology with key stakeholders and has contributed to the development of local standards, such as TD-SCDMA in China. NSN organizes new product development on a global basis to ensure diverse inputs in innovation process, vital to deliver differentiated technologies. A number of R&D centers simultaneously develop similar technologies in different locations, with each taking a lead in a specific area, such as software development in India.

'In this industry, the telecom equipment and solution cycles are very short, hence facilitating different mindsets to flow into the products and solutions is critical. It is possible to do end-to-end product/technology development in India explicitly but it is very likely that it then results in an Indian centred perspective which is possibly not fit for some other countries'[32].

2.1 Presence in emerging markets

NSN has a large presence in India and China, but the focus of R&D in two countries differs. In China, it employs a total of 3000 people at its 6 R&D centres. The large presence of NSN in China can be attributed to the role played by the company in the development of the local technology standard, TD-SCDMA. Its strategy was to collaborate with the Chinese government and other local stakeholders such as universities suppliers and users to develop a network solution for this technology[33]. The key to the success of this venture was the large pool of local engineers with right skills in an emerging area of technology. This is in contrast to the situation in India where such skilled personnel were in short supply. The NSN's R&D center in Hangzhou, China was set up in 2007 with 500 R&D employees. The R&D team was expanded in 2009 to support China's home-grown TD-LTE technology and currently has 1600 R&D employees. It is now among the company's top 3 global R&D centres and is fully integrated into its global network of LTE Centers of Competence. It has built a global facility for developing complete telecommunication infrastructure system. The centre has collaborations with leading operators in China and Europe to evaluate the performance of TD-LTE technology under differing situations. Recently, a TD-LTE Open Lab was inaugurated at the centre that will be used by major TD-LTE smart-phone and terminal manufacturers to test the interoperability and functionality of their devices across TD-LTE networks.

In India, Siemens Network Services (subsequently NSN) originally entered in 1994, to leverage on the low cost skills.

[31] ibid
[32] ibid
[33] http://us.nokiasiemensnetworks.com/news-events/press-room/press-releases/nokia-siemens-networks-drives-development-of-td-lte

'*The reason for setting up the centre was because of the Software Technology Park (STP), the cost of setting up and running a centre was negligible. It was not a strategic decision to begin with but turned out to be one as cost pressure mounted in Europe'*[34].

The facility in Bangalore was used merely as an extended workbench undertaking implementation and testing at the module level based on blueprint developed in Germany. There were 250 R&D personnel at the start and all strategic decisions were made at the HQ. More complex functions such as product architecture and integration testing did not happen as the engineers did not have the system know-how or the domain knowledge. By 2000, due to the increasing cost pressure in Europe, the projects and programs that needed large volume of staff and a quick turnaround started to be delegated to the centre. Gradually, with increased experience, the nature of work being done evolved and since the merger business and global projects are managed in India. In 2001, a decision was taken to put Bangalore on a par with other European centres. The local leadership was developed by movement of personnel with 20 people transferred to Europe to undergo training to become global managers. The centre was equipped with latest technologies to enable strong interaction with the company's other global development sites. The Bangalore centre has now grown to 2400 R&D employees and hosts one of NSN's three remote testing laboratories. Engineers at the site develop, test and deliver software to support the world's telecoms networks. Currently, about 30 Products & Solutions for the global business are undertaken at the development centre. The result has been that NSN India has increased specialisation in services portfolio like telecommunication features. The areas of expertise include: Support systems, Network systems and Business systems.

'India is one of NSN's prime locations in the development centre landscape, ….the so called growth locations…. involved in software development and integration for certain part of the components and also developing telecommunications features such as services like SMS'[35]

There has been an effort underway at NSN to consolidate network operations into global centres. NSN created the Global Network Solutions Centre at Chennai in India, a hub for company operations across the globe, offering solutions ranging from 'business consulting and network design to network delivery and integration to enable full end-to-end solution capabilities in multi-technology and multi-vendor environments"[36]. In 2008, NSN decided to shift its Global Services headquarters from Germany to India[37]. India was chosen because the managed services model within the company was pioneered in India. Moreover, the large customer base in India, allowed NSN to co-evolve the technology and solution with key customers and there were enhanced cost and scale benefits by locating here.

[34] Interview with Head of NSN India Development Center, Bangalore, 24th March, 2010.

[35] Interview with Head of NSN Global Development Center Management & Head of Wroclaw Development Center, Poland, 8th April, 2010

[36] http://www.nokiasiemensnetworks.com/portfolio/services/global-service-delivery

[37] http://www.intology.com/business-finance/nokia-siemens-planning-to-shift-head-quarters-from-munich-to-india/

3. Managing cross-border and cross-functional development tasks

The challenges posed by the co-ordination of cross functional or cross country project teams are overcome by means of well organised management processes. One such process is labelled 'Business Ownership'. For example in the case of a development project within Global Services which has contributions from India, Poland and China, the leader of the team located in India may have the business ownership. This leader provides a vision for products, customers and markets; coordinates the teams located at the other two centres; and is responsible for the overall profit/loss of the business. The business "owner" has to have program managing abilities, solution and product architecture capabilities and technical expertise, so as to be able to translate the visions into a tangible product[38]. The company also has policy for communicating its strategy with a large body of staff. 'In the first instance the top one hundred people of the company come together and discuss the direction and changes. In the next round of strategy communications, the head of each unit presents to his or her top one hundred people. This is complemented with global Web casts where the strategy and plans are presented to almost all employees very quickly. That is further cascaded down through the organization so that within three to four weeks everybody has seen the slides and the explanation that goes with them and has had their questions answered. Next they aim to link the strategy to a unit specific 18-month action plan. It helps people understand where the company is going and how they can contribute[39].

In order to address the cultural differences the company offers multicultural training and exchange of people in similar functions between locations for short periods. Thus there are a number of Chinese and Indian staff located in Poland as part of the exchange programmes. The company also promotes and facilitates interaction between people of different nationalities in telephone conferences, video conferences, and programme discussions. It promotes new technologies such as WebEx for this purpose.

38 Drawn from the interview with Head of Value-added Services (VAS), Communication & Entertainment Solutions Business, NSN, India, 21 July 2010.

[39] Interview with Herbert Merz, Head of Operations, NSN, 15 June 2009
http://www.prtm.com/strategicviewpointarticle.aspx?id=3234&langtype=1033

Auto Sector

Case I: Volvo AB

The Volvo Group headquartered in Sweden, was founded in 1927. It is one of the world's largest manufacturers of heavy-duty diesel engines and the fourth largest in construction equipment. The Volvo Group has about 90,000 employees, with production facilities in 19 countries. Sales in 2010 were SEK 264 billion. The main markets are Europe (39%), Americas (29%) and Asia (25%). The Volvo Group is organized into 9 product-related business areas[40] and similar number of supporting business units. Approximately, 70% of the employees work in business areas and 30% work in the business units[41]. Volvo Trucks is the largest business area, accounting for close to two-thirds of total sales (63%). The business units have the overall responsibility for product planning and purchasing, and also for developing and delivering components, subsystems, services and support to the Group's business areas. They are organized globally and combine expertise in key areas. This is to ensure close customer cooperation, while leveraging economies of scale by utilizing Group-wide resources in areas like product development, production, spare parts supply and logistics, and other support functions. The largest Business Units are the Volvo Powertrain, Volvo Technology Corporation, Volvo 3P, Volvo Technology Transfer and Volvo IT[42].

1. R&D organisation

The Volvo Group spent SEK 12.9 billion on R&D in 2010 (5% of sales) and this is undertaken mainly in the business units. About 50% of the R&D is performed in Sweden and the rest is undertaken in France, US, Asia, and South America. The central research activities for new products and new solutions within the Volvo Group are all undertaken at the *Volvo Technology Corportaion* (VTEC) (mainly in Europe). It is a core group constituting of 431 people who are based at 4 sites. Two of these are located at Göteborg in Sweden and the other two are located at Volvo's establishments at Lyon in France and at Greensboro in the US. The R&D for engines and transmissions is undertaken by the *Volvo Powertrain*, which are the Group's largest business unit employing 9181 people, with HQ in Sweden. Outside Sweden there are facilities in France, the US and Brazil. The facility in Hagerstown, US is the headquarters for Mack Powetrain division, while France is the headquarters for Renault powertrain division and has 3 facilities[43]. The facility in Brazil is mainly for developing engines. Further, there is a core group of about 20 to 30 people undertaking the product design for the Volvo Group, who are based at Sweden, France, US and

[40] Business Areas include Volvo Trucks, Renault Trucks, Mack Trucks, UD Trucks, Buses, Construction Equipment, Volvo Penta, Volvo Aero and Financial Services.
http://www.volvogroup.com/SiteCollectionDocuments/VGHQ/Volvo%20Group/Volvo%20Group/Presentations/Volvo_2010_eng.pdf
[41] http://www3.volvo.com/investors/finrep/ar10/ar_2010_eng.pdf
[42] Other Business Units include: Volvo Business Services, Volvo Parts and Volvo Logistics.
[43] http://www.istma-europe.com/istma-world/ISTMA_Conferencehall/uddeholm2006/Volvo%20Powertrain%20Partnership%20Program.pdf

Japan. All strategic tasks that requires specialised know how and high investments are centralised, mainly at Europe locations and some in the US and Japan[44].

> '*We have engineers specialised in developing Bench, where you would put an engine in a cell and you simulate. This requires very expensive investments and assets, we have this in Europe and so far we have no willingness to develop this in India'*[45].

The applied research and adaptation are carried out at the globally dispersed *Volvo 3Ps*, which undertakes all product development work for the Group's four truck brands. In total there are about 4000 employees working in multicultural teams at 8 3P locations who are involved in all aspects of vehicle development, such as suspension, electronics, Interior/exterior, seating etc. The largest Volvo 3P is located in Sweden employing 1300 people. 3P in France and in the US employ 800 and 700 respectively, while in Japan and India it has 600 and 500 employees, respectively. The smaller teams are located in Australia and Brazil.

2 Management of global R&D

At Volvo, the R&D is performed in such a way so as to drive synergies and 'relies on the combined expertise within the organization. By coordinating R&D initiatives as well as general processes and tools across the company, substantial economies of scale are created. Any R&D activity which is of strategic nature and that which is of interest to the Group as a whole is centrally coordinated by a global function called Group Issue Board Technology. For all research activities undertaken at the VTEC, the aim is to develop a lead in existing and future technology areas of high importance. Its customers are primarily the Volvo Group companies, but services are also provided to selected suppliers. VTEC carries out both strategic technology programs and expert functions for the Volvo Group. It also participates in national and international research programs involving universities, research institutions and other companies. The expertise at VTEC is used to drive common group initiatives in certain key expert functions such as intellectual property, standards, intelligence and Volvo Production System[46]. *Corporate Standards* is responsible for developing, producing and distributing common standards for the Volvo Group. By providing design guidelines manuals, training material and data systems for processing and searching information it also helps to implement the standards. It is also responsible for the co-ordination of the Volvo Group's external standardization activities[47]. *Corporate Patents* supports the Group's Business Areas and Business Units in areas like patents, design IP, infringements, licensing etc. *Corporate Intelligence* offer technology and business intelligence research services to the Group's Business Areas and BU and are located in Göteborg, Sweden. VTEC's technology-related expertise is organized into five departments[48].

[44] for Mack in the US and for UD Trucks in Japan
[45] Interview with VP, PD Asian Cooperations 3P Volvo, 2nd April , 2010
[46] http://www.volvogroup.com/group/global/en-gb/volvo%20group/our%20companies/volvotechnologycorporation/expert_functions/corporate_standards/Pages/corporate_standards.aspx.
[47] ibid
[48] The 5 departments include: Energy Conversion & Physics; Mechatronics and Software; Transport, Information & Communication; Technical Infrastructure; and the Humans, Systems & Structures.

As part of the Group's strategy focused on creating synergies and economy of scale, it has developed common engine platforms. This is undertaken by the *Volvo Powertrain* which is responsible for the development and production of heavy engines, gearboxes and drive shafts that constitute the 'driveline', often described as the heart of a vehicle. The driveline is designed so that they can be adapted to a large number of applications for most of the Group's products. This ensures competitive product offering for the entire Volvo Group brands, by allowing for application engineering, customer adaptation and brand distinction and uniqueness, based on common architecture and shared technology[49]. It is thus able to address some of the strongest driver of the development of drivelines, i.e., customer requirements and preferences, as well as new legislation with stricter emissions requirements. According to the Volvo Group these platforms 'fulfill the latest environmental requirements- a more focused research and development program, more efficient production and a more focused supplier structure'[50].

The Volvo 3Ps is involved in Product planning, Product range management, Product development (including Global Engineering and Global Vehicle Development) and Purchasing for the Group's truck operations. It was formed in 2001 following the acquisition of Mack and Renault Trucks. It is organised as a project-driven organization. Functions such as project management, application and adaptation to the markets etc. are undertaken in most sites. At the same time there are also certain specific activities that are concentrated in order to ensure greater efficiency. For example in electronics they have a specialised hardware development unit that cater for all the Business Areas at Volvo.

There is also a separate Business Unit dedicated to manage Complex IT systems at the Volvo Group, *Volvo IT* employs 5,326 people with expertise in product lifecycle management, SAP solutions and IT operation. It delivers solutions for industrial and commercial process within and outside the Group.

Volvo also seeks long term external partners for mutually beneficial projects. As an example, the Academic Partner Program was launched globally in 2009 for research cooperation with selected universities. The Volvo Technology Transfer, a Business Unit within the Group is a project-driven organization focusing on creating value by developing and supporting new businesses that have relevance for the Volvo Group. It firstly, brings the Volvo group closer to new technologies or new services, further it invests in companies and projects of technical and commercial interests. It also supports the development of entrepreneurship and innovation.

3 Presence in emerging markets

The Volvo R&D facilities in emerging markets of India and Brazil are basically the Volvo 3P Business Units. The India facility has about 500 employees and in Brazil it is less than 100 employees. The product development undertaken at these locations are based on the product designs for specific brands developed by the Group's dedicated core design group. For example, the 3P

[49] http://www.volvogroup.com/SiteCollectionDocuments/VGHQ/Volvo%20Group/Investors/Calendar%20and%20presentations/2010/Investor%20Day%20in%20Sk%C3%B6vde%20June%2022/100622%20PK%20CMD%20Sk%C3%B6vde.pdf

[50] http://www.volvogroup.com/group/global/en-gb/volvo%20group/our%20companies/volvopowertrain/Pages/volvo_powertrain.aspx

team in India has recently started developing products for the emerging markets, based on the product designs created by the core design group in Japan. Similarly, in Brazil, there is a small group of about 150 people undertaking some product development for the local market. This group is located at the large factory set up many years ago as part of Volvo's strategy to develop trucks locally, since there was a low cost advantage in Brazil. The product development is undertaken in close consultation with the dedicated group based in the US. The centre located in Bangalore, India is one of the Volvo 3Ps supporting the truck, construction equipment and bus business. 75% of the work force is involved in engineering aspects and the product development amounts to 25%. Out of the 500 people employed at the centre, 120 are involved in electrical and electronics aspects of engineering. The primary reason to set up in Bangalore was because of the quality of engineering skills available at a good price. Lately the growing market is also a factor influencing the nature of activity and responsibility passed down.

> '*We made analysis to decide between India and China and based on this we decided to set up 3P in Bangalore. From cost point of view it was not very different for India and China, other main reasons like the English level is much better compared to China helped…t o keep the secrecy about what you are doing was better possible in India*.'[51]

Further, Volvo finds the ecosystem in Bangalore to be an advantage and has formed strong links with local consulting companies such as Mindtree, Geometric and Indian MNEs (Wipro). These companies help with software development and verification. The centre is starting out to establish collaboration with Indian Institute of Science, and with other Auto MNEs to share best practices.

The process of moving up the value chain has been a gradual one. The India centre was started in 1998 with about 20 people. The work from 1998-2001 was primarily focused on localization of Volvo FM. From 2001-2004, the focus was on emerging market sourcing development. The idea was to be there in Bangalore to develop the local sourcing, to look for suppliers which were able to provide better solutions to Europe and Japan. Product development was still not a big part of the centre's agenda. Since 2005, it has focused on engineering outsourcing in the region, where non-strategic routine support functions were initially offshored as a low cost strategy, requiring a heavy dependency on the Swedish team. The main objective was to reduce the engineering costs.

> '*Instead of having expensive consultants in Europe, because we were paying 800 or 1000 consultants in a year roughly. Instead of using this if we had our own base in India, i.e., people employed by Volvo it is much less expensive. So market was not the reason, it was to be in local country for the local engineering skills. It started with electrical and electronic aspects, and for this we found that very high skilled people were available in Bangalore. We have extended to mechanical engineering*'[52].

The 3P in India continues to undertake these two functions that were set out in the beginning, additionally there is effort to develop for the emerging markets.

> *'….we added developing local products for emerging markets, low cost products. So we have another interest in localisation in India, not only to have better cost on engineering but also to have locally the capacity for development in the markets for trucks. It is a new development*

[51] Interview with VP, PD Asian Cooperations 3P Volvo, 2nd April , 2010
[52] ibid

and we have engineering and purchasing working together but we are also adding other project management and all which is necessary to achieve this possibility.'[53]

The centre is an autonomous unit (within Volvo's broad guidelines) and the Head has a capex approval of EUR 1 million. It has a matrix reporting structure where the individual teams have dual reporting, to the India centre head and to the respective departments like vehicle architecture, electrical & electronics engineering, etc. Corporate standards and common operational routines are followed and if there is a requirement, it is adapted to suit local needs. Several leaders and technologists from other parts of Volvo often visit the centre to enable a cross-fertilization and transfer of ideas and knowledge.

Case II: Fiat

The Fiat Group is the largest private industrial enterprise in Italy. It designs and produces automobiles, trucks and machines for the agriculture and industrial sectors, engines, transmissions and components. The group has 188 production plants and more than 190 thousand employees worldwide. The revenue in 2009 was EUR 50.1 billion, realized in the following geographical areas: 25% in home country, 35% in Europe, 20% in the Mercosur area, 10% in North America and 10% in the rest of the world (mainly Asia). The Fiat Group is composed of four operative sectors: Automobiles, Industrial vehicles, Agricultural and construction machines, Components and production systems.

1 R&D organisation

Fiat undertakes R&D activities at the R&D centers of its various organizations constituting the Fiat Group (Fiat Research Centre (CRF), Elasis, etc) and at its various 'Style centers'. Fiat Group has 117 R&D centers in total, some of which are more research focused, while others are more development focused. There are 48 R&D centers located in the home country, 33 in other regions in Europe, 15 in North America, 10 in Mercosur, and 11 in rest of the world., In total there are 14,000 employees in R&D with an annual R&D spend of 1.69 billion euros (in 2009). The core group of 800 research staff are based at the CRF, a large and independent research centre at the Fiat Group that was set up around 35 years ago. It is the driving force for research and innovation within Fiat. It has ten technology focus areas and basically do research on engines, vehicles, electronic systems, production processes, technical-managerial methodologies etc. All this is done entirely at its different HQ locations. Elasis employs 1200 researchers and focus on advanced engineering. It was founded in late 1980s and was later integrated into CRF.

The research undertaken at the centre is not curiosity-driven, but problem-driven, where the innovation is not purely theoretical but has a market implication and is economically sustainable. In general, CRF apply the basic research undertaken by the universities to the product and process

[53] ibid

needs of the automotive sector, and are a sort of link between them and the industrial world. The main objective is to tailor the research to the specific needs of the industry and to accelerate the transfer of knowledge and the product development. When it comes to the designing of concept for new vehicles, all of this is undertaken at Fiat's 9 'Style centers'.

2. R&D location strategic drivers

In general, the core technologies (e.g. common-rail or multi-air) and design concepts are primarily carried out in the home country, where the researchers and engineers develop core technologies and products which have global relevance and are later spread worldwide. At the same time it is seen that some specific applications are developed elsewhere, for example at the Brazilian R&D centre. There is great emphasis throughout the Fiat group on the importance and need to have common platforms to be used with different brands and different types of vehicles. The strategic importance of the use of common technological platforms is one factor why development like that of the common rail, multi-air, environmental friendly cars etc., is carried out in the home country. The main reason why CRF implements such activities in HQ locations is that they require high investments costs, which many in the industry may not be willing to undertake. The CRF instead are able to raise funds from the public (mainly European) initiatives and make substantial own investments to develop new products. For example, the idea behind the development of multi-air technology was not considered interesting at first; yet CRF succeeded in testing its validity and to patent it.

The strategies driving the internationalisation of Fiat R&D activities take into account two factors, the closeness to the markets and to access the competencies and knowledge existing locally. The local centers are generally focused on the customization of basic technologies to the specific needs of their market. For example, the specific conditions of the street pavement in Brazil require a different kind of suspension. Locating in close proximity to the key market such as USA, China and Brazil is important to solve the specific problems encountered in each of these markets efficiently, to address these needs markets faster, and also to ease the knowledge transfer. The use of common technological platforms and the modular product development facilitate this to a great extent.

Fiat group strategy in China shows that strong IP protection in local markets is not the main drivers for R&D localisation in emerging countries, rather several other factors in local markets are more important. Even though the degree of IP protection is weaker, the opportunity to explore new high growth markets in emerging countries compared to the smaller home market was a key factor. Further, even though China has started investing in research in the areas like nanotechnologies, and is implementing initiatives to facilitate knowledge transfer from the foreign R&D FDIs, it still lacks skilled human resources and competences. In such instances, IP protection is not considered a problem.

In the case of one of Fiat group's subsidiary, with an R&D spend of 245 million Euros (in 2009), the R&D is undertaken at its 10 R&D locations worldwide, mainly doing R&D on high-technology systems and components for different divisions (automotive lighting, powertrain, electronic systems, exhaust systems, etc.). R&D on basic products is primarily undertaken at the main two centres in home country and the technologies and products for special and low volumes vehicles, info-telematics for urban mobility etc. is done at another location at home. Whereas, the R&D centres in the US, China, India and Brazil basically do product development for the local market

and provide support to client. There are 3 R&D centres in Germany and one in France again involved in providing support to the clients. Thus the kind of R&D activities outside home country is different compared to the activities carried at home.

One other Fiat subsidiary dealing with research, development and production of engines and transmission systems has 13 R&D centres. Here most technologies which potentially can be used worldwide are developed centrally because of the huge investments requirements. Its main research coordination centre is at its main location at home and is part of the CRF, undertaking the design of prototypes of engines and test on engines. In addition to this, it has 6 other centers in the home country. Three of these undertake research on the diesel and gasoline automotive engines, and in truck engines. The centre for high-performance gasoline engines and the centre for small gasoline engines are at two other HQ locations. The centre in France undertakes R&D in power generation and the one in Switzerland carries out test on components, heavy-duty engines, their combustion systems and engine controls.

But its R&D centres outside Europe is seen to be involved in responding to local needs. Its centre in China is the centre for the large gasoline and diesel engines, basically responding to the local demand. The centre in Brazil is for diesel engine and powertrain for trucks and agriculture, tailored to the South American market place. Its centre in the US also caters for the local needs, implementing special assignments for its agricultural and machinery demands.

The different international research centers are seen to have evolved in different ways. In one of the home country locations the R&D centre evolved from a plant previously devoted only to production, while, the R&D centre in Switzerland was a result of the acquisition of a Swiss company by the Fiat Group, mainly for their strengths in the development of heavy duty and diesel engines. In Brazil the R&D centre developed along with Fiat group's expansion in Brazil. Similarly, the R&D centre for engine propulsors created in China, specifically to address the needs of that specific market have grown in size in response to the increasing demand of the Chinese marketplace.

It is seen that some of the local centers have developed the capabilities to undertake research and to develop new technologies and components. For example, one of its centers in the US is focused on electronic technologies and has developed strong capabilities in that field. In the case of Brazil, the Fiat R&D centre dealing with bio-fuels was placed in that country because of the existence both of a special need and because of the know-how on that technology. This centre collaborates on a regular basis with the University of Mina Gerais which is highly specialized in bio-fuel technologies and has patented new technologies in that field. Another Fiat subsidiary in Brazil developed the flex-fuel engine by taking advantage of the external linkages and from the spillovers from local knowledge sources. The degree of collaboration with the local universities is largely determined by the level and quality of local competencies and the presence of a good education system in offering highly trained human resources. At Fiat, the innovative technologies once developed are patented in the country where it has been developed (usually in HQ, but it can be also in other countries, even the emerging ones), and is then spread and transferred worldwide, if needed.

3. Management of global R&D

The Central Committee is in charge of taking the strategic decisions for the whole group. It is a core group consisting of Fiat Group's director and other key personnel such as the managing directors, the technical head of the product development, engines etc. The central level strategic decisions such as on how to transfer the technologies between different centers is done through a system of agreements and delegations, and the decisions on specific technology development is by considering the core capabilities at a particular location. Decisions are not only top-down. Local centers are free to propose new products and test their feasibility and are able to get financial resources in order to carry out the experiments and tests. Depending on the size of the local centre and that of the market, and on the strategies which Fiat wants to pursue there, some of centers outside the home country are either centrally controlled and coordinated by CRF divisions or given greater autonomy. Usually, the larger the investments, the more centralised the governance tend to be.

CRF have an intermediate role between the Central Committee and the R&D centers, and coordinate the R&D activities of the Group. CRF has a matrix organization constituting of ten technological areas, aggregated in 3 divisions (engines, innovative technologies and vehicles), and 6 well defined staff areas such as for research promotion, research networks, technology transfer etc. which plays a critical role in maintaining CRF's independence and strategic importance within the Fiat group. In fact, CRF is one of the few examples of an independent centre with a leading role within the automotive sector.

Among the various staff functions, the Research Promotion function has strategic importance. Firstly it facilitates CRF's participation in publicly-funded research programs. The CRF's internal orders and assignments come to only 50% of its turnover. The rest is from external sources which is by pursuing external revenues through participation in publicly-funded national and European research programs, and from the transfer of technical services (catering mainly for SMEs). The Research Promotion function is also in charge of identifying the organizational strategy and plan for the research transfer process (from the product development to the final clients). In order to reach the final objective of satisfying the client's needs, CRF's researches are often required to integrate know-how and competences from different technological areas. At certain times, this is accompanied by the transfer of human resources as well, to ensure a complete and efficient technology transfer to the customer.

CRF also play a central role in creating and activating international research networks. CRF collaborates with more than 1500 partners, including universities (in Brazil, Canada, Poland, Serbia), research centers and other companies. It has participated in close to 560 projects that are mainly financed by the European Commission. In many cases it has collaborated with competitors on early-stage research on technology that are of common interest. It is strongly linked to the leading University in Turin. Fiat has been financing the university degree on motor vehicle engineering over a long period in order to guarantee that the new generations of engineers have the competencies needed by the company. CRF was able to leverage wider global networks from its contacts at the University at Turin, and develop new forms of global collaboration.

3.1 Effective integration of the R&D activities

In general, Fiat aims not to have any duplication of functions across its 117 R&D centers, and this is always taken into account when a new centre is created or when new activities are assigned. In this way it is ensured that there is collaboration amongst centers to share relevant expertise and that there is no competition among centers for funds. For example, the objective of the integration of Elasis into CRF in 2006-07 was to avoid the duplication of functions. Similarly, the Fiat Group's materials labs is a department within CRF, that was put together by concentrating the activities at four labs that were dealing with R&D in materials and nanotechnologies. It is a coordinating centre and one of its objectives is to reduce the research costs by creating synergies and reducing duplication of functions. The aim is to extend such network to all Fiat's labs, in order to exploit the synergies and the local specificities.

Cost savings is achieved through the implementation of economies of scope. The use of common procedures, shared components and same platform for different models, etc. are sort in order to attain cost efficiency in engineering, development and related functions. A high degree of horizontal integration and unification of competences at all levels is evidenced such as for the Product Engineering area. The unification in the development of different types of engines and components is achieved by the creation of three specialized product platforms: one for gasoline engines, the second for diesel engines and the third for transmissions. The Product Engineering area uses common drawings and procedures worldwide, in order to simplify specific actions and to be more effective. Finer detail such as ensuring all engineering reports and drawings are in English, is basically to have wider understanding and acceptance. In certain circumstances, a second language (like Chinese or Russian) is also used. All design work is carried out with the most modern tools and more than 500 computer aided design (CAD) stations are employed to facilitate internal dialogue and streamline communication with external customers. An integrated marketing, engineering and style approach is also used in order to offer the customer differentiated products. Thus the unification of processes and technologies is considered to be crucial in bringing cost saving and for speeding the time-to-market.

3.2 Effective communication and knowledge transfer

Fiat has the shortest time-to-market in the automotive sector, it takes only 15 months to progress from the prototype stage to the final product. The reduction of the time-to-market is ensured by effective communication and knowledge transfer, and is also a strategy to better address the customer needs and preferences, and thus to reduce the risks. The management of knowledge flows globally is facilitated by virtual platforms and by the effective use of ICT such as video conferences, Product Lifecycle Management (PLM) software and internet websites dedicated to specific projects, allowing the engineers to work simultaneously on common design tools. The main problem with integrating the knowledge from far locations such as China pertains to the culture and the specificities of market, rather than the language. In brief, ICT and English are the languages used to unify the knowledge flow. Physical co-location and transfer of engineers for short periods in both directions (from HQ to external centers and from abroad to HQ) is still considered one of the best ways to transfer knowledge. Even within the same country, job rotation is sometimes done to guarantee an exchange of knowledge and the transfer of capabilities within the Group.

Part II – B: International innovation strategies in two Southern MNEs in the ICT sector - insights from Estonia

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This part of the discussion draws on the insights from case study of two Southern MNEs from the ICT sector based in Estonia: Skype Technologies and Elcoteq and focuses on their international innovation strategies.

1. Skype Technologies

The rapid spread of the Internet and the development of the underlying communications technologies, have brought about major technological disruptions in the telecom industry since the 1990s. The provision of data communication services, which until early 1990s was a minor side business for the major telecomm operators, became, in less than a decade, a major business. For example, for broadband Internet access, the international communications are now virtually free of charge as there is no billing per minute. Furthermore, the bandwidth of the today's consumer Internet access channels exceeds on most occasions the bandwidth of the voice channels in digital (mobile) telephone networks[54]. The above technological change paved the way for a major disruption in the whole telecommunications industry, since it became feasible to route otherwise costly telephone calls over the Internet, where international communications are virtually free of charge and no traditional billing per minute of use applies. The Voice over Internet Protocol (VoIP) in mid-1990s is a disruptive technology that benefits enormously from the continued advent of the Internet communications infrastructure, and carries an ongoing potential for changing drastically the whole telecom industry. Skype is a VoIP software application that allows one to talk to anyone else on the Internet free of charge. It also allows calls to be routed to 'old school' telephone network for a modest fee.

1.1 The establishment of Skype

Skype was founded in 2003 by a Swedish and a Danish entrepreneur. Skype's software development team was from the very beginning located in Tallinn, Estonia, which became immediately its largest office in terms of the number of staff. The first beta version of Skype released in August 2003 enabled computer-to-computer voice calls. This very first software attracted 1 million registered users in only a matter of months. Subsequently, additional services

[54]The bandwidth of the voice channel in the GSM mobile telephone network is 9.6 Kbps. Fixed line digital telephone networks allocate 64 kbps for voice channels. The bandwidth of the usual end-user Internet access is at the same time between a few hundred Kbps and a few Mbps.

(text chat, SkypeOut and SkypeIn calls to and from regular telephones, video calls, etc.) and support for additional devices (Apple Mac, Linux, special Skype Phones and Skype application for various smartphones) appeared.

Skype was not the first service to enter the VoIP market, but its ease of use, and the possibility of (multiparty) video calls, along with the free service, differentiated Skype from both other traditional and VoIP telephone services. This in combination with a hugely scalable peer-to-peer architecture and clever marketing made it an instant success. Skype, which offered initially only voice calls, has also differentiated itself increasingly from the competition by offering video and multi-party conference calls. Video capable software for Microsoft Windows was introduced in 2008. The Android and iPhone software introduced in 2009 included video functionality. Skype was also the first to utilise networked flat screen TV-s, which have started to include built-in Skype software since 2010. Skype had already 75 million registered users by 2005. As of 2011, Skype has more than 560 million registered users. The "cross-border traffic routed by Skype, by far the largest provider of Internet-based voice communications, is projected to grow by 45 billion minutes in 2010, more than twice the volume added by all of the world's phone companies, combined" (Figure I). Furthermore, 40 percent of Skype calls are video calls (Skype 2010, Tuaw 2011).

Figure 1: The international long-distance calls and Skype traffic 2005-2010

Source: Telegeography 2011

1.2 Evolution of Skype corporate structure

Skype has become truly global not only in terms of its customer base, but also in terms of the location of its business functions during the last five years. As noted above, it was the combination of the experienced Scandinavian start-up managers and Estonian engineering talent that were at the core of Skype's immediate success. Soon, as Skype was seeking to attract international venture capital and to get closer to major marketing channels, the corporate headquarters were established in Luxembourg and an office was also set up in London. Although the HQ was in Luxembourg, Tallinn and London remained the largest offices, and critical decision-making continued to take place in these two offices.

In Q4 2005, eBay purchased Skype for approximately 2.5 billion U.S. dollars (eBay 2005). In connection with this deal, a Skype office was also set up in the United States, close to eBay's headquarters. The Skype office in the United States continued to operate as the marketing, sales and support office, servicing the Americas. More recently, general management of the *Skype4Business* business line was also moved to the U.S., as the Americas are globally the largest market for enterprise communications, and some of the Skype's strategic partners for this business line, e.g., Avaya, are located there. Smaller Skype offices emerged in Singapore and Hong Kong., which were in charge of the marketing, sales and support in Asia. Nevertheless, maintaining close contacts with the manufacturers of the increasing variety of different Skype enabled devices, including flat screen TVs, in Asia was an even more important function.

However, eBay itself was not able to build major synergies between its main business line and Skype, even though PayPal, another eBay firm, proved a good payment partner for Skype. Furthermore in 2008, a legal dispute emerged between Skype and its original founders over the rights to Skype's underlying peer-to-peer communications technology. This contributed to the lessening of eBay's interest in Skype even further. Eventually, in November 2009, eBay sold 70% of Skype to a consortium comprising Silver Lake Partners, CPPIB, Andreessen Horowitz, and the original Scandinavian founders, valuing the business at 2.75 billion dollars. Less than a year later, in August 2010, Skype filed with the SEC for listing on the NASDAQ stock exchange, where it sought to raise up to 100 million dollars in an initial public offering (Skype 2010). These plans were, however, cancelled, as Skype and Microsoft entered into a definitive agreement in spring 2011, whereby Microsoft will acquire Skype for 8.5 billion dollars. Once approval is received from the regulators, Skype will become a new business division of Microsoft. It is quite obvious, even though no public information exists in this relation, that Microsoft was willing to pay a very high price for Skype both in order to secure its late entry into the very rapidly growing VoIP market as well as to avoid the further strengthening of the other dominant firms in this market, such as, e.g., Google and Facebook.

Figure 2: The location of Skype sites

Source: Skype, October 2010

1.3 Interplay between Business Dynamics and Skype's Innovation Activities

Skype has been, typically for a venture capital backed start-up, essentially from its birth in an aggressive growth phase, and the availability of suitably qualified labour has been one of its important concerns. Initially Skype hired engineers and other personnel, e.g. for localisation and support functions, etc., rather aggressively in Estonia. However, as it emerged that no more suitably qualified labour was available in Estonia, a second engineering centre was established in Prague in 2007.

Overall, Skype continued to recruit its personnel internationally, indicating quite often for an open position two or three key locations where the newly enrolled person could start working. This has led to Skype's rather unique management model, where the various multidisciplinary teams operate indeed in most cases within Skype but on a trans-country basis. For example, the Prague engineering centre operates today largely as a satellite of the primary engineering centre in Tallinn The Prague-based developers report to the team leaders who typically are located in Estonia. It is also quite common for the product managers and other mid-level managers who are in charge of development to be located part- or even full-time outside Estonia, for example in London or elsewhere.

Skype has acquired talents rather aggressively by acquiring other smaller firms that have the personnel with the required capabilities, and by relocating, the persons concerned to one of its offices. The purchase of the Norwegian start-up Sonorit Holding AS, a provider of voice technology for the Internet, in April 2006 is an example of the flexibility companies like Skype exhibit in attracting the very top talents[55]. The main motivation behind this acquisition was the knowledge and talent regarding audio-video *codecs*[56] and regarding VoIP systems more broadly. As the acquired company itself did not yet even have an office in Norway, an office was set up for them in Stockholm, the closest possible location to the engineering centre in Tallinn. Nowadays, in this Skype Stockholm office some of the most advanced audio-video R&D in Europe takes place. Given the deep specialisation and the knowledge pool that is available in this Skype unit, a close exchange of information also takes place there with different research institutes and universities across the globe. "Skype currently employs 850 staff, with most of its engineers in Estonia, though its disparate operations include a Luxembourg headquarters, marketing operations in London and audio-visual engineering in Stockholm. [The Skype CEO] Mr Bates said he plans to hire up to 400 new staff this year, with 80 per cent of these in Silicon Valley" (FT 2011). The newly established engineering facility in Palo Alto, California, will specialise primarily on development for the Apple IOS and Google Android mobile computing platforms, for which engineering personnel is more easily available on the western coast of the United States as compared to Europe.

[55] In early 2011, Skype acquired another well-known Internet video communications firm Qik, in order to reinforce Skype's video functionality even further.

[56] A codec is a specialised software (or device), which is capable of encoding and/or decoding a signal or a digital data stream. Audio and video codecs that are discussed here are responsible for encoding the analog audio and video signals into a digital data stream and decoding these in the receiving end pack into a voice and video that a human being can understand.

2. Elcoteq

2.1 The establishment of Elcoteq

Elcoteq[57] was founded as Lohja Microelectronics in 1984 to support the Lohja Corporation's (Finland) development and production of electroluminescent displays. However, this business did not develop as initially hoped, and some free capacity became available in Lohja Microelectronics. Meanwhile, Nokia Mobira in Finland and Ericsson in Sweden at that time had both developed their first Nordic Mobile Telephony (NMT) telephones and were looking for additional manufacturing expertise since the full-scale production was held back by their small components assembly capacity. This led to Lohja Microelectronics becoming an electronics manufacturing service (EMS) provider, with Nokia and Ericsson as its largest customers in the early 1990s (Elcoteq 2010a). In 1990, in preparation for a merger with another Finnish industrial conglomerate, Wärtsilä, Lohja Corporation restructured itself and registered its different business operations as separate companies. Microelectronics was renamed Elcoteq. Metra corporation, which emerged as the result of the merger, did not however consider microelectronics to be its core business, and Elcoteq went through a management buy-out in 1991. This was the beginning of Elcoteq as an independent enterprise with both Nokia and Ericsson as its key customers.

2.2 The first steps in the internationalisation of Elcoteq

In the early 1990s, the Swedish and Finnish entrepreneurs were the first to invest in Estonia. Elcoteq started pilot production in Estonia in 1992, and formally established a subsidiary in Estonia in 1993. This was Elcoteq's very first subsidiary abroad. Although initially various Asian countries had been considered as a potential location, a better alternative was eventually found closer to home in Tallinn. One of the Elcoteq Tallinn's veterans has described the creative destruction that took place in the early 1990s with the following words: "*It was a productive time, the industry had collapsed and the town was full of unemployed engineers*." The newly employed engineers were initially sent for training to Finland or Sweden. Later on, training was increasingly organised in Estonia.[58]

In 1996, Elcoteq Tallinn started to operate as the repair centre for GSM mobile telephones[59]. In the following year, volume production of GSM mobile telephones was initiated, and Elcoteq became the very first EMS business that started to 'box build' mobile phones for a major brand name from start to finish. The fact that Ericsson had subcontracted the whole production of its Ericsson 628

[57] Hereinafter 'Elcoteq' refers to the Elcoteq corporation globally, and 'Elcoteq Tallinn' refers to the particular subsidiary established in Estonia.

[58] When Estonian independence was restored in 1991, its economy was in a poor state. So was the economy of the whole former USSR. Therefore, both for political and economic reasons, Estonia began immediately to reorient its economy to western markets, which had both greater purchasing power and growth prospects. However, as became evident very soon, the majority of the electronics industry that Estonia had inherited was not competitive on western markets, and was therefore forced to close down (Tiits 2006). As a result of this, experienced workforce for the electronics industry was readily available in Estonia in the early 1990s.

[59] GSM is widely a used acronym for the Global System for Mobile Communications, originally Groupe Spécial Mobile, standard, which is used in digital cellular networks.

mobile telephones brought Elcoteq to a completely new level of collaboration with its clients. Most notably, Nokia soon followed suit. What followed can be characterised as a true co-evolution of the major brand names and Elcoteq as an EMS that was an integral part of their value chain. By the late 1990s, Elcoteq was producing mobile handsets in Estonia for two market leaders of the time.[60] This was a prosperous time both for the Nordic mobile telephone producers and the EMS businesses that were working with them. The European mobile telephony market was booming and production and sales volumes went up very rapidly. This is also very vividly reflected in both the Nordic and Estonian foreign trade statistics. In Estonia, telecommunication equipment had reached up to 20% of the manufactured exports by the turn of the century. In this period, most of the production technologies and components were imported and virtually all of the produced goods were exported. The share of local content other than labour remained virtually nonexistent. Hence, not surprisingly, the value added generated in the Estonian electronics industry also remained significantly lower than that in traditional industries, e.g., wood processing, etc. (Tiits et al 2006).

2.3 The globalisation of Elcoteq

In the late 1990s, Elcoteq also started to expand internationally, as increasingly it made sense to locate manufacturing activities close to the rapidly growing consumer markets. The need to serve the key customers – Nokia and Ericsson – at their new markets was the main driver of Elcoteq's very rapid globalisation. To finance the expansion, Elcoteq's shares were floated on the Helsinki Stock Exchange in 1997. Initially, a new manufacturing site was established in Hungary, and one office was established in the United States. An office was also established in Hong Kong for managing the manufacturing activities that were located in southern China. In effect, within two short years Elcoteq became a truly global corporation. By the end of 1999, Elcoteq's network of plants covered more than ten countries in the three fastest growing regions of the world: Europe, America and Asia.

The business model and the *modus operandi* that were originally adopted in Finland and Estonia provided a good starting point, but needed adapting for Hungary, Russia, Germany, Mexico and China. Elcoteq's Finnish and Estonian business development and engineering staff were therefore actively involved in the establishment of the new sites elsewhere in the world, and in training the local staff. Also, through these experiences, a well-documented system was established in Elcoteq for transferring any specific production line from one site to another. As opposed to some other multinational corporations, the individual units within Elcoteq continue to rely on uniform standardised technologies and processes even today.

The NASDAQ crisis brought about consolidation and global restructuring in the whole ICT and electronics industry from 2001 onwards. The large-scale manufacturing of consumer electronics, including mobile telephones shifted increasingly to the low-cost locations close to the final markets. For example, Ericsson, as the part of streamlining its value chains, moved the manufacturing of its mobile telephones from Elcoteq Tallinn to St. Petersburg (Russia). Furthermore, a number of mergers and acquisitions took place between ICT enterprises. The establishment of Sony Ericsson Mobile Communications company and the subsequent sale of Ericsson's own mobile telephone manufacturing plants to a competitor was, further to the general market downturn, another major

[60] Both Nokia and Ericsson were clients of the Finnish EMS firm Elcoteq already since the mid-1980s; and Elcoteq had manufactured mobile telephone circuit boards for Ericsson already for a number of years.

blow for Elcoteq (Elcoteq 2010a). Despite the above, in Tallinn (and in other sites) the manufacturing of Ericsson mobile network equipment and Nokia telephones continues for the time being.

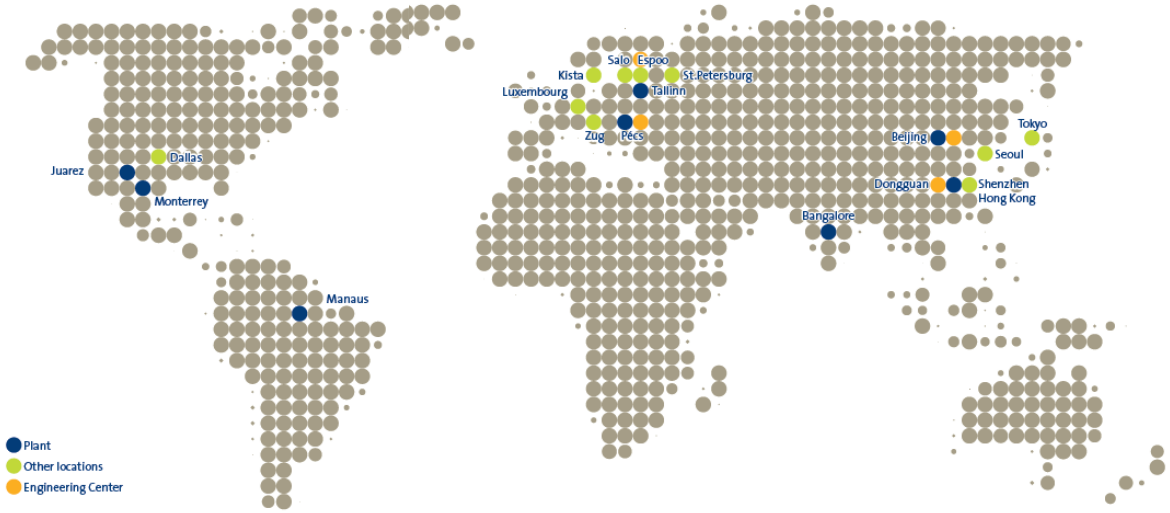
2.4 Interplay between the industry dynamics and Elcoteq's innovation activities

Initially, Elcoteq engineering centre, which is in charge of prototype testing and new product introduction, was located in Finland. In 2000, a new engineering centre was established in Tallinn, Estonia. In 2002 one more engineering centre was established in Beijing, China. To strengthen its engineering capabilities even further, Elcoteq bought the R&D unit of the Finnish mobile telephone and telematics company Benefon in 2002 (Elcoteq 2010a). In the 2000s, Elcoteq had to adjust to a weaker demand and a general slowdown in the ICT industry. It was acknowledged that manufacturing activities alone would not be sufficient for sustaining profit margins in the changed market environment. Consequently, Elcoteq started to further its own design, R&D, engineering and after-sales services. Special New Product Introduction (NPI) centres were established within Elcoteq to strengthen the co-operation with clients and their design houses in testing prototypes and making preparations for actual production.

Although Elcoteq had all the capabilities for designing mobile telephones, and even developed at one point in time one handset for Ericsson, it did not challenge its main customers in R&D and product development, but remained a contract manufacturer. The competition continued to intensify in the EMS business on all fronts in the 2000s. For example, Nokia started to source some of its printed circuit boards from Foxconn (Hon Hai) and GKI in Asia, and handled the manufacturing all together in-house in Brazil. In the mid-2000s, Nokia continued to streamline its supplier network, and gave a preference to larger vertically integrated suppliers such as the Foxconn and BYD. As a result Elcoteq was eventually forced to downsize significantly its Nokia handset business (Seppälä, 2010). Elcoteq started therefore to capitalise increasingly on its telecommunications equipment manufacturing competences by manufacturing, later in the 2000s, to an even broader set of clients. Along with this, new plants were also inaugurated in Bangalore (India) and St. Petersburg (Russia) in 2005. In the same year Elcoteq was reincorporated as a European Company (SE) and the regional headquarters was established in Budapest (Hungary) for managing European operations. Furthermore, the domicile of the company was transferred from Lohja to Luxembourg in 2008.

The recent global financial and economic crisis brought about another restructuring of the Elcoteq global network. During 2009 the factories in Arad (Romania), Richardson (US) and St. Petersburg (Russia) were closed down. The factory in Shenzhen was consolidated into the factory in Beijing in China. Part of the Elcoteq Tallinn plant, which earlier served Ericsson, was sold to Ericsson. With this transaction, some 1200 employees of Elcoteq Tallinn moved also to Ericsson (Elcoteq Annual Report, 2009). After this transaction, Ericsson continues to produce 4G (LTE) mobile network equipment in Tallinn, for which TeliaSonera in Sweden is one of Ericsson's most important customers. In response to the above, Elcoteq has extended its client portfolio and continues to operate its EMS business on a global scale (**Errore. L'origine riferimento non è stata trovata.**).

Figure 3: The location of Elcoteq sites



Source: Elcoteq Annual Report 2009

It continues to produce both mobile handsets and infrastructure systems. On a global scale, almost all major telecommunications equipment producers, including Nokia, Samsung, LG, Motorola, Sony Ericsson, Huawei, etc., continue to be Elcoteq's clients. Further to this, Elcoteq has established itself also in the production of flat screen TVs. (Elcoteq, 2010b). In Europe, the plant located in Hungary is Elcoteq's main mass production plant, while Elcoteq Tallinn with its approximately 300 staff continues to cater for smaller niche markets.

Despite this Elcoteq still continues to be a fairly small electronics manufacturing service provider when compared to other global players. Elcoteq revenues were 1500 million euros in 2009 (Elcoteq, 2010b). The revenues of Foxconn and Flextronix – the largest contract manufacturing companies in the world – were, however, 21 and 15 times larger in the same year. Elcoteq continues to focus on the technologically and organisationally more demanding small and medium scale manufacturing rather than large scale mass production, where the big competitors have an advantage.

3. Comparative insights from the two cases

Based on the insights it is evident that Skype's very rapid globalisation experience has been, for the most part, about securing access to talents, marketing channels, strategic partners and venture capital that have collectively allowed this firm to become such a success story. One could argue that Skype's success story can be attributed to its international management and start-up financing, which came together at the right point in time, vis-à-vis the disruption the VoIP technologies brought to the telecommunications industry. The world class management and the strong venture capital backing also allowed Skype to select the right global spots for its different activities, overcoming the weaknesses (or institutional voids) in its initial key locations in Estonia and Sweden. Skype itself has become in the course of time a truly global and very closely integrated innovation network. Furthermore, as the number of different software and hardware platforms that

Skype seeks to support has continued to increase, Skype has also started to open up its platform for selected third-party developers, e.g., flat screen TV or car manufacturers or similar. Skype has, thus, also become a central co-ordinating node of an even broader network of software developers and hardware manufacturers who are developing the Skype client software or the various devices that support the Skype communications platform.

The insights from the Elcoteq case on the other hand suggests that in the course of recent decades, business and innovation co-operation has become increasingly close and intense between the design houses that are responsible for product development and the electronics manufacturing service providers. The intensity of R&D activities of the different firms involved in telecommunications equipment manufacturing continues, nonetheless, to vary very significantly. Also, there is an increasingly strong hierarchy emerging in the industry. The major brand names, e.g., Ericsson, Nokia, Apple, etc., are the firms that orchestrate the global innovation and production networks, which include the whole product life cycle from product development, marketing and sales, to after-sales services and support activities.

In this division of labour, the major brand names, as well as semiconductor designers and manufacturers, are responsible for the vast majority of the R&D investments in the telecommunications equipment manufacturing industry. The electronics manufacturing service providers, like Elcoteq, co-operate very closely with the design houses that are responsible for product development, but they do little R&D[61] themselves. The EMS firms' R&D and innovative activities are primarily related to the development of the manufacturing processes and the various specialised testing equipment needed.

[61] Elcoteq's research and development costs were approximately 0.9 million euros, or 0.06% of net sales in 2009 (Elcoteq 2010b); and 3.2 million euros, or 0.3 percent of net sales in in 2010 (Elcoteq 2011).

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Conclusions

The growth in global R&D alliances and the surge in FDI in R&D in the emerging economies are changing the characteristics of internationalisation of R&D which was previously confined largely within developed economies like EU, US and Japan. This has attracted considerable attention among policy makers (*OECD, 2008; UNCTAD, 2006; TIFAC, 2005*) and academics alike. In the light of this, our study is motivated in an attempt to provide a better understanding of the phenomena based on insights from new empirical evidence using both a MNE head quarter perspective, as well as their R&D subsidiary perspective.

Based on the insights from the cases it can be said that the recent surge in interests in the phenomena can be attributed to three important trends. Firstly, increasingly new products are seen to embody multiple technologies. Its wider application and at the same time novel combination of existing technologies is vital in order to recoup the escalating cost of R&D. Secondly, due to compressed product life cycle and greater risks involved and uncertainty about the outcome of R&D, increasing the speed to market and flexibility have become critical factors for MNEs involved in technology platform development in order to stay ahead of competition. Thirdly, the emergence of new economic powerhouse, such as India, China, Brazil etc., as the most preferred destination to conduct R&D at low cost and the enormous market potential that is largely untapped in these emerging markets. As a result, MNEs are seen to be attracted to these locations not due to localisation requirement alone, but by adopting a distributed innovation approach to R&D it enables them to keep a lid on R&D cost and to access wide sources of knowledge. This is due to host supply factors like access to talent at low cost and tapping into local knowledge centres etc. and due to demand factors like proximity to large growing markets, (*Kuemmerle, 1999; Pearce, 1999; von Zedtwitz and Gassmann, 2002; von Zedtwitz, 2004*). It also enables MNEs to focus on core research and strategic matters at corporate HQ.

The general trend where MNEs are pursuing emerging market strategies and rapidly setting up R&D centres there, does not suggest that there is a relocation of R&D from Europe to other markets. Based on our evidence from ICT, Auto and Agro-Food MNEs in the EU, it is seen that the strategic R&D that requires specialised know how and high investments are centralised, mainly at HQ locations, some in European location outside the HQ and in the US, whereas the applied research and application, and engineering are dispersed and are located near their important markets. But this is not in any way substituting for the R&D undertaken in the Europe. Rather the globalization of innovation is due to the distributed nature of scientific and technical knowledge, to allow MNEs to become embedded in regional innovation hubs and to be present in some of the most important markets. The cases presented the rationales for locating in specific regions and provided the various R&D strategies pursued in order to implement it.

From our evidence it can be concluded that MNE's R&D internationalisation is driven by various pull and push factors that are both external as well as internal (within the MNEs). The external location specific advantages include the presence of specialised suppliers, the technical expertise in the region, the unique knowledge inflow from the market that is indispensable for innovation in order to enable greater responsiveness etc. The industry characteristics such as the extent of the fragmentation of the value chain and vertical specialisation, as well as the extent of advanced technology utilised to ensure flexibility in the innovation process, are certain other factors explaining dispersion of the MNE's innovation process. R&D internationalisation is also driven by the internal factors such as need to increase R&D productivity, and the need to ensure greater returns from R&D investments, in order to stay competitive.

It also confirms that the dual imperatives of global integration and local responsiveness are becoming more critical than ever before (*Bartlett & Ghoshal 1989).* Specifically, in emerging markets, localisation is a precondition and the extent of local responsiveness is higher for foreign R&D centres. To balance the global integration of R&D with the local responsiveness at the subsidiary level, there are well structured mechanisms for system-wide coordination and market-specific differentiation. The use of advance technologies and systems that allow for the codification of knowledge to promote its dissemination is seen to be crucial and so is the interaction of individuals within organisation (*Criscuolo and Narula 2007*). Mechanisms such as creation of common culture, convergence towards the same set of values, etc. also facilitated efficient technology transfer (*Gupta and Govindarajan 2000*). Cross-borders research projects, short-term visits and training, rotation of key personnel, and several others are used for cross-functional integration. The creation of mixed teams from different parts of the company and sending several people from different functional units to each R&D sites were some of the important mode of knowledge transfer. Several tools and routines were developed by MNEs to avoid duplication and to facilitate synergies across the geographically distributed sites. The use of technology platforms and physical meetings, networks etc. The transfer of both technological and market-related knowledge is important in a rapidly integrating global economy.

Our evidence shows that multiple strategies are seen to feature in the MNE's R&D internationalisation driven by competence and technology enhancing motives, as well as by the market. Externalisation of R&D is an important element of the R&D internationalisation strategy, where it serves multiple purposes. Examples include partnering with universities globally on basic and fundamental research, and outsourcing of non-core development and support functions to specialised technology suppliers and service providers overseas as a cost-effective strategy. It also involved the in-licensing and acquisition of external technological assets to develop differentiated innovative products and to cater for the local market (examples are provided in each of the 6 cases discussed below). Externalisation of R&D also involved out-licensing and the option of spin-off ventures by MNEs to help develop and commercialise technology outside its core area, where it participates in option-based alliances globally.

Another R&D internalisation strategy is to develop low-cost products and solutions. In order to develop low cost products that are price sensitive, stripping down the functionality to basic minimum level and providing low-end features alone cannot achieve this. This is done to some extent, but it is more the case where this is achieved by cheaper design implementations that are very different from that in high-end markets in advanced countries. Moreover, these low cost products do not compromise on quality. For example, the safety in a small car or two wheeler, minimum speed of the processor, fuel efficiency in small engines, food safety measures in developing food ingredients etc are all still relevant. Interesting aspect is that the technology developed locally as a result if found relevant are increasingly used in global products and adopted in the whole organisation. Our evidence showed that MNEs acquired local companies specifically, to develop the economic versions in order to expand its product portfolio and to develop affordable technologies to capture the low-end market. MNEs also emphasise on upgrading the local in-house capabilities to take full responsibility for the local development, because of the greater potential for commercial advantage from the marketing of cheaper products. This also involved identifying the under-developed market with potential and growing new markets for existing products/technologies. Other strategies include developing local purchasing and sourcing as an inroad to important high-growth markets as in the case of Volvo, and undertaking the development of standardised products/technologies in leading markets which can be later rolled out globally as in the case of NSN.

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