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Barriers to Innovation in SMEs: Can the Internationalization of R&D Mitigate Their Effects?

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Barriers to Innovation in SMEs: Can the Internationalization of R&D Mitigate Their Effects?

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ABSTRACT

Technological advancements, especially in Information and Communication Technologies (ICT) have enhanced greatly the competition spurred by the globalization of the world economies. Even small and medium-sized enterprises (SMEs) are no more immune to the challenges that the globalization brings about. It is a remarkable, and in certain instances worrisome, situation since SMEs play a key-role in most economies, in that they constitute the largest business block and provide the bulk of employment.

However, opportunities presented by the globalization and the entwined, simultaneous pressure to innovate opens for SMEs new arenas to engage in what we may call are "global innovation" activities so as to gain, retain, and further strengthen the competitive position. This pressure to go for global innovation is enhanced by given socio-demographic factors, e.g. shortage of skilled labour, in many industrialized countries.

This paper presents the findings of a survey by the authors carried out in the Metropolitan Region of Hamburg in Germany to identify barriers to innovation in selected industries and to work out solutions. The project "RIS-Hamburg" was initiated by the State Ministry of Economic and Labour Affairs in Hamburg and co-financed by the European Union (EU). The findings of this survey are here matched against perceived opportunities and challenges presented by global innovation.

KEYWORDS: Barriers to Innovation, Globalization of Innovation, Internationalization of R&D, Research & Development, Small and Medium-sized Enterprises (SME)

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1 - Introduction

Technological advancements, especially in Information and Communication Technologies (ICT) have enhanced greatly the competition spurred by the globalization of the world economies. Even small and medium-sized enterprises (SMEs) are no more immune to the challenges that the globalization brings about. It is a remarkable, and in certain instances worrisome, situation since SMEs play a key-role in most economies, including in Germany, in that they constitute the largest business block and provide the bulk of employment.

Innovative ideas and products are becoming increasingly important to counter the price-oriented competition from low-cost producers from emerging economies, on home turf and abroad (Tiwari et al., 2007). On this crucial score, however, SMEs often find themselves confronted with a number of barriers to innovation, e.g. resource constraints, which hinder their capacity to invent and successfully commercialize new products, services or processes, see e.g. Herstatt et al. (2007b).

Opportunities presented by the globalization and the entwined, simultaneous pressure to innovate, opens for firms, also for SMEs, new arenas to engage in what we may call are “global innovation” activities so as to gain, retain, and further strengthen the competitive position. This pressure to go for global innovation is enhanced by given socio-demographic factors, e.g. shortage of skilled labour, in many industrialized countries.

This paper presents the findings of a survey by the authors carried out in the Metropolitan Region of Hamburg in Germany to identify barriers to innovation in selected industries and to work out solutions. The project “RIS-Hamburg” was initiated by the State Ministry of Economic and Labour Affairs in Hamburg and co-financed by the European Union (EU). The findings of this survey are here matched against perceived opportunities and challenges presented by global innovation.

The paper is structured on the following lines: After this brief introduction in Chapter 1, the terms innovation and SMEs are defined and their relation to each other established in Chapter 2. Chapter 3 presents the findings of the “RIS-Hamburg” survey, and gives a brief overview over previous and post-survey studies. Chapter 4 introduces the concept of global innovation and how it may be used as an instrument to mitigate the effects of innovation barriers in SMEs. Challenges associated with the chances of global innovation are discussed in Chapter 5. Chapter 6 entails general implications and research outlook. The final chapter (7) contains a brief summary.

2 - Innovation and SMEs

This chapter defines the terminological base for this paper and establishes the need for innovation in SMEs, while elaborating the crucial role that SMEs play in the economy.

2.1 Innovation

Innovation, according to Rogers (2003), is “an idea, practice, or object that is perceived as new by an individual or other unit of adoption”. This “newness” need not necessarily involve “new” knowledge thereby effectively implying that the “newness” may also concern

advancement or modification of existing knowledge. For the purpose of this paper, we may regard innovation as invention and commercialization of new (or betterment of existing) products, processes and/or services (Tiwari, 2007).

Innovations usually do not take place in a given, static environment. They are rather a result of a dynamic process in an organisation that involves interplay of several internal and external factors. Research and Development (R&D) constitutes a major – though not exclusive – part of the "innovation process". According to Verworn et al. (2000/2006) it encompasses several systematic steps such as requirement analysis, idea generation, idea evaluation, project planning, product development, product testing, and product marketing. The individual steps may overlap each other and may be categorized into 3 broad phases, which represent a simplified innovation process.

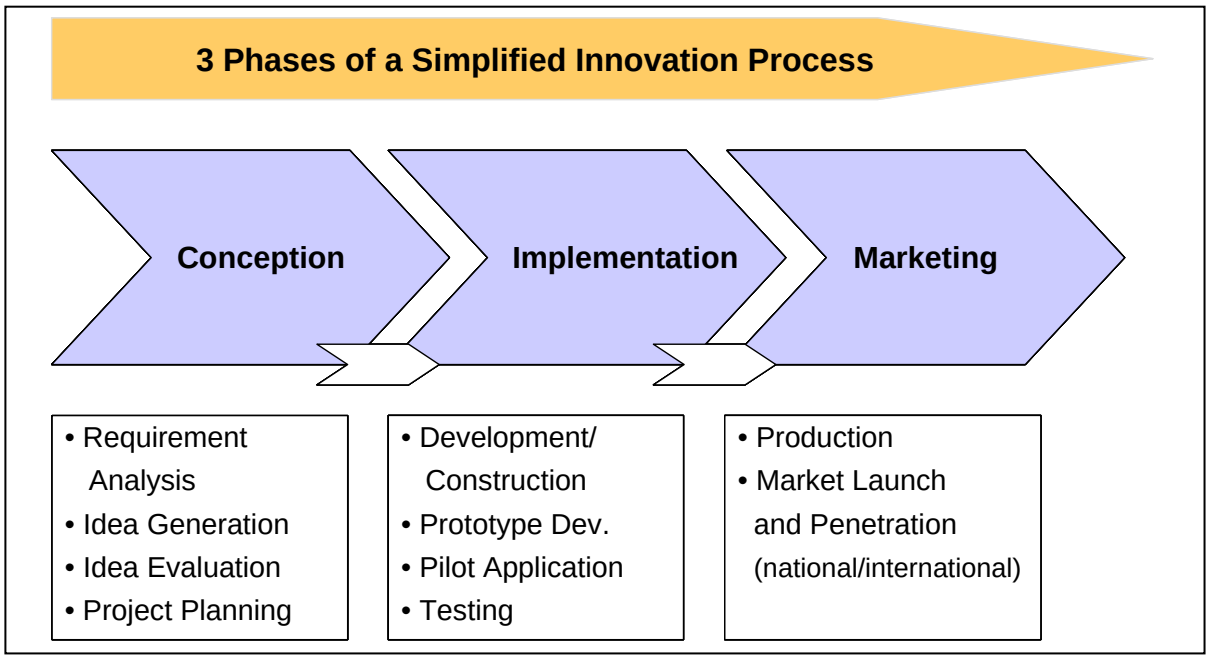

Figure 1: Three Phases of a Simplified Innovation Process

2.2 Small and Medium-sized Enterprises (SMEs)

The term "small and medium-sized enterprises" (SMEs) consists of two components: The first component "small and medium-sized" relates to the size of an entity while the second component "enterprise" relates to the economic nature of that entity. An enterprise, as defined by the European Commission (EC) in Article 1 of its recommendation on "definition of micro, small and medium-sized enterprises", may be understood as "any entity engaged in economic activity, irrespective of its legal form" (EC, 2003a). As far as the size-component is concerned, there is no single, universally accepted definition of what constitutes the "right", numerically measurable size of a SME. Two somewhat differing schools of thought have in the past gained prominence:

The renowned, Bonn-based *Institut für Mittelstandsforschung* (IfM) defines SMEs as firms that employ less than 500 workers and whose annual turn-over does not exceed 50 million euros (IfM, 2007a).

In a differing approach the European Commission defines SMEs as “enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million”, subject to certain additional conditions regarding the ownership structure (EC, 2003a). This paper – unless specified otherwise – works with the EC definition primarily since this definition has been adopted by most of the member countries of the EU including Germany thereby building the basis for most public policies and support programmes meant for SMEs in Germany and the EU.

Notwithstanding the difference in their nuances both the definitions inherently imply that SMEs have lesser human and financial resources at their disposal than large firms. Contrasted against some large corporate houses that generate billions of euros in annual sales and employ hundreds of thousands of workers, SMEs are *per definition* equipped with much lesser resources. This implication is also supported in the academic literature relating to SMEs; see e.g. Herstatt et al. (2001). This resource constraint exists even though SMEs play an important role in the national economy as discussed in the following.

According to a report by the European Commission there existed in 2003 some 23 million SMEs which represented 99% of all enterprises in the enlarged European Union of 25 countries while providing around 75 million jobs (EC, 2003b). In Germany, according to IfM Bonn[1], SMEs accounted for 99.7% of all enterprises in year 2005 and provided employment to 70.9% of all employed persons in 2006 (IfM, 2007b). In absolute terms German SMEs provided employment and/or apprenticeship to 20.42 million people in 2006 in the country. Nearly 83% of all apprenticeship placements in 2006 were offered by SMEs, which amounted to 1.36 million (IfM, 2007b).

Recent calculations by the authors of this paper, based on Germany’s official “statistics portal” data, show that the high percentage of SMEs amongst all enterprises continues to remain high. As on 31.12.2006 large firms (with 250 employees or more) constituted a miniscule 0.33% of all enterprises. Of 3,215,238 enterprises active on the aforementioned date an overwhelming 3,204,519 were SMEs (with less than 250 employees).[2] These data exemplarily demonstrate the key-role which SMEs play in Germany’s economy. For detailed discussions on SMEs’ role in the German economy see Hamer (1997), Bundestag (2002), Günterberg and Kayser (2004), and IdW (2004).

2.3 Connecting SMEs to Innovation

Notwithstanding their large share in all enterprises and the overall employment generated, SMEs in Germany continue to remain week on the revenue front when compared with their large counterparts: For instance only 39.1% of the total turn-over generated by all enterprises in Germany in 2005 went into SMEs’ account (IfM, 2007b).

At the same time, the increasing globalization is bringing in more competition in the home market, the traditional stronghold of many SMEs. In Germany as well as in many other EU member countries SMEs usually operate under high overhead costs, such as labour costs, and find themselves faced with tough price-oriented competition from low-cost producers from emerging economies in Asia and Eastern Europe.

[1] IfM Bonn works with a definition of SMEs that differs from the official definition.
[2] Definition criteria such as annual turn-over or balance sheet total have not been taken into account here.

However, as Adam Smith concluded in his treatise on the “wealth of nations”, published over 230 years back in 1776, blocking international competition is not a solution to such problems (Smith, 1994). For the increased competition is ultimately beneficial for the consumer in the form of cheaper and/or better goods and services. “Consumption is the sole end purpose of all production;” observed Smith, “and the interest of the producer ought to be attended to, only so far as it may be necessary for promoting that of the consumer” (Smith, 1994). Moreover, blocking foreign firms from doing business in the country may lead to trade retaliations abroad that could severally affect an export-oriented economy like that of Germany.

Besides, the globalization does not bring in only challenges but also presents an opportunity to internationalize sales in new, rapidly growing markets and thereby to generate additional revenues. New markets however (may) also require products and services which are adapted to the local needs and tastes of those markets.

Providing innovative products with enhanced utility may help firms strengthen their competitive position in home as well as international markets. This necessitates innovation efforts to bring new and/or better products into the market while developing organizational and manufacturing processes that enable more efficient and cost-effective production, distribution and after-sales services; see e.g. Dangayach et al. (2005) and Spielkamp & Rammer (2006). Figure 2 shows a “goal model” for innovation activities in SMEs. This model may be referred to as a “BCF model for innovation”, (BCF = better, cheaper and faster).

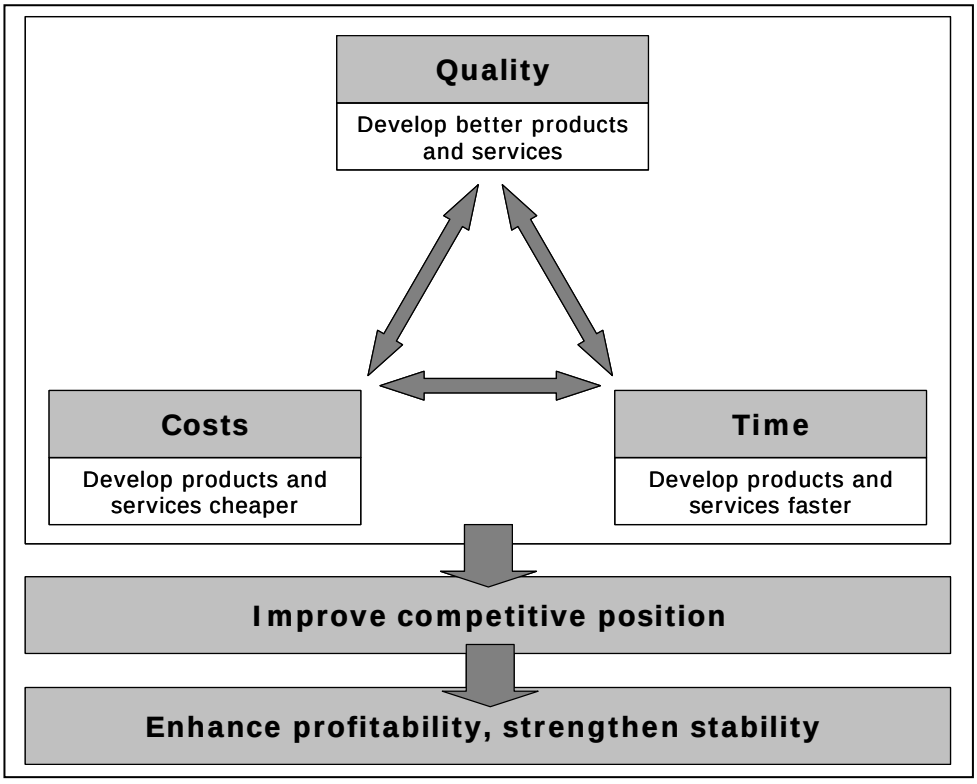

Figure 2: The “BCF” Model for Innovation in SMEs

SMEs frequently operate in niches and have direct contact to customers thereby potentially gaining valuable impulses in the form of customer feedback. Acting often in a

more informal manner and confronted with fewer intra-firm hierarchy levels than large firms, SMEs seem to be, in many respects, better placed for innovations than their large counterparts. This potential edge, in normal course, should enable them to develop products better suited to market demands and thus bring more success.

In practice, however, the resource constraints coupled with market uncertainties (and a few other factors) limit the ability of SMEs to indulge in dedicated R&D and to experiment with the purpose of new product development, as demonstrated by many studies, some of which are discussed in the next section.

3 - Barriers to Innovation in German SMEs

In this chapter the findings of various studies dealing with barriers to innovation in SMEs are discussed. Starting with an overview of previous international surveys the main focus will be on our own survey "RIS-Hamburg" which investigated barriers to innovation in SMEs of the Metropolitan Region of Hamburg in Germany. Finally we present the latest results of recently published studies / reports in this field.

3.1 Previous Studies

Barriers to innovation in SMEs have been the object of investigation in a large body of national and international studies. A few are mentioned here: Acs and Audretsch (1990) worked on this topic in the US, Ylinenpää (1998) in Sweden, while Mohnen and Rosa (1999) as well as Baldwin and Gellatly (2004) researched on them in Canada. In Germany the Centre for European Economic Research (ZEW), has conducted several studies in recent years (e.g. ZEW and DIW, 2004), Rammer et al. (2005), and Rammer et al. (2006). Further studies dealing with the German situation have been conducted by the Friedrich Ebert Stiftung (2004), and Hamburg Institute of International Economics (HWWA, 2004).

Comparing the findings of the aforementioned surveys it would not be an unreasonable assumption that SMEs in the respective countries or regions are often facing similar barriers to innovation. The most dominant problems are listed below in Table 1.

Barriers to innovation in SMEs	Studies (amongst others)
Financial bottlenecks - hindered access to external finance, - high innovation costs (and therefore) - high economic risks	Acs and Audretsch (1990), Baldwin and Gellatly (2004), Rammer et al. (2006)
Shortage of and hindered access to qualified personnel	Ylinenpää (1998), FES (2004), Rammer et al. (2005), Rammer et al. (2006)
Limited internal know-how to manage the innovation process effectively and efficiently (e.g. missing project management know-how)	Mohnen and Rosa (1999), Rammer et al. (2005), BMBF (2006)
Missing market know-how - to meet customer's needs - to enter foreign markets	Ylinenpää (1998), Friedrich Ebert Stiftung (2004), HWWA (2004)

Bureaucratic hurdles - long administrative procedures - restrictive laws and regulations	Acs and Audretsch (1990), HWWA (2004), Rammer et al. (2006), BMBF (2006)
Lack of intellectual property rights	Baldwin and Gellatly (2004), BMBF (2006)

Table 1: Previous studies on barriers to innovation in SMEs

To analyze whether SMEs in Hamburg are facing similar barriers to innovation as firms elsewhere in Germany and other developed economies we conducted a new set of investigation. The methodology and selected results of this study are explained in the following.

3.2 Findings of the Survey "RIS-Hamburg"

To identify barriers to innovation in SMEs in the Metropolitan Region of Hamburg we at first conducted an empirical study in form of an online questionnaire. Parts of the structure and content of this survey were based on questionnaires which were used in the studies mentioned in section 3.1 and complemented with our own ideas.

A modularized questionnaire was developed with questions regarding to the "early phases" (fuzzy front-end) of innovation, project management, internationalization activities, cooperation and technology transfer, management of intellectual property rights (IPRs), marketing, bureaucratic hurdles, and financial constraints. The conceptualization process and the literature review part may be consulted in Herstatt et al. (2007b). The complete results of the survey are contained in Herstatt et al. (2007a).

According to the specifications of the State Ministry of Economic and Labour Affairs ("*Behörde für Wirtschaft und Arbeit*") in Hamburg, which initiated this study, the survey targeted mainly SMEs from the fields of IT, Media, Civil Aviation, Electronics, Machinery Manufacturing, Maritime Economy, Medical Equipments, Logistics, and Services sector. To reduce the time needed to fill out the questionnaire, respondents could choose to answer only questions from modules which, in their opinion, were relevant for their individual firm. To achieve a high participation rate the survey was further more advertised through different measures, e.g. references in the monthly newsletters of involved cluster managers and promotions via diverse online intermediaries, e.g. newsletters of industry associations.

Despite multiple promotions and reminding activities only 131 respondents filled out the questionnaire, out of which the answers of only 70 could be analyzed. The rest was rejected because of containing incomplete and/or contradictory data. Figure 3 shows the representation of the industry sectors in the sample.

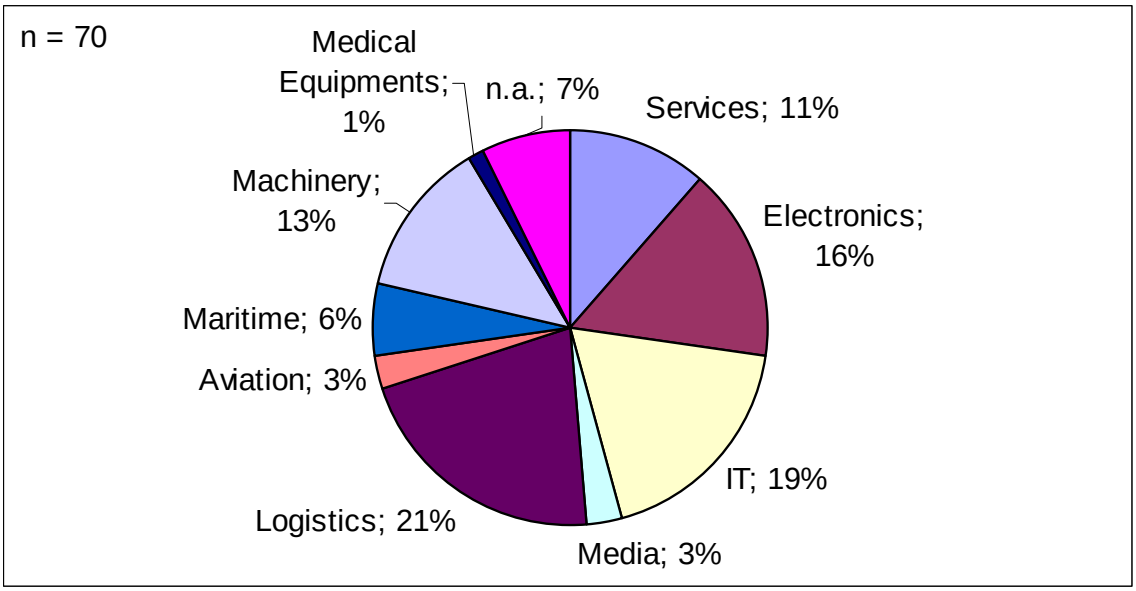

Figure 3: Representation of Industry Sectors in the Sample

Nevertheless, the findings seem to be significant because they correspond strongly with the results of the studies presented in section 3.1. In addition they were confirmed in different industry specific workshops. Following the online survey these workshops were organized to discuss, confirm, or extend the data base with experts from the selected industries like firm representatives, representatives of industry associations and cluster managers. In the following we present selected findings of the online survey.

3.2.1 External Barriers to Innovation

Top “external” barriers to innovation, which owed their existence to external factors and as such could not be influenced in a significant manner by the firm concerned, included financing issues, the problems in finding suitable and qualified personnel, bureaucratic hurdles, and the trouble finding “right” cooperation partners, as seen in Figure 4.

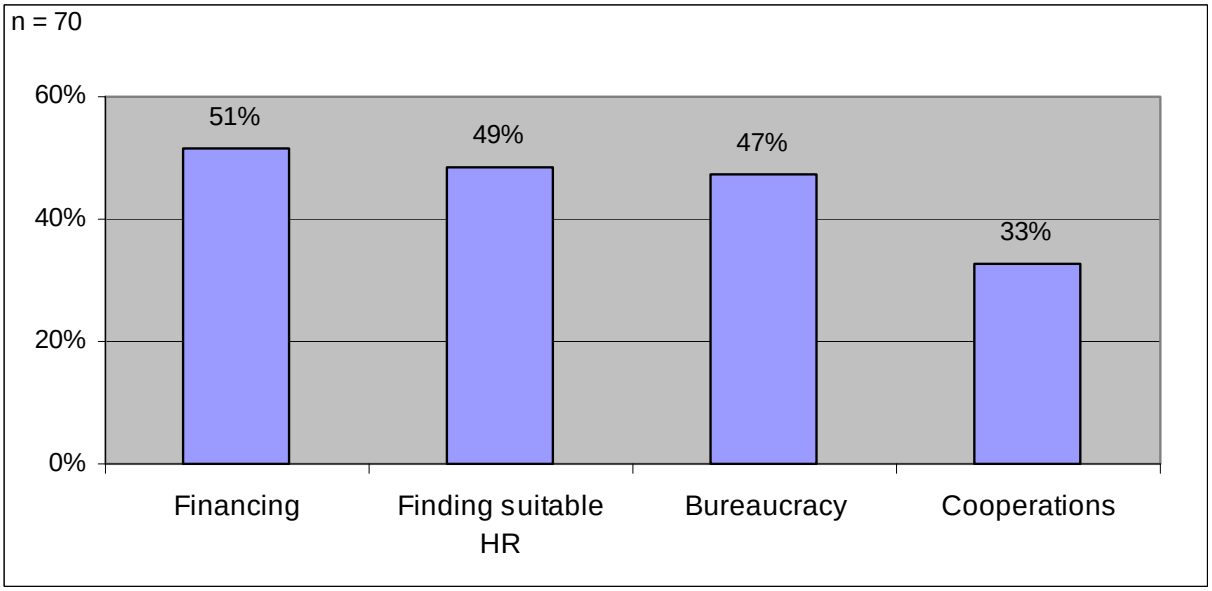

Figure 4: Top External Barriers to Innovation in Hamburg’s SMEs

3.2.1.1 Financial Constraints

The lack of financial resources was found to be one of the major barriers to innovation for SMEs. More than half of the responding firms reported problems in financing innovation projects. The negative impact of this barrier can be gauged from the fact that the financial constraints were cited 22 times as having led to abandonment of one or more innovation projects in the surveyed SMEs within past 3 years. Many projects were aborted in late phases, causing significant losses in the form of sunk costs and lost opportunities.

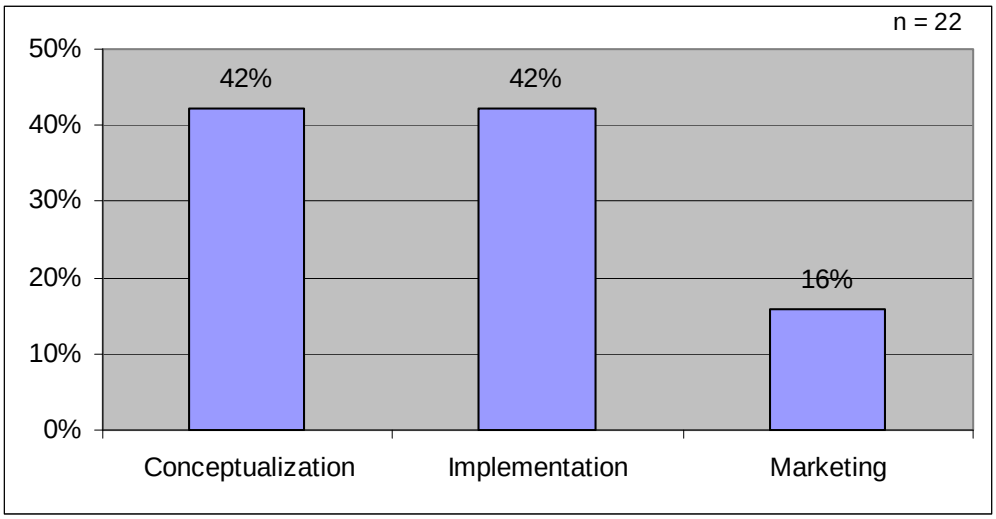

Figure 5: Abandonment of Innovation Projects owing to Financial Constraints

3.2.1.2 Availability of Skilled Labour

Another major hurdle faced by the survey respondents related to the difficulty in finding suitable, qualified personnel. In 33 instances, the firms cited vacant positions in past 3 years which could not be filled owing to a lack of suitable candidates. Almost all respondents who cited such a problem reported the shortage of experienced engineers. However, experienced skilled labour was generally difficult to find.

Figure 6: Lack of Qualified Human Resources as Barrier to Innovation

This problem is particularly interesting since both Germany and its Hamburg region endure substantial unemployment with an unemployment rate of nearly 9%. At the same time the industry is unable to fill vacant positions with skilled labour. Moreover, this problem may be expected to worsen further due to the aging population and the relatively low birth-rate in the society.

3.2.1.3 Bureaucratic Hurdles

There are several ways in which bureaucratic regulations may hamper the innovation activities of firms in a region. To cite an example closely related to the previous issue we can have a look at “restrictive” labour laws in Germany, which according to a McKinsey study cause many firms not to hire and thereby cause bottlenecks (Farrell, 2004). In a survey by the German Chambers of Industry and Commerce (DIHK) in Germany, 24% of firms with offshore engagement in R&D cited “less bureaucratic hurdles” at offshore locations as one of the reasons for their decision (DIHK, 2005).

Other bureaucratic hurdles are related to financial constraints stated above. Respondents of the online survey and participants of the workshops criticized complex and therefore resource straining procedures regarding the application as well as administration of public funds initiated to support firm’s innovation projects. Interestingly, especially funding programs of the EU were often evaluated as “not transparent” and cumbersome. National and city-level support programs fared somewhat better.

3.2.2 Internal Barriers to Innovation

“Internal” barriers to innovation were reported, amongst others, in the areas of marketing, conceptualization of innovative products, internationalization, as shown in Figure 7.

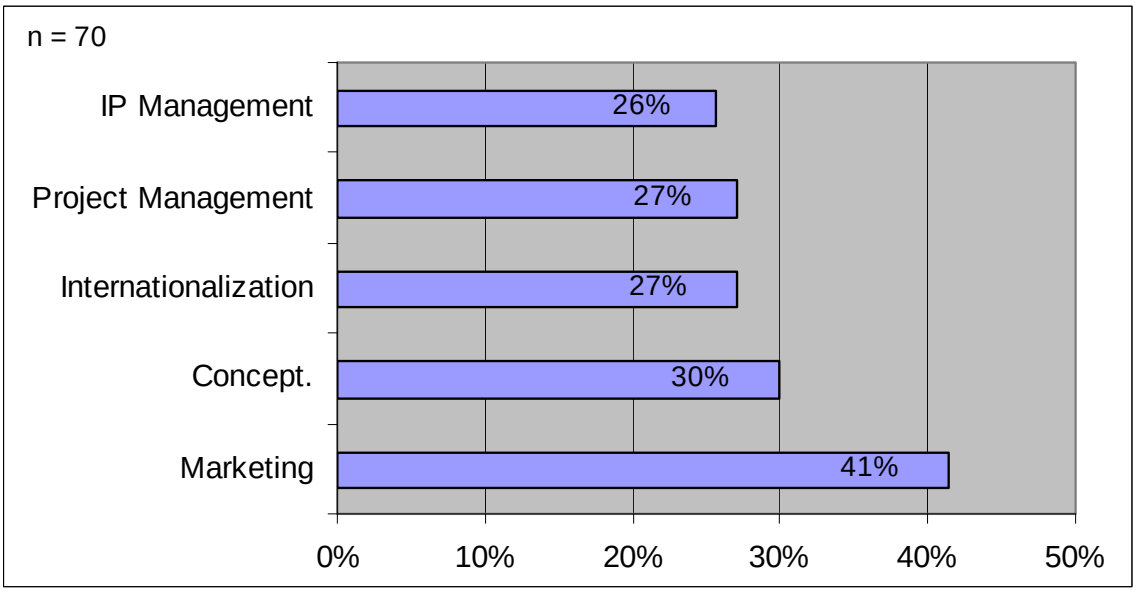

Figure 7: Top Internal Barriers to Innovation in Hamburg’s SMEs

The extent to which an industry-sector was hit by certain barriers to innovations varied considerably. Figure 8 illustrates this point in an interesting manner. While the IT sector

had relatively less trouble managing its projects, the tradition-rich machine-manufacturing sector faced more inconvenience. Also the shortage of suitable and qualified personnel though present in both the sectors to a significant extent, affected the latter more, reflecting the declining interest of the youth in studying engineering and natural sciences.

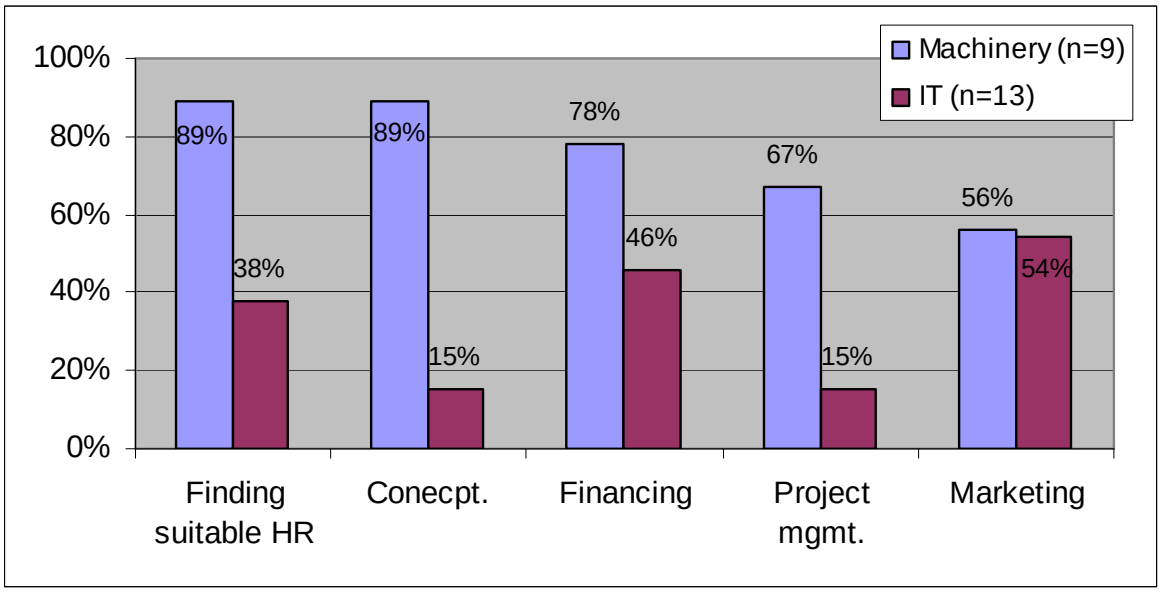

Figure 8: Barriers to Innovation in SMEs of Machinery and IT Sectors

3.2.3 Status Quo of Internationalization Efforts

The challenges of the internationalization are not mastered by many SMEs, as can be seen in Figure 9. Out of 56 respondents who chose to disclose the share of international sales in their firm's annual turn-over, 38% reported purely domestic business; another 30% had a share of up to 15%.

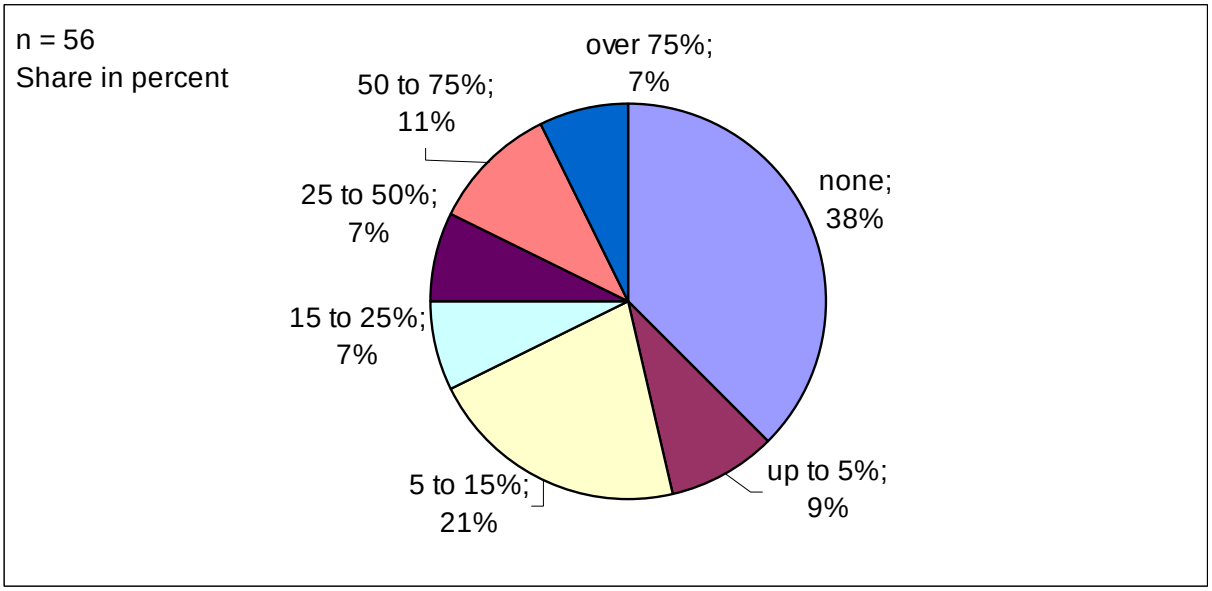

Figure 9: Share of International Sales in the Firm's Turn-over

Over one-fourth of all respondents characterized the failure of their firm to manage internationalization as a “significant” barrier to innovation. Many SMEs, probably owing to their limited resources and often missing know-how on international markets, seem to be particularly affected by the challenges of managing the “globalization”. This problem affects, interestingly enough, both traditional and modern industry sectors, such as Machinery and IT, faced this problem.

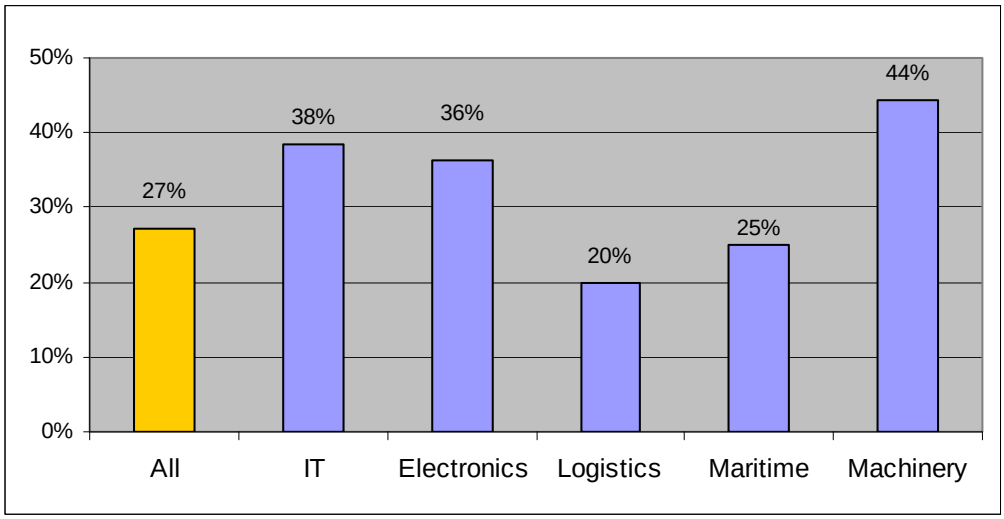

Figure 10: Failure to Internationalization as a Major Hurdle to Innovation

3.2.3.1 Reasons for Interest in Internationalization

In order to understand the importance attached to internationalization, the survey participants were asked about their motives for internationalization of innovation activities. For this purpose they were presented a set of possible motivations, the degree of importance could be stated on a scale of 1 (= very important) to 6 (= not important at all). Additionally, the respondents had the option of stating and evaluating motives other than those listed in the questionnaire.

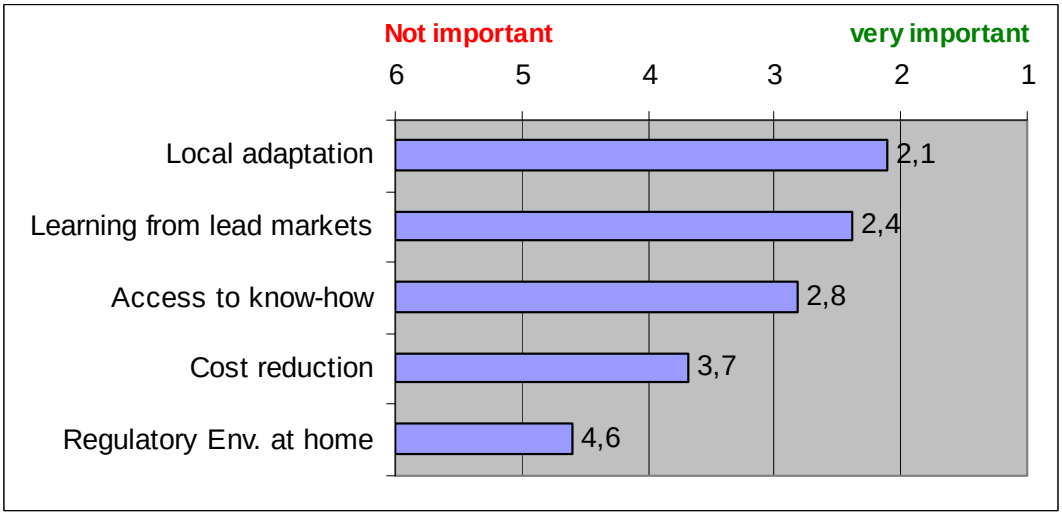

Figure 11: Motives for Internationalization in Hamburg’s SMEs

As Figure 11 suggests, the desire to adapt their products to specific needs of the local target markets played a major role in the internationalization effort of the innovation activities by the participant firms. The aspiration to learn from “lead-markets” or to get access to knowledge-resources were found to be more important than, for instance, the desire to reduce costs by getting access to cheaper labour. Supposedly “unfavourable” regulatory conditions at home also did not play any worthwhile role in the decision to go international.

3.2.3.2 Challenges of International Innovation

The desire to engage in international innovation activities however either did not materialize or did not run satisfactorily for many. The primary reasons cited, and evaluated on a scale of 1 (= very important) to 6 (= not important at all), were a general concentration on the “home market”, lack of resources and know-how, and the fears relating to the legal uncertainties in the target markets including the potential danger of not being able to protect one’s “intellectual property”.

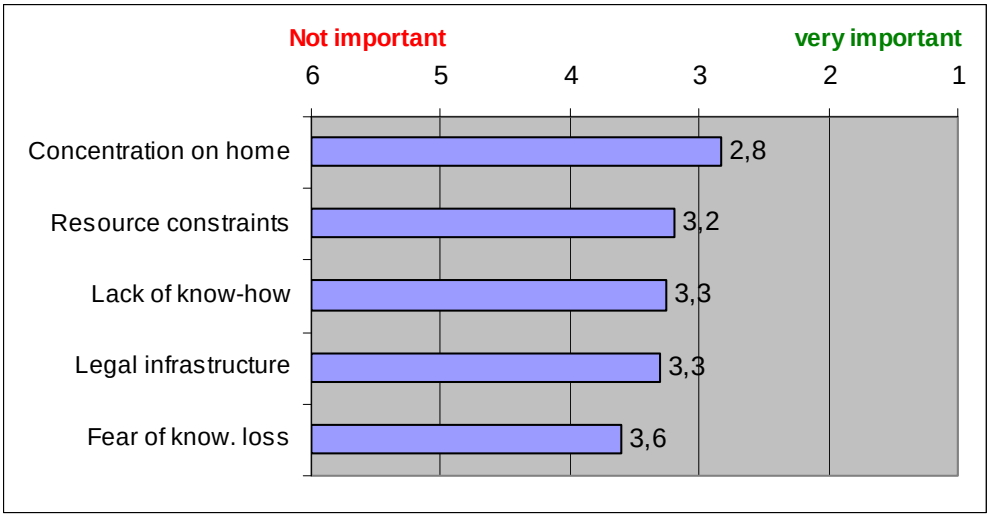

Figure 12: Difficulties Faced by SMEs in Internationalization Efforts

An important tool to improve the firm’s knowledge base and therefore its innovativeness is to enter cooperation with partners like other companies and/or universities and specialized research institutions (here jointly referred to as universities) at home or abroad; see e.g. Buse (2000).

Due to this the participants of our survey were asked about their existing cooperation, and/or their willingness to cooperate, with universities abroad. Many survey participants expressed their desire to cooperate with universities on an international scale. Over one-third of all such SMEs however cited financial constraints as being a major hurdle for the cooperation. Significantly, but not surprisingly, over one-fourth of the survey did not know how to find a suitable academic partner abroad, especially in emerging countries.

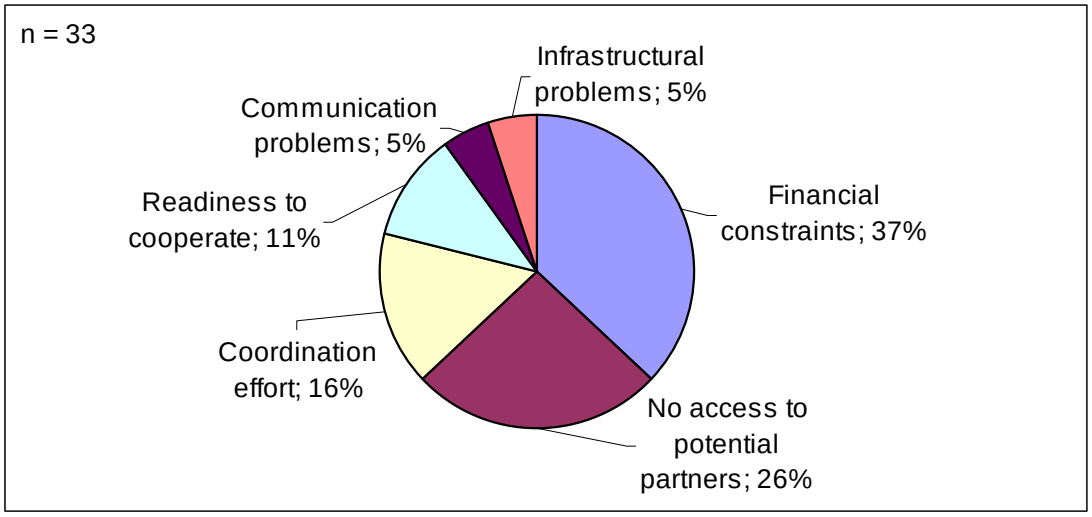

Figure 13: Problems in International Cooperation with Universities

The discussion above has brought to fore the chances and challenges that firms, especially SMEs from selected industry sectors in the Metropolitan Region of Hamburg, expect from the internationalization of their innovation activities. These expectations however often have a universal character and are not limited to SMEs or the Hamburg region alone.

3.3 Post "RIS-Hamburg" Research

In this section we describe research that has taken place after the "RIS-Hamburg" survey was conducted. Since then there have been new studies, e.g. BITKOM (2007b), DIHK (2007) and Koppel (2007), and media reports, e.g. Bovensiepen (2007a/b), Dunkel & Kühnlenz (2007), and Rademaker (2007), on factors hindering innovations in Germany. These studies and reports – though generally of cross-sectroal importance – entail significant clues about SMEs, which by and large confirm the findings of RIS-Hamburg. In the following we describe the two most important aspects of this new research.

3.3.1 Shortage of Skilled Labour

Firms not only in Germany but in many other Western countries are faced with scarcity of skilled labour owing primarily to two reasons:

a) Demographic developments ("aging population") (see Reinberg & Hummel, 2004)
b) Lack of student interest in engineering and natural sciences (see IWD (2007))

In Germany alone firms are facing a severe crunch of skilled labour, despite high rates of unemployment in certain sections of the society. According to some preliminary calculations the shortage of skilled (technical) labour, primarily of engineers and scientists, is leading to a loss of over 20 billion euros a year in the form of unrealized business opportunities. The study carried out by Cologne-based *Institut der deutschen Wirtschaft* (IdW) on behalf of Germany's Federal Ministry of Economics and Technology (BMWi) predicts that Germany will be short of 95,000 engineers and 135,000 scientists by the year 2014 (Bovensiepen, 2007b). In another study IdW found out that German firms failed to fill

47,998 engineer job-vacancies in 2006 resulting in a loss of 3.5 billion euros (Koppel, 2007).

BITKOM, Germany's industry association for Information Technology (IT), reports a shortage of 40,000 IT professionals (BITKOM, 2007a). SMEs with a staff of 50 to 249 employees were found to be suffering more from this scarcity (60%) than did large firms (40%) (BITKOM, 2007b).

According to a recent "Innovation Report" by DIHK which is based on over 10,000 interviews with firm representatives, recruiting skilled technical labour is increasingly becoming a grave problem (DIHK, 2007). Firms are reporting vacancy periods of 3 to 6 months to fill an engineer vacancy; while the official labour mediation agency *Bundesagentur für Arbeit* confirms this trend (Dunkel & Kühnlenz, 2007; Rademaker, 2007). In some industry clusters like Ingolstadt in Southern Germany where concerns like *Audi* and *Mediamarkt/Saturn* are headquartered, situation is so dramatic that firms, especially SMEs are not receiving even a single application in response to their vacancy advertisements (Preuß, 2007).

DIHK expects a shortfall of 30,000 researches alone in firms engaged in innovation activities by 2010 and thereby not including engineers needed for routine activities. 6,000 of these researchers would be needed in SMEs, as defined by IfM Bonn (DIHK, 2007). Germany's Federal Ministry of Education and Research (BMBF) in its latest report on the country's technological performance expects a shortfall of 335,000 university graduates, including 59,000 engineers, in year 2014. This expected shortfall is based on the assumption that till then there will be no change in the employment basis. In case the employment basis increases by 2.5% in this period, the shortfall would grow to 492,000 (of which 95,000 engineers). In case of a decrease by 2.5% the shortfall would still be to the tune of 178,000 (of which 23,000 engineers) (BMBF, 2007).

As BITKOM (2007b) puts it, SMEs are more prone to suffer from the shortage of skilled labour than large firms, owing to various reasons, e.g. attractive brand names or access to human capital abroad.

3.3.2 Financial Problems and State Support

As stated in section 3.2 the lack of financial resources hinders many SMEs from initiating or – even worse – completing their innovative ideas. Financial constraints as a barrier to innovation in German SMEs were just recently confirmed by DIHK. They found out that SMEs have problems to acquire loans because financial institutions are often reluctant to (co-)finance risky innovation projects (DIHK, 2007). Another financial constraint refers to the already stated problem of getting access to public funding for innovative ideas. According to DIHK (2007) German SMES complained about non-transparency caused by a large number of local, national and EU programs and the bureaucratic application procedures associated with them. Further, it was pointed out that innovation projects must be delayed owing to regulatory reasons until the application has been approved.

However bureaucracy is not the only problem while seeking access to public financial support. German SMEs complained about the need for lobbying especially in high-technology industries to get any realistic chance of funding. However due to limited

resources SMEs, in contrast to larger ones, rarely have the chance to establish the relationships “needed”; see Georgescu and Vollborn (2007) and DIHK (2007).

Summarizing the key-findings of Chapter 3, the “RIS-Hamburg” survey, in accordance with other comparable studies, has demonstrated that many SMEs suffer from barriers to innovation, which may be caused by either external or internal factors. These barriers are not limited to the Metropolitan Region of Hamburg alone but have by and large nation-wide, and in many instances even EU-wide, validity and implications. The primary barriers faced by SMEs are:

a) Financial constraints
b) Finding qualified, suitable human resources
c) Finding suitable cooperation partners with knowledge resources
d) (International) Marketing of innovative products
e) Conceptualization of innovative products (The “Front-end” of innovations)

4 - Global Innovation as a Chance

In this Chapter we discuss how global innovation, and more specifically the internationalization of R&D, may help mitigate the effects of the earlier discussed barriers to innovation in SMEs.

Based on the results of several studies and reports, e.g. Boutellier et al. (2000), DIHK (2005), UNCTAD (2005a; 2005b; 2005c), Ernst (2006), OECD (2006), KPMG (2007), LTT Research (2007), and Tiwari et al. (2007), it seems reasonable that global innovation activities, including internationalization of R&D, may at least help mitigate the effects of the barriers faced even if not completely overcome them.

It is therefore not surprising that many SMEs have started recognizing the opportunities that the globalization enables not only in the production but also in R&D. In many instances, SMEs have set up R&D centres abroad, as a survey by DIHK revealed. The survey with a sample base of over 1,600 firms, 77% of them SMEs, showed that as of February 2005 one-third (33%) of all German firms were engaged in offshore (international) R&D. Interestingly enough over 25% of surveyed SMEs too engaged in offshore R&D. Some had their own R&D facilities abroad, while others forged cooperation with firms and R&D institutions abroad (DIHK, 2005).

Global innovation activities, particularly when conducted in emerging, fast-growing markets such as China and India, may offer tremendous opportunities, e.g. in the form of vast pools of qualified human resources in science and technology, cheaper labour costs and access to new, fast growing consumer markets with substantial purchasing power and/or infrastructural needs. In the following we discuss the “motivators” of global innovation, which can be categorized in three main categories, as exemplified in Figure 14.

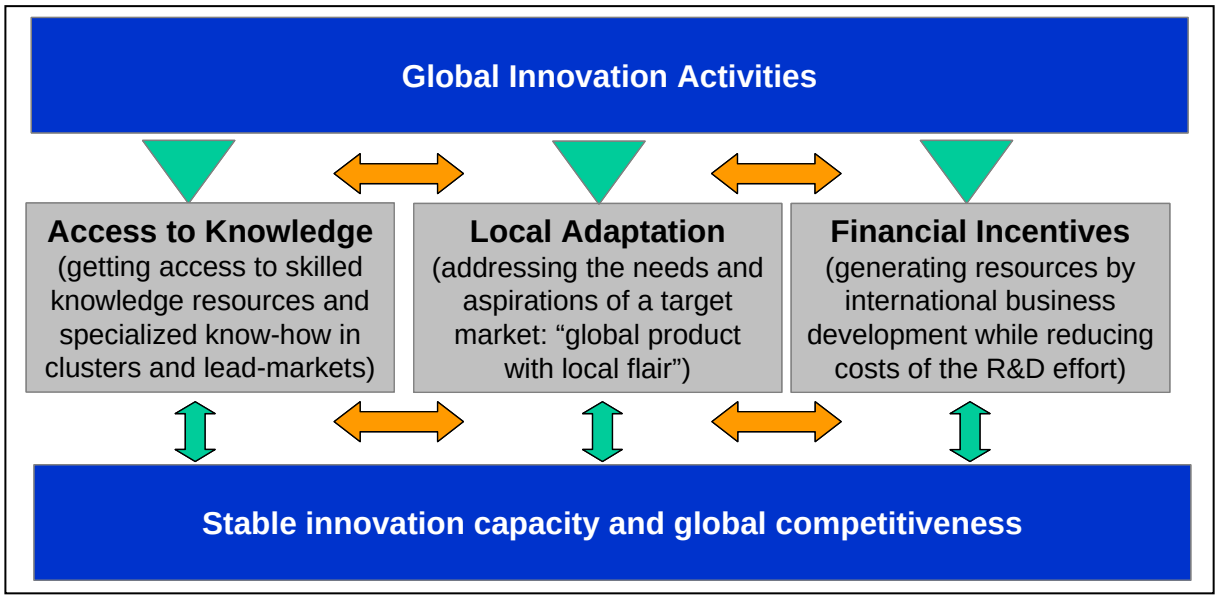

Figure 14: Chances of Global Innovation Activities

4.1 Leveraging Access to Knowledge

Many studies, e.g. EIU (2004), DIHK (2005), Kazmierczak & James (2005/2007), and Doz et al. (2006), suggest that seeking "access to know-how" (e.g. in the form of skilled labour) is one of the most important drivers of global innovation. The quest for knowledge resources, in turn, is motivated by following factors:

4.1.1 Quantitative Availability of Skilled Labour

The demographically disadvantageous factor of an aging population in many Western countries, including Germany, is coupled with another challenge, namely the decline in the number of science and technology (S&T) students, as discussed in section 3.3.1. While countries such as China and India are producing a large number of S&T graduates. In China, 61% of undergraduates are studying for a science or engineering degree. Also as far as the quality of the higher-education is concerned many "emerging" countries around the globe, especially in Asia and Eastern Europe, are able to produce world-class graduates. In fact, 3 of the top-5 Asian schools for S&T are located in India (EIU, 2004).

Particularly India seems to possess a demographic advantage, as the bulk of its population is young, one-third of it being under 15 years of age. With 14 million young university graduates (with seven years or less of work experience) India's talent pool is estimated to be the largest worldwide, overlapping Chinese talent pool by 50% and that of the USA by 100% (Farrel et al., 2005).

India and China alone are reported to produce 350,000 and 600,000 engineers a year respectively in contrast to 70,000 in USA and nearly 33,000 in Germany (DBR, 2005; Farrel et al., 2005; Farrel & Grant, 2005; BMBF, 2007).[3]

[3] DBR (2005), citing India's Department of Industrial Policy and Promotion, puts the no. of India's graduating engineers at 200,000, along with 300,000 non-engineering technicians and 9,000 PhDs.

Setting up offshore R&D centres provides firms with an opportunity to tap into a larger talent pool which is otherwise not accessible, for instance owing to restrictive immigration policies, which are often caused by social, political and/or security-related concerns and are not rarely supported by strong pressure groups in the society. On the need of immigration in Germany and the refusal of the political establishment to accede to it, see BITKOM (2007a/b) and Bovensiepen (2007a/b). Two reports by American Electronics Association (Kazmierczak and James, 2005/2007) document this angle from an American perspective. In a concrete example of the effects that such policies may cause, Google Inc. cited troubles in obtaining work visas for its prospective employees as a reason to set up its "first engineering research and development centre" outside the US in Bangalore in India (The Hindu, 2003).

4.1.2 Reducing Bottlenecks in Product Pipeline

Global innovation activities may ensure that work can be carried out simultaneously from multiple locations and on multiple projects, if needed. Several independent modules of a single project may be worked upon at the same time to shorten time-to-market. Following the same logic, even a single step of a project may be worked upon round the clock in changing shifts the world-over whereby the data is transmitted electronically from one centre to next. Such a step could be of crucial importance for time-critical projects, e.g. for Pharma firms while conducting clinical trials. The shortened time-to-market may be crucial to ensure large-scale competitive advantage (BCG, 2006).

4.1.3 Proximity to Production Centres

The globalization has moved production centres of many industries to emerging countries, where new industry clusters have grown up. Some industry-specific innovation activities, e.g. in Automotive sector, may require close interaction with the production department. It may be useful to locate R&D facilities in the proximity of the production centre, unless other factors (e.g. availability of knowledge resources, affordable costs etc.) threaten to hamper the process. Especially German firms seem to locate their R&D activities in close vicinity of their production centres. Whereas many international studies found "access to knowledge-resources" as the leading reason for many international offshore R&D activities, a DIHK survey in Germany revealed that the "proximity to production centres" prompted German firms most often to offshore R&D (DIHK, 2005). Another study by KPMG (2007) also confirmed this finding.

4.1.4 Learning from Lead Markets

Unsaturated, emerging economies in Asia are rapidly taking over the role of "lead markets" by their openness for consumption and the willingness to spend money on technological innovation. The Asian consumers already play a key-role in the electronics industry, today. For a discussion on the role of "lead markets" see Beise (2001).

4.2 Leveraging Cost Advantages

Innovation activities too generate costs which need to be minimized in order to compete with other "innovators", especially so since the outcome and the ensuing commercial

success of innovation efforts remain to a large extent uncertain. Global innovation, in addition to access to skilled labour, may also contribute to reducing costs of innovation.

4.2.1 Cheaper Costs for (Skilled) Labour

Global activities, particularly in emerging countries, may lead to significant reduction in the costs (EIU, 2004). According to a McKinsey study, a software developer costs 60 USD an hour in USA. A software developer with similar skill costs only one-tenth of this amount in India (MGI, 2003). The starting salary of a software developer working for the German software firm SAP in India was reported at 8,000 euros per annum in 2004, while the salary for a similarly qualified person at the headquarters in Germany was reported 5-times higher at 40,000 euros (Müller, 2004). The DIHK survey in Germany found out that 41% of all offshore R&D activities of German firms were motivated by the incentives of the lower costs abroad (DIHK, 2005). The labour costs are however going up, see section 5.2.

4.2.2 State-induced Incentives

There may be lucrative state-induced incentives to indulge in R&D activities abroad if the host country offers significant financial support, e.g. in the form of “tax holidays”, subsidies and/or other tax incentives. In India, for example, expenditure incurred on R&D may be deducted from corporate taxes with a weighted average of 150% (DSIR, 2006).

Moreover there might be high barriers, or altogether restrictions, on carrying out R&D in certain fields, e.g. genetics. Such restrictions either increase the R&D cost in order to fulfil the legal requirements (in case of high barriers) or they may cause high opportunity costs in the form of lost business opportunities (in case of prohibition). If R&D in that particular field is allowed in another country or is possible with significantly lower restrictions then it may make sense to locate R&D efforts in that country.

4.3 Leveraging Market Opportunities

In addition to knowledge and cost factors there might be significant market opportunities abroad in the form of demand for localized products in fast-growing markets. More and more people in emerging economies are having financial resources to buy high-end products (EIU, 2004), and the number of the middle class consumers is growing rapidly in emerging countries particularly China and India.

A McKinsey study predicts that China will move to become the third largest consumer market worldwide, surpassing Germany and behind Japan and USA, by 2025. The urban incomes are set to rise significantly providing ample opportunities for the manufacturers to sell not only items of basic necessities but also of a “discretionary” nature (MGI, 2006).

The situation in India too looks similar. The Indian middle class, comprising of estimated 200 to 250 million people, is believed to be one of the largest worldwide. According to estimations by McKinsey, India is expected to become the 5th largest consumer market by 2025, moving up from its 12th position (MGI, 2007). The study forecasts that India will have a 583 million strong middle class by 2025. It also observed a shifting focus in the consumer behaviour which is connected with increasing income-levels: As comparatively smaller share of the income is spent on basic necessities, more “discretionary items” are being purchased (MGI, 2007). The McKinsey study is not only a confirmation of an earlier

study by Deutsche Bank Research (DBR, 2005) which foresees a “richer consumer market” in India by 2020. The study, furthermore, is itself also validated by the fact that over 6 million new mobile phone subscribers are added per month in India (TRAI, 2007).

5 - Challenges of Global Innovation

The section above has given us a broad overview over how global innovation may be used as a chance to mitigate the effects of innovation barriers prevalent in Germany and *inter alia* in advanced economies. These “chances” – though realistic – are fraught with certain challenges that need to be addressed and mastered to realize the full potential of global innovation. In the following we describe some primary challenges.

5.1 Finding “Qualified” Personnel

The access to knowledge may be fraught with difficulties, as the “global war for talents” gets murkier. Even China and India are reportedly experiencing shortage of skilled labour with international knowledge standards; see e.g. Farrel et al. (2005). Many firms, including as reputed names as Google and Infosys, are complaining of a shortage of suitable candidates. This shortage leads to a high attrition-rate (“Job-hopping”) in firms (Hirschfeld, 2005), which sometimes reaches 30 to 40%. The shortage of qualified personnel is also felt in the booming economy of China, where German firms are finding it increasingly difficult to recruit local technicians, as a McKinsey study found out (McKinsey, 2006).

5.2 Cost Explosion in Booming Economies

The cost advantage of many “emerging” nations with booming economies is disappearing in many respects, for instance, wages of highly skilled labour in India reportedly grow by 10 to 15% and above per annum on average; see Hein (2004, 2007). The wage growth in senior positions, like project manager, has been even higher at about 25% per annum (Farrel et al., 2005). Wage costs for semi-skilled or unskilled labour, however, remain significantly lower than in Western, industrialized nations.

5.3 Protection of Intellectual Property Rights (IPRs)

The protection of IPRs remains a concern, even if to a varying degree, in most emerging countries, particularly when seen in conjunction with often delayed judicial processes and/or often prevalent corruption. Fabian and Schmidli (2005) report problems related to IPR protection and the fulfilment of contractual obligations in China.

5.4 Market Uncertainties

Local adaptation of products may cause financial constraints if the size of the target market does not provide scale effects. R&D efforts for local adaptation can only be justified in the presence of a large market. At the moment there are not many such markets if one excludes China and India, and probably some Eastern European countries. That effectively means that the global activities are actually “Asian” or “East European” activities. This problem may however be overcome by concentrating on regional markets, such as East Asia or Eastern Europe.

5.5 Start-up and Operational Costs

It is possible that some firms, particularly SMEs, may not have sufficient financial resources to set up and operate an innovation centre abroad. Hence, the financial effects

of global innovation activities may not be equal for all firms. As a 2004 study by McKinsey suggests, German companies save 0.52 euro for every euro of corporate spending on IT jobs offshored to India, whereas their US counterparts save 0.58 cents for every dollar they spent on jobs in India. The higher costs for German firm's operations in India are caused by "differences in language and culture", which "raise the cost of coordinating offshoring projects" (Farrell, 2004).

5.6 Cross-cultural Issues and Communication

Global innovation invariably involves multi-disciplinary teams of international backgrounds. The resultant disparity requires a high degree of social competences, and a sound understanding of cross-cultural interactions. For instance, Hirschfeld (2005) reports several incidences of inter-cultural nuisances in Indo-German software development work. Fabian and Schmidli (2005) report similar problems in Sino-Swiss projects.

5.7 Acceptance Issues

The parent unit (headquarters) tend to interfere in the innovation work being carried out at the foreign location, which often limits the flexibility of the subsidiaries "to bring their innovation initiatives fully in line with host country best practices", as a large-scale empirical study by Sofka (2006) revealed.

Additionally, there might be reservations / biases in certain quarters at the headquarters regarding R&D capabilities of the colleagues abroad. An example is cited by Hein (2003), wherein Jürgen Schubert, Chief Executive Officer (CEO) of Siemens India and a German national himself, is quoted with the complaint that products designed by his engineers in India were often rejected by the central R&D unit on flimsy grounds. Schubert narrated that those very same products, however, passed the test without any hassles whatsoever, once they were labelled as "Made in Germany". "The quality of the products was identical", recalled Schubert, "only India's image was not befitting" (Hein, 2003).

Furthermore, some employees in the R&D units at the headquarters tend to see the new location as a potential threat to their job security leading to resentments, antagonism and even non-cooperation, as some managers confessed during our research interviews.

A recent investigation in India (June/July, 2007) by the authors of this paper confirmed these acceptance issues in several talks with Indian units of multinational firms.[4]

6 - Implications and Research Outlook

As the discussion above has demonstrated, global innovation activities, especially, the internationalization of R&D, may lead to a mitigation of the effects of innovation barriers faced by SMEs in their home country. However, going abroad with a sensitive function like internal R&D and/or other functions from the innovation process requires a deep and thorough understanding of internal business processes and of business environment conditions in the country concerned.

[4] The investigation report is under preparation. Details shall be available at: http://www.global-innovation.net.

Based on these considerations firms needs to decide which form of R&D internationalization ("captive offshoring", "joint venture" or "offshore outsourcing") is more suitable for their needs; see Figure 15.

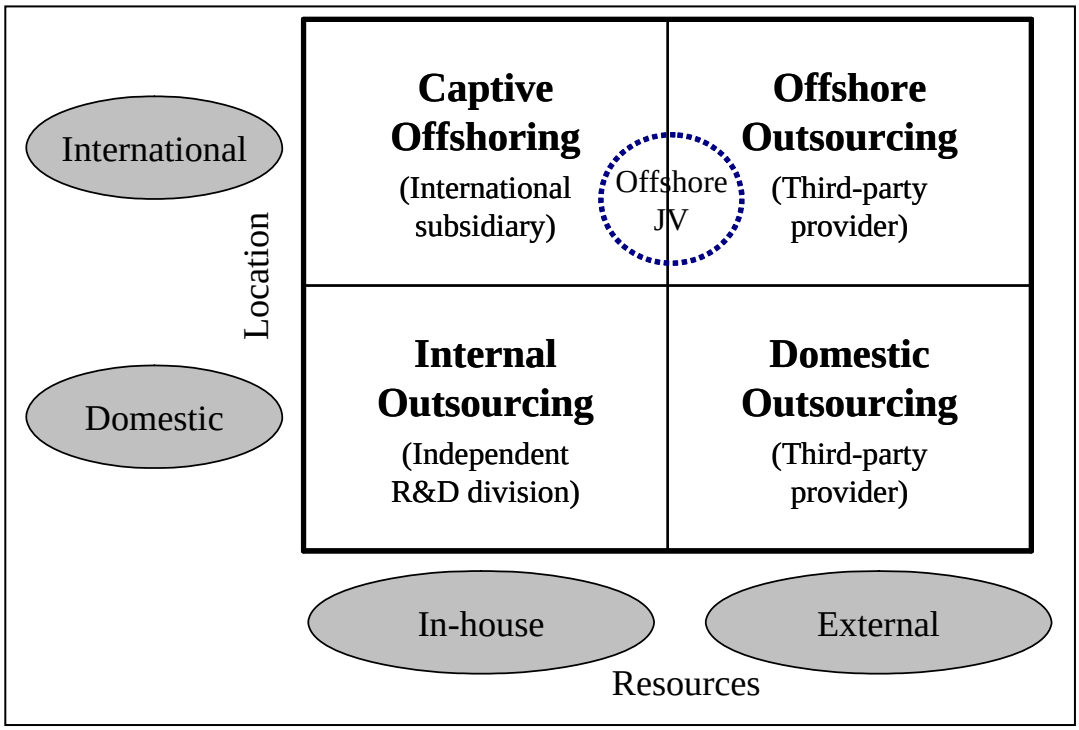

Figure 15: Dimensions of R&D Sourcing

(Modelled after OECD (2006))

Additionally, firms should bear following factors in mind:

- To get access to local knowledge abroad, firms especially those which are facing financial or managerial constraints should initially focus on those forms of internationalization, which do not require a high level of capital investments. Potential strategies, for instance, could be:
  - Cooperative agreements with local research institutions and/or firms
  - Outsourcing of parts of the innovation process
  - To limit the financial burden of setting up and maintaining own international R&D facilities firms might consider sharing resources (facilities etc.) with partners. These partners might be other domestic firms with interest in global innovation, firms from other countries with an interest in the target country, or local firms and research institutions in the target country.
- In case of any kind of partnering the involved parties must find ways:
  - To protect their individual core competences
  - To share the intellectual property generated by such a joint venture, in a justified manner
- If companies enter foreign markets that require local adaptation of products (and therefore local R&D) they need to be sure that the potential of the target market is sufficient to achieve a favourable cost structure. If companies have reasons to expect problems in achieving needed experience curves (economies of scale and learning curve effects), they should reconsider the market entry.

- Firms need to pay attention to cultural aspects and should provide their employees involved in international activities with cross-cultural training. This sensitization to mutual cultural issues may play a key-role in the success of an international venture.
- The motivation (potential benefits) as well as the necessity behind global innovation activities (e.g. tapping new markets and reducing time-to-market) must be explained and discussed with existing R&D units so as to secure their benevolent cooperation with overseas operations.

The above discussed measures may play a crucial role in mastering the challenges of global innovation management. Exact modalities of global innovation activities, particularly for SMEs, however need further ascertainment and are set to be examined by our further research under the aegis of “Research Project Global Innovation” (RPGI) at Institute of Technology and Innovation Management at Hamburg University of Technology (TUHH). RPGI focuses on R&D internationalization in ICT, Pharmaceuticals and Life Sciences industries, Mechanical Engineering industry, Automotives and Automotive Components industries, and Aerospace (Civil Aviation and Space Research). The research is basically focused on following issues:

a) What is the role of outsourcing and/or offshoring in the R&D strategy of firms today? Hereby special attention is to be paid to the needs of two groups of firms: i) German firms, and ii) SMEs.
b) What are the advantages and possible risks of internationalization of innovation activities, particularly of R&D? Which are the factors that are critical to success?
c) Which are the most attractive R&D locations for particular branches? What are the reasons for their attractiveness?
d) Could firms be at a disadvantage if they choose not to internationalize their innovation activities, especially R&D?
e) How to implement and coordinate international R&D activities at the organizational level while securing the cooperation of all the parties involved?
f) What are the lessons that SMEs can learn from the success/failure of international innovation / R&D activities of multinational firms?

The research is currently in progress and the RPGI team hopes to publish soon its preliminary findings from a 6-weeks research trip to India undertaken in June/July 2007.

7 - Summary

The discussion in the chapters above has established that global innovation opens up new arenas for firms, especially SMEs, to strengthen their innovation capabilities and thereby to increase their competitiveness in a global world. In this respect the internationalization of R&D seems to be a useful instrument to mitigate the effects of barriers to innovation often faced by SMEs in Germany, the EU or anywhere else in industrialized economies.

At the same time these “global” opportunities are invariably associated with challenges that need to be mastered in order to fully exploit the chances of global innovation. A thorough understanding of internal business processes, organisational backing not only by senior management but also by other employees, especially in R&D departments, as well as a profound analysis of business environment conditions of the target offshore country are prerequisites of a successful global operation.

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