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# Knowledge-Intensive Business Services in the New Mode of Knowledge Production*

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**Abstract:** The new mode of knowledge production is seen as a distinct form of economic organisation used for exchanging and creating knowledge. The emphasis is laid on the role of business services in innovative networks as carriers of knowledge and intermediates between science (knowledge creator) and their customers (knowledge user). The empirical analysis shows that knowledge-intensive business services are able to make existing knowledge useful for their customers, improving the customer's performance and productivity and contributing to technological and structural change.

**Keywords:** Business services; Empirical analysis; Innovation process; Knowledge diffusion; Knowledge networks

## 1. Introduction

### 1.1 New Modes of Knowledge Creation

In recent years the contribution of knowledge and information to the competitiveness of nations has been analysed from different perspectives and on different levels.[1] Hertog and Bilderbeek (1997) argue that knowledge is a key resource in the economy

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[1]To define "knowledge" I will use the definition by Nonaka and Takeuchi (1995 preface, 8–9). They classify knowledge into two different kinds: (1) *explicit knowledge* which can be articulated in formal language including grammatical statements, mathematical expressions, specifications and manuals. This kind of knowledge can be transmitted via individuals formally and easily; (2) *tacit knowledge* is harder to articulate in formal language. It is often personal knowledge embedded in individual experience and involves intangible factors like personal beliefs, perspectives and the value system.

today for two reasons: firstly, the competitiveness of most industries depends on the innovative knowledge creation and transforming process; and secondly, knowledge-intensive industries contribute to the economic growth and competitiveness of countries. Guinet (1997: 173–174) summarises first results of a project on 'Knowledge Flows in National Innovation Systems' currently being undertaken by the OECD (selection):

1. There is a clear trend towards higher knowledge intensity in all economic sectors, and there are indicators that higher knowledge intensity leads to better performance at the firm, sectoral and aggregate level.
2. Flows of tacit knowledge have an important positive effect on innovation performance, and particularly on the ability of firms to detect, adapt and use new knowledge and technologies.
3. In most countries 'clusters' exist, in which firms interact through closely linked knowledge networks and which show above-average performance in terms of international competitiveness, growth and employment. These clusters are not necessarily high-technology or R&D-intensive, but they are – without exception – knowledge-intensive, when one takes into account the intensity of knowledge interactions among sectors.

Gibbons et al. (1994) emphasise the need for a new understanding of the innovation process which goes far beyond the linear or the chain-linked model normally used in innovation theory. This new – knowledge-based – approach should be able to illustrate the increasing group entrepreneurship and network dependencies (Hanusch and Canter, 1993; Jacobs, 1997).[2]

We can conclude that the structural change – from a technology-based industrial economy to a service economy where knowledge is one of the most important resources – is also reflected in the shift from a scientifically and technologically based innovation process to new forms of knowledge creation, which are to a lesser degree dominated by technology. Instead, they are more transdisciplinary, including intellectual and social aspects.

### 1.2 Role of Knowledge-Intensive Business Services (KIBS)

Different studies[3] show that knowledge-intensive business services play an important role in the changing knowledge infrastructure of the national system of innovation and '*become the prime source of sustained high value-added .... In each case the producer services sector uses specialist knowledge to provide solutions which give products, even mass produced ones, their specific market edge*' (Gibbons et al. 1994, 121).[4]

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[2]For additional literature which concentrates on the network approach, see DeBresson and Amesse (1991), Foray (1991), Freeman (1991), Lundgren (1995), Rammert (1997), Sydow (1992) and Teubal et al., (1991).

[3]See Hauknes and Miles (1996), Miles (1996), Smith (1995), Strambach (1997), Wood (1996) and ZEW (1998).

[4]Machlup (1962: S. 19) identifies some services as highly productive for the economy because of their role as knowledge transfer agencies. But he neglects the ability of services to create own knowledge. Machlup argues that '*some of the mass of knowledge, general-systematic or particular-concrete, which is of only transitory relevance has nevertheless great economic value. Certain services of specialists in particular kinds of transitory knowledge have a market value, not because it takes especially scarce qualifications to acquire this knowledge, but because the "division of knowledge" is a great time-saver and thus a highly productive arrangement in the economy.*'

In order to boost economic performance and the competitiveness of the national innovation system, it is important to increase the information stock and to make the existing stock more socially useful. David and Foray (1995) underline that the efficient distribution and utilisation of knowledge cannot be expected to rise automatically. It is necessary to concentrate more on the knowledge distribution power than on the creation process of new information. The ability to transform information into knowledge as well as to receive and use knowledge for solving economic problems is at least as important for change and growth as the process of learning and discovery.[5]

Recently, enterprises in manufacturing have started to divide themselves into smaller, more flexible units, to become members of firm networks and to learn '*from co-operation with specialised companies in the service sector*' (Hammerer, 1996: 4). KIBS are important agents in the development of new knowledge (e.g., R&D). These companies also assist in the widening of knowledge, as their interaction with clients leads to greater client understanding. One reason for the use of business services is to avoid the costs of acquiring and maintaining such up-to-date knowledge in-house (Miles et al., 1994).

Due to their 'boundary-spanning' role and their ability to create new and combine existing knowledge, KIBS play a significant role as knowledge-broker in the national innovation system. One of the most dynamic industries for employment growth in Germany are the technical consultants and the providers of other corporate business services (Licht et al., 1997: 12). This indicates the growing importance of these services, as well as the increasing intertwining of manufacturing and business services.

### 1.3 Research Questions

Unfortunately, up to now there are only rudimentary theories about the knowledge-creating process in the service sector. Traditional approaches try to describe and analyse the innovation process in manufacturing. Barras (1986) was the first to develop an innovation theory for the service sector. The innovation process in the industrial goods sector usually at first represents a product innovation before improving the product quality and eventually leading to process innovations.[6] Based on this, Barras suggests a reverse product life cycle for the third sector, starting with the adaptation of new technologies to improve service processes before improving the quality of existing products, and finally developing new service products with the support of the new technology.

Barras helps us to understand the interactions and interdependencies between process and product innovation in the service sector and their influence on the internal learning process. He also emphasises the role of technology[7] in the service innovation process, but he does not shed light on the knowledge creation process in detail and different forms of information and knowledge flows, learning processes and innovation networks in the economy. So a more detailed analysis of the innovation

[5]Gibbons et al., (1994), Hammerer (1996) as well as Roelandt and den Hertog (1996) argue similarly.

[6]See Utterback and Abernathy (1975) and Utterback (1994).

[7]There is a difference between technology and knowledge. Technology combines technical equipment and machines as an artefact as well as technical knowledge, while knowledge includes also non-technical (like organisational and social) aspects.

process in the knowledge-based economy, which takes into account the dynamics of structural change and the heterogeneity of the emerging and existing services and manufacturing industries, is still needed.

Based on the theoretical literature I will aim at a new, industry-independent definition of KIBS which represents the role of KIBS in the national innovation system to a greater extent. This approach also takes into account the fact that the official industry classification is not perfect, and in more than 50% of all cases does not represent the real activity of the companies. The data and indicators from two German surveys in the service sector carried out in 1995 and 1997 enable me to analyse the characteristics of KIBS in terms of their internal knowledge creation process, the use of technology, external sources of knowledge and the innovation output. The hypothesis are (1) that knowledge-intensive business services are highly integrated in an innovation network of clients, customers and competitors; (2) that they have their own, internal knowledge-creating processes; and (3) that they play the role of a knowledge broker, i.e. that they make existing knowledge usable for other companies. This is a first step towards a new description of the innovation process for KIBS, as well as a first empirical step towards a new understanding of the role of KIBS in the new mode of knowledge creation.

Based on existing definitions of KIBS, this paper will introduce in Section 2 a new understanding of KIBS which takes into account the boundary-spanning role and the network capabilities of KIBS. Section 3 will give a brief overview of the methodology and some general empirical results, followed by the analysis of external sources of knowledge (integration in the innovation network) as well as the internal knowledge creation process, while Section 4 will examine the contribution of KIBS to the innovation system.

## 2. Definition of Knowledge-Intensive Business Services

### 2.1 Existing Definitions of Knowledge-Intensive Business Services

Firstly, KIBS provide their services to other companies and not to private households or the public sector ('business services'), and secondly they are 'knowledge-intensive'. The understanding of knowledge intensity is different and ambiguous, which makes KIBS hard to grasp. The literature is rather vague: different authors emphasise different aspects of 'knowledge intensity'. The variety of terms reflects a variety of points of emphasis – some authors focus more on the performance, others on professional functions, the formal qualification or the differences in wage structures (NIW, 1995).

Machlup (1962) was one of the first to evaluate business services. He describes services in terms of their knowledge activities. All companies which sell knowledge belong to the 'professional services'. This comprises legal services, engineering services, accounting and auditing services, and some medical services. Miles et al. (1994: 7) argue in the same direction. They define KIBS as business units that '*involve economic activities which are intended to result in the creation, accumulation or dissemination of knowledge*'. They distinguish between KIBS I, which are traditional professional services (liable to be intensive users of new technology), and KIBS II, which are new technology-based KIBS.

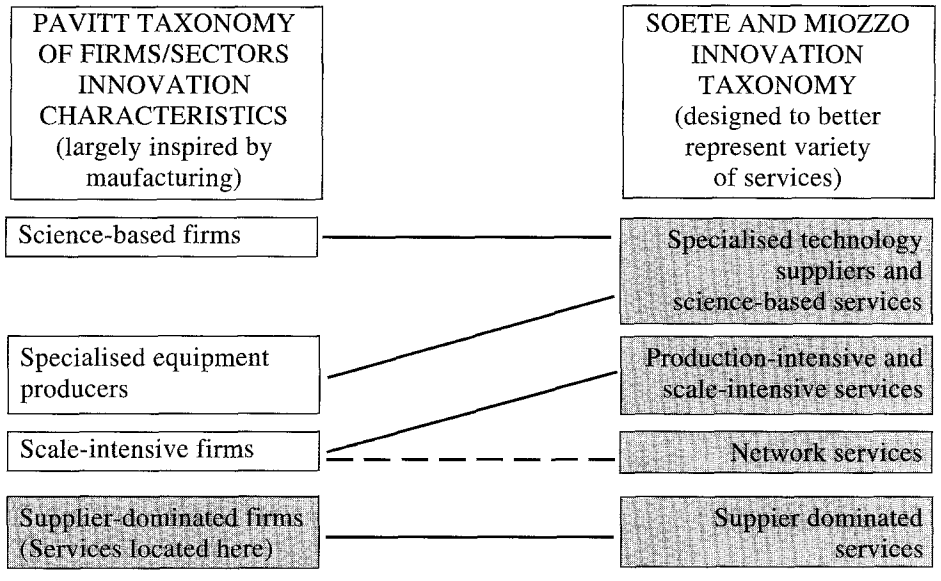


**Fig. 1.** Changing views of innovation in services.

A different approach is used by Alvesson (1993: 1004). He assumes that knowledge-intensive business services offer '*products and services to other organisations so that these conform to the institutionalised expectations of their environments*'.[8] He distinguishes – like Hertog and Bilderbeek (1997) – between the products and services on the one hand and the KIBS as carriers of advanced knowledge on the other hand.

Strambach (1997) emphasises another important aspect. Her understanding of knowledge intensity stresses that companies do not – like cleaning enterprises – offer routine services. Her analysis differs explicitly from approaches where knowledge-intensive organisations are defined with the help of the number and the proportion of knowledge workers (defined by formal education level) inside the company. Strambach criticises that the 'education approach' does not take into consideration other forms of knowledge, like tacit knowledge inside the firm, or the ability of companies to learn, and to adopt all kinds of knowledge from outside the organisation. The problem with her definition of KIBS is that she does not clearly define what 'routine' means in her context.

In 1984 Pavitt developed his famous taxonomy which characterises sectoral patterns of innovation and technical change (Pavitt, 1984). He distinguishes between three different types of companies: (1) science-based companies (chemical, electronics industry); (2) production-intensive companies: divided into specialised equipment producers (mechanical, instrument industry), and scale-intensive firms (metal

[8]Alvesson (1993: 1003) argues that formal organisations are obliged to have the 'right' structures like personnel departments, management development programmes and modern technologies. Otherwise legitimacy problems arise. The concepts of organisational work are institutionalised, i.e. are taken for granted as legitimate, in society. In his opinion there is a decoupling of efficiency and response to institutional issues in order to attain legitimacy.

manufacture and vehicles industry); and (3) supplier-dominated firms (textile industry, service industry). Pavitt classified the whole service industry as supplier-dominated, without R&D, receiving their innovations from outside the sector.

Because Pavitt's approach does not reflect the variety and heterogeneity of the service sector in terms of its innovation activities, Soete and Miozzo (1989) developed a new adapted taxonomy (see Fig. 1). In the new supplier-dominated cluster one can find public, personal and distributive services. The second cluster is divided into production- or scale-intensive services and network services. These firms depend on large-scale back-office administrative tasks (banking) as well as on physical and information networks (transport and telecommunication). The last cluster contains specialised technology suppliers and science-based services. In this category Soete and Miozzo (1989) classify firms which have own innovation activities, using and developing new technologies.[9]

Soete and Miozzo never tested their approach empirically, so their analysis is a good starting point for a new definition and empirical test of KIBS which can be located somewhere in the category of specialised technology suppliers and science-based services.

There is one main problem with the existing theoretical and empirical approaches. Normally, all authors relate their definitions to special service industries, which might be characterised by the suggested distinctions. But the measurement of such knowledge-intensive business services by official sources represents a universal dilemma (Wood, 1996). Often these categories (e.g. NACE classification) include consumer (and not business) services, even at the four-digit level.[10] The classifications on national and international level also vary. This is especially true for business services. Furthermore, Grupp (1997a) and Scherer (1982) show that firms group more around new products than in terms of industries. In the new knowledge-intensive economy this effect will enlarge. In addition, especially in the service sector, a lot of new services appear which do not fit into the traditional classification scheme. Thus, taking also into account the weakness of the classification itself (see section 1), it is not very useful to analyse KIBS empirically with the help of the official industry classification. A new definition of KIBS is needed.

## 2.2 A New Definition of Knowledge-Intensive Business Services

Although there are conflicting statements, it is possible to highlight some peculiarities of service products, commonly used in the literature: (1) heterogeneity of different service industries; (2) close interaction between service provider and customer (integration of the external factor);[11] and (3) highly intangible content of service products and processes (information, knowledge) and therefore the need for knowledge/information-creating and -transforming processes. These peculiarities mean for KIBS: (1) that their innovation activities are not comparable to other service industries or activities; (2) that they require a closer supplier-user interaction than

[9]Miles(1996:9); see also Gallouj and Gallouj (1997).

[10]However, statistical data for the service sector is normally still not available on a disaggregate level.

[11]Franke (1991: 90–100).

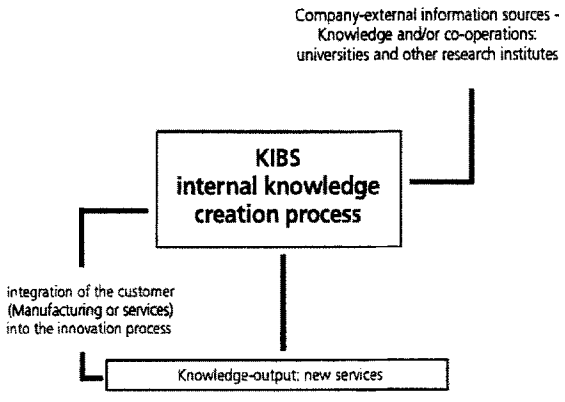


**Fig. 2.** Definition of knowledge-intensive business services.

many other information and communication services; and (3) that they are highly integrated in the knowledge creation and knowledge diffusion network.

We can summarise that KIBS are characterised by the ability to receive information from outside the company and to transform this information together with firm-specific knowledge into useful services for their customers. Von Hippel (1988) was one of the first to draw attention to the role of users in the innovation process. The new mode of knowledge production as well as the service literature underline the importance of the integration of the customer into the production and innovation process (e.g. Franke, 1991; Miles et al., 1994; Strambach, 1994). So the first characteristic feature is the existence of a close link between the customer (manufacturing or services) and the innovation process of the service firm (see Fig. 2).

The only remaining challenge is to find an indicator for knowledge intensity. Roelandt and den Hertog (1996) propose indicators which separate knowledge bases, knowledge flows and competitiveness. They emphasise the importance of measuring the transfer and absorptive capacity, types of knowledge and knowledge carriers, as well as the potential role of intermediaries. So I will define 'intense' as the capability to integrate different sources of information and knowledge into the intra-firm's innovation process. To consider knowledge intensity in terms of scientific or technological knowledge and to be in line with the typology offered by Soete and Miozzo (1989), we assume that KIBS have a close link to the science base embodied in universities or other research institutes (see Fig. 2).

The advantages of this new, industry-independent definition are as follows:

- The definition automatically takes into account that KIBS are intermediaries between knowledge producers and knowledge users, without being committed to a specific service output. KIBS are defined in terms of their role in the system of innovation, which is 'constituted by elements and relationships which interact in the production, diffusion and use of new, economically useful, knowledge' (Lundvall, 1992: 2).
- Indicators provided by the innovation survey allow for a clear distinction between KIBS and other companies. This distinction avoids the disadvantages of the official industry classification.

- The definition takes into consideration the (disembodied) information and knowledge flow between different organisations and the ability to receive tacit and codified knowledge from outside (science base and customer). This overcomes the weakness of qualification indicators (e.g. level of employees with university degree).[12] At the same time, the social capability of learning through interaction between people coming from different organisations and institutional backgrounds is guaranteed.

## 3. Empirical Analysis of External and Internal Knowledge Sources

### 3.1 Description of the Service Innovation Survey in Germany: Methodology

To illustrate the theoretical work, I will use data taken from two German innovation surveys in services. The surveys were carried out on behalf of the German Ministry for Research and Technology (BMBF) and were jointly conducted by the Centre for European Economic Research (ZEW), the Fraunhofer Institute for Systems and Innovation Research (FhG-ISI), and INFAS.

For the first written survey the questionnaire was sent out to more than 11,000 German service companies, asking for data ranging from turnover, employment, human capital structure, innovation and R&D efforts, the supplier/customer interfaces, the relevance of certain technologies, obstacles to innovation and certain other firm characteristics. As sampling frame we used the database of CREDITREFORM, the largest credit-rating agency in Germany. This data set provides us with background information on all companies, e.g. ownership structure, number of employees and sector affiliation (for a detailed description, see Licht and Stahl, 1995). Based on this information, we decided to apply a stratified sampling procedure. The strata are made up by region, size and industry. In 1995 2900 companies returned the questionnaire. From the non-respondent firms, a random sample of 1100 enterprises was drawn, and these were contacted once again. The non-response study is designed to reveal any distortions in the implemented sample, and to correct them if necessary (Licht et al., 1997: 91–94).

In 1997 we started a second survey with a revised, CIS[13]-standardised questionnaire, asking the same companies again. Since the service sector is very dynamic, we had to add new companies to the sample while others had to be removed because they had folded. For this paper I used data from companies who answered in the first as well as in the second survey. So I analyse companies which already existed in 1995, and which are still in business.

### 3.2 Descriptive Analysis: General Overview

After two surveys, the data is available for 3845 German service companies. Around 1000 firms answered both questionnaires. 15% of them are defined as KIBS. Less

[12]Strambach (1997).

[13]Community Innovation Survey.

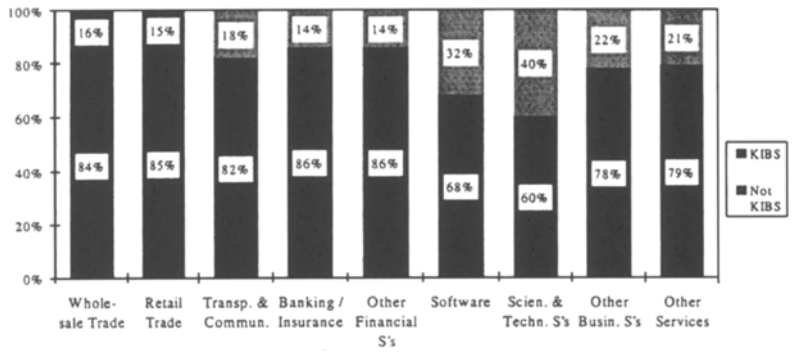


**Fig. 3.** Knowledge-intensive business services by industry (unweighted)

than one third did not innovate during the last 3 years, while 73% carried out product, process or organisational innovations. I analysed only innovators; that is, I compared innovative firms which are not KIBS with innovative KIBS.[14] In the end the sample consists of 785 innovative companies (161 KIBS and 624 other innovators), which is biased in the sense that I ignored companies founded after 1994.

The distribution of KIBS by industry is not completely industry-independent (see Fig. 3). 40% of the science and technology services and one third of the software companies are KIBS (but not all of them).[15] In banking/insurance and other financial services there are only 14% (but anyway there are some). This result promotes the underlying assumption that KIBS need to be defined as industry-independent if their specific knowledge characteristics are to be taken into consideration.

### 3.3 External Sources of Knowledge and the Internal Knowledge-Creating Processes

There are different dimensions of knowledge. Firstly, it can be classified into explicit and tacit knowledge.[16] Explicit knowledge is articulated in formal language while tacit knowledge can hardly be formalised. Secondly, knowledge can be embodied or disembodied. Embodied knowledge is linked to humans, technology or equipment. Disembodied knowledge is written or stored knowledge. Thirdly, knowledge has different levels of proprietary (Grupp, 1997b: 320). The last dimension is important if one looks at knowledge as an output of the innovation process and at the 'incen-tive' structure for innovation. In this paper the emphasis is on the knowledge creation process, where knowledge is regarded as input factor and the proprietary dimension is neglected.

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[14]Question 22 in the survey from 1997 and question 26 in the survey from 1995 deal with the sources of knowledge for innovation. KIBS are companies which answered that customers either coming from manufacturing or services *and* universities or other research institutes are important or very important knowledge sources. Since we asked these two questions *only* for innovative firms, we do not have answers from non-innovators.

[15]The distribution of KIBS by industry (cross-tabulation) has a significant Pearson Chi-square of 99%. The adjusted residual is 2.1 for KIBS and software and 4.2 for KIBS and science/technology services (n = 785).

[16]See Polanyi (1966) and Gibbons et al. (1994).

Gibbons et al. (1994: 24) point out that the innovation process cannot be understood without opening the 'black box' of knowledge creation. Nonaka and Takeuchi (1995: 71 and 84) suggest a five-phase model of the organisational knowledge creation process which consists of four major processes of knowledge conversion ('knowledge spiral'): (1) socialisation (from tacit to tacit); (2) externalisation (from tacit to explicit); (3) combination (from explicit to explicit); and (4) internalisation (from explicit to tacit). The survey offers some possibilities to measure different forms of knowledge which lead to different knowledge conversion. Table 1 gives an overview of a theoretical concept offered by Nonaka and Takeuchi and the assignment to relevant indicators.

Socialisation is a process of sharing experiences and thereby creating tacit knowledge. In this case learning takes place not through language, but through observation, imitation and practice. Through interactions with customers and other

**Table 1.** Assignment of knowledge conversion to survey indicators.

| | Knowledge conversion | Description | Indicators from the German service survey |
|---|---|---|---|
| Socialisation | tacit ⇒ tacit | • Process of sharing experiences<br>• Learning through observation<br>• Interactions with customers before product development and after market introduction | • External sources of knowledge for innovation: customers and collaborating organisations<br>• Market tests<br>• Knowledge based on personal experience |
| Externalisation | tacit ⇒ explicit | • Creates new, explicit concepts from tacit knowledge<br>• Holds the key to knowledge creation | • Internal research and development<br>• Development of new service concepts |
| Combination | explicit ⇒ explicit | • Individuals exchange and combine knowledge through media such as documents, meetings, telephone conversations, or computerised communication networks<br>• Reconfiguration of existing information through sorting, adding, combining, and categorising of explicit knowledge | • Qualification level of employees<br>• Training of employees<br>• External sources of knowledge for innovation: patent disclosures, journals, conferences, computer-based information networks, published or other public knowledge |
| Internalisation | explicit ⇒ tacit | • Closely related to learning by doing<br>• Documentation helps individuals internalise what they experience | • Internal codified knowledge |

Source: Nonaka and Takeuchi (1995, 62–70), enlargement by the author

**Table 2.** Empirical comparison of KIBS and other innovators (non-KIBS) (unweighted)[1]

| | | KIBS | Non-KIBS |
|---|---|---|---|
| Socialisation | External sources of knowledge for innovation: | | |
| | • Suppliers** | 42% | 20% |
| | • Competitors** | 62% | 32% |
| | • Enterprises within the group* | 46% | 36% |
| | • Marketing and consultants** | 41% | 24% |
| | • Fairs and exhibitions* | 33% | 24% |
| | Collaborating organisations: | | |
| | • Suppliers** | 16% | 2% |
| | • Competitors** | 17% | 6% |
| | • Enterprises within the group** | 23% | 6% |
| | • Marketing and consultants** | 9% | 3% |
| | Market research** | 32% | 21% |
| | Knowledge based on personal experience (only 'very important')** | 61% | 49% |
| Externalisation | Internal research and development** | 47% | 17% |
| | R&D continuously** | 35% | 12% |
| | R&D occasionally** | 12% | 5% |
| | Organisation of R&D: | | |
| | • R&D departments* | 23% | 12% |
| | • R&D project groups* | 51% | 66% |
| | • Others | 26% | 23% |
| | Development of new service concepts* | 49% | 38% |
| Combination | Qualification level of employees, Mean (Std dev.): | | |
| | • University degree in natural or technical sciences** | 22% (27) | 11% (20) |
| | • University degree in economics or social sciences | 8% (12) | 8% (13) |
| | • Technical college degree | 12% (15) | 11% (14) |
| | • Completed apprenticeship | 41% (27) | 47% (28) |
| | • Without degree or training | 18% (26) | 23% (28) |
| | Training linked to innovation** | 71% | 37% |
| | External sources of knowledge for innovation: | | |
| | • Patent disclosures** | 11% | 2% |
| | • Conferences and journals** | 72% | 32% |
| | • Computer-based information networks** | 46% | 17% |
| | • Published or other public knowledge** | 52% | 31% |
| Internalisation | Internal codified knowledge** | 61% | 42% |

ZEW/ISI: Innovation in Services, Survey 1995 and 1997, calculations by the author.

[1]The qualification level of the employees is given in average figures (standard deviation) while all other answers are based on a Likert scale ranging from 1 (not important) to 5 (very important). The numbers in the table show which percentage of the companies regards the respective feature as important or very important. Differences between KIBS and non-KIBS: **significance level of 99%; *significance level of 95% (adjusted residual (>=2).

collaborating organisations, tacit knowledge is shared. The survey comprises questions that ask for external sources of knowledge, for the importance of market research, and for the importance of knowledge based on personal experience.

According to Nonaka and Takeuchi (1995: 66) externalisation is called the process of concept creation, that '*holds the key to knowledge creation, because it creates new, explicit concepts from tacit knowledge*'. The survey specifically asks for the organisation of the internal process of research and development.

Combination means creating new concepts through networking with codified information and knowledge. In this process, existing information is exchanged and reconfigured. An example for combination is the formal education and training at schools. Indicators for the combination process are the qualification level and the training of the employees, as well as explicit external sources of knowledge.

With respect to the measurement of the internalisation process, the internal codified knowledge is the only indicator provided by the survey. Documentation helps individuals to internalise what they experience, although documentation is not a necessary prerequisite for internalisation.

The descriptive analysis of the suggested indicators is shown in Table 2. These results give a first idea how the innovation process of KIBS differs from other innovative service companies.

Within KIBS the socialisation process is based on different external sources like marketing, consultants, suppliers, competitors and enterprises within the group. Additionally, they use market research more often than non-KIBS.

Knowledge based on personal experience is very important for the creation of new knowledge for KIBS. A major difference between KIBS and non-KIBS is reflected by the degree of internal research and development. KIBS conduct R&D more often than non-KIBS, and they do so more continuously. Furthermore, KIBS are characterised by an intensive externalisation process. KIBS also use explicit external sources of knowledge more often, such as conferences and journals, computer-based information networks etc. Apart from this, typical features of their combination process are the great importance given to training, as well as the large share of employees with a university degree in natural or technical sciences. The conversion from explicit to tacit knowledge through internal codified knowledge is significantly more common for KIBS than it is for other innovators. So far we have focused on the internal knowledge creation process. In the following we will shift our point of emphasis to the role of technology.

### 3.4 Descriptive Analysis: Role of Technology

The existing traditional literature on innovation neglects services because of the low technology intensity and the inability to develop or to use technological innovations for products and processes (Pavitt, 1984). Recent studies, however, underline the interdependencies between the technical-economic paradigm in manufacturing and in particular services. For instance, Moulaert et al., (1991) point out that technical consultants do have a significant influence on technological change. Also Miles (1996) assumes, as well as Hauknes and Miles (1996), that some new services play an important role in transferring and creating technological knowledge, and knowledge related to user's assimilation of new technologies. Gallouj and Gallouj (1997) identify

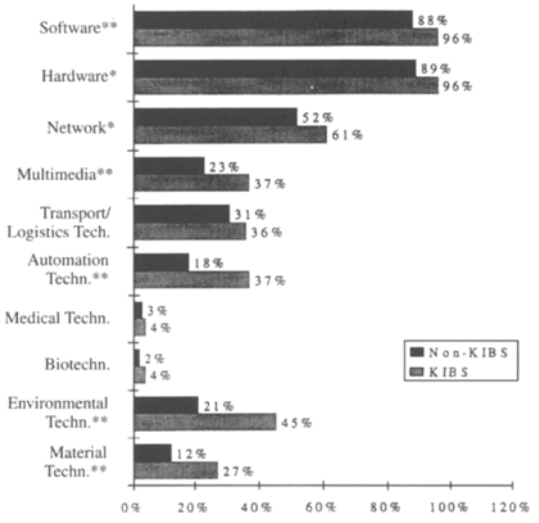


**Fig. 4.** KIBS and Technology (unweighted)[5]

[5]Differences between KIBS and non-KIBS:** means significance level of 99%;* means significance level of 95% (adjusted residual >=2).

five different relations between services and technologies: (1) substitution relation (replacing human capital by technical capital); (2) identity relation (consubstantiality between tool and services, e.g. electronic mailing); (3) determination relation (technological innovation determines the emergence of new service functions); (4) diffusion relation (services help to diffuse technological innovations); and (5) production relation (services produce technological innovations).

The service survey is not able to measure these different relations in detail. But Fig. 4 shows the overall importance of technologies for innovative activities in the service sector. The picture indicates that all of the different technologies are more often important to KIBS than to other innovators. The differences are significant almost everywhere (exceptions: transport/logistic technologies, medical and bio technologies). This is an additional indicator for the fact that KIBS act as an intermediary between the science base (which produce new technological knowledge) and the economy (which use new technological knowledge for their own products and processes). Furthermore, it shows that KIBS do have innovation processes which are technologically based, far from being supplier-dominated.

## 4. Contribution of the Innovation Output to the New Mode of Knowledge Production

Based on the results of the analysis of external sources and the internal knowledge creation process (section 3), we now focus on the innovation output and the diffusion

process of the services. The definitions of 'innovation output' are various (Hauschildt, 1993: 9). In general an innovation output can be either a new process or a new product. A process innovation is concentrated on internal changes to increase the efficiency of the production process. Product innovations are new or improved products. The success and the impacts on the market depend on manifold factors and elements.

As a first step to evaluate the effects of innovation in services we used a qualitative, multidimensional approach. The literature normally concentrates on product innovation which opens up new markets or improves the quality of an existing product, or process innovation, which helps to improve the internal production processes. In our survey we used a broader understanding, taking into account all kinds of effects of innovation which are not measurable in the common sense. Firms are asked to rate different dimensions of the impact of innovations on a Likert scale ranging from 1 ('not at all important') to 5 ('very important'). The dimensions and results for KIBS and other innovators (non-KIBS) are given in Table 3.

The effects mentioned in Table 3 represent both an internal and an external dimension of the service output. The user friendliness or the increased speed of the service production/delivery is an enhancement of the service quality depending on internal changes. But there are other effects which reflect the direct influence on the clients. Especially two impacts are interesting: (1) KIBS are more likely to increase

**Table 3.** Effects of innovation (unweighted) by KIBS and other innovators (non-KIBS)[2].

| Effects of innovation | KIBS | Non-KIBS |
|---|---|---|
| Flexibility to adjust service products to customer needs | 78% | 77% |
| User friendliness | 60% | 58% |
| Reliability of the service products* | 80% | 70% |
| Time availability of service products | 70% | 69% |
| Space availability of service products | 48% | 41% |
| Increasing the speed of service production/ delivery | 78% | 75% |
| Fulfilling safety/standards / regulation | 39% | 38% |
| Fulfilling ecological, medical features* | 24% | 16% |
| Improving the performance of the customer** | 52% | 38% |
| Providing an improved pleasure for the customer** | 37% | 26% |
| Productivity of the customer* | 42% | 33% |
| Durability of service products** | 31% | 16% |
| Motivation of company-internal employees** | 76% | 66% |
| Productivity of company-internal employees** | 90% | 78% |

ZEW/ISI: Innovation in Services, Survey 1995 and 1997, calculations by the author.

[2]The numbers show which percentage of the companies regard the respective effect as 'important' or 'very important'. Differences between KIBS and non-KIBS: **significance level of 99%; *significance level of 95% (adjusted residual >= 2).

the performance of the customer than non-KIBS. More than half of the KIBS – compared to 38% of the other innovators – consider this effect as 'important' or 'very important'. The difference between KIBS and non-KIBS is significant at the 99% level. (2) KIBS are also more likely to increase the productivity of their clients, 42% of the KIBS compared to one third of non-KIBS. The difference is significant at the 95% level.

To analyse the effects in more detail, we did a factor analysis, obtaining four different factors: (1) improved quality; (2) fulfilling environmental standards and requirements, safety; (3) internal effects (improved motivation and productivity of the employees); (4) improved customer performance/productivity.[17] A probit analysis

**Table 4.** Probit analysis of effects of innovation[3].

| Effects of innovations | | Coeff. | Signif. |
|---|---|---|---|
| INDUSTRY | Wholesale trade | 0.131 | 0.625 |
| | Retail trade (base) | | |
| | Transportation/communication | 0.092 | 0.730 |
| | Banking/insurance | –0.069 | 0.803 |
| | Other financial services | 0.210 | 0.546 |
| | Software | 0.669 | 0.025 |
| | Science and technological services | 0.848 | 0.003 |
| | Other business services | 0.295 | 0.290 |
| | Other services | 0.275 | 0.283 |
| SIZE | 1-19 employees | 0.115 | 0.534 |
| | 20-49 employees | –0.084 | 0.572 |
| | 50-249 employees (base) | | |
| | 250 and more employees | 0.635 | 0.000 |
| REGION | East Germany | 0.114 | 0.352 |
| EFFECTS of innovation activities | Factor 1: Quality of the service product | 0.061 | 0.310 |
| | Factor 2: Safety/regulation/ durability of the service product | 0.225 | 0.000 |
| | Factor 3: Company-internal improvements | 0.144 | 0.017 |
| | Factor 4: Performance/productivity of the customer | 0.151 | 0.010 |
| Prob > ch2 = 0.0000 | Pseudo R2 = 0.10 Constant: -1.271 | **Number of obs. = 703 | |

ZEW/ISI: Innovation in Services, Survey 1995 and 1997, calculations by the author.

[3]The probit model has the following equation:

$$P(Y \le c) = \int_{-\infty}^{c} \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-1}{2\sigma^2}(y - \alpha - \beta\chi)^2\right) dy$$

The dependent variable is binary and represents the distinction in KIBS and non-KIBS. The independent variables are the different factors for the effects of the innovation. The model has been controlled for industry, size and region (East Germany and West Germany).

[17]For a detailed description see Licht and Moch (1997: 9).

helps us to understand the relation between these different innovation effects and KIBS. The model is controlled by industry, size and region (see Table 4).

There is no significant difference in terms of qualitative features (factor 1), quite unlike factor 2, where regulations and standards are correlated with environmental technologies.[18] In Germany there are many (regulation-driven) movements to more 'green-based' companies and KIBS support this tendency with new adopted services.

Factor 3 combines the effects which reflect internal changes. The organisation of KIBS seems to be more capable of handling changes. It is also possible that the milieu of KIBS is more dynamic, with shifts in the technological as well as the institutional environment. As already mentioned above, KIBS are also more likely to offer service products which help the clients to develop or improve their products in terms of performance and productivity (factor 4).

We can summarise that KIBS on the one hand support other companies' competitiveness: the service output influences the production process of the customers; or the service outputs influence features of the output of the clients. On the other hand, my definition of KIBS is based on the importance of knowledge input of the customers – either coming from manufacturing or services. That is, the customers affect the innovation process of the service company. For Penrose (1959: 25) service is a function to render resources into a useful input for the production process. This function depends highly on experience and knowledge accumulated within the firm, and is thus firm-specific. If a company decides to get parts of their knowledge from outside, this knowledge input has to be adapted to the special requirements of the company.[19] KIBS and their customers are part of an innovative network where the customers influence the knowledge creation process of the KIBS to get a service output which improves their performance or productivity. This direct influence on the customer is accompanied by more general, economy- and society-wide effects of the service innovation concerning the technological development and the support of environmental and safety features.

## 5. Conclusion

The paper shows that KIBS play an important role in the knowledge-based economy because they help to distribute information and create knowledge. KIBS combine and transform tacit and explicit knowledge to create new services. The information and knowledge are coming from different sources and co-operation partners. Internal knowledge is embodied in qualified employees or disembodied in internal codified knowledge.

The knowledge creation process is characterised by a more formal and institutionalised research and development process, integrating all kinds of tacit and explicit knowledge from vertical (suppliers) and horizontal (competitors), co-operation partners and other external knowledge sources. KIBS are integrated in a system of innovation which can be described as a network where information and knowledge

[18]Correlation coefficient of factor 2 and environmental technology is 0.4043 (significance level of 99%).

[19]For a discussion of several advantages and disadvantages of external knowledge sources, see Foray (1991) and Preissl (1998).

are vertically and horizontally diffused and created. This innovation network can be characterised by group entrepreneurship and learning-through-networking (Hipp 1998).

The empirical analysis shows that the category of specialised technology suppliers and science-based services offered by Soete and Miozzo (1989) can be characterised by KIBS to a certain extent. The results permit the assumption that KIBS not only distribute information, but transform it into, and create, new knowledge, where technology plays a dominant role. KIBS are integrated in the new mode of knowledge production, improving the customer's performance and productivity and contributing to technological and structural change.

Information and communication technologies especially are important in their activities. Communication networks are very important in collecting data from different sources and in helping to intensify service producer and customer interactions. Multimedia is probably the new technology with the highest potential for market growth and the emergence of new services; environmental problems represent one of the important challenges of economies and societies. '*Where our societies are confronted by major technological challenges, as in the case of IT and "clean" technology, new services are playing an important role in transferring and creating technological knowledge, and knowledge related to user's assimilation of new technologies*' (Miles, 1996: 2).

The link to the universities is reflected in a closer link to technologies as artefact.[20] Strambach (1997) points out that KIBS find themselves pulled in two directions: towards the customers and towards the science-based organisations. The network relations cause synergy effects and help to reduce uncertainty. But this leads on the other side to the establishment of structures and relations where the willingness to take risks for radical new products on new markets is shrinking (Leonard-Barton, 1995: 187). Future research needs to concentrate on the dangers and challenges of the new mode of knowledge creation, as well as the contribution of KIBS for technical, economic and social change and the competitiveness of national innovation systems.

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[20]In Germany the institutional conditions for technological services (e.g., engineering services) are very good in terms of education (technical universities) and government programmes (Strambach, 1997). Yet Strambach emphasises that other forms of service products (e.g. management consulting), which are less technology-dominated, are also important knowledge providers for the innovation network. For them, universities and government research programmes do not offer much support. It might be possible that the definition of KIBS given in this paper does not cover low technology-intensive (but knowledge-intensive) business services to a certain extent.

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