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Torsti Loikkanen, Jari Konttinen, Jukka Hyvönen,
Laura Ruotsalainen & Kirsi Tuominen

VTT

Mika Waris, Veli-Pekka Hyttinen & Olli Ilmarinen

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VTT, Vuorimiehentie 5, PL 1000, 02044 VTT
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VTT, Bergsmansvägen 5, PB 1000, 02044 VTT
tel. växel 020 722 111, fax 020 722 7001

VTT Technical Research Centre of Finland, Vuorimiehentie 5, P.O. Box 1000, FI-02044 VTT, Finland
phone internat. +358 20 722 111, fax +358 20 722 7001

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Keywords patent and market information, innovation, innovation process, duplication of R&D

Abstract

Knowledge and information are ever increasing strategic assets for enterprises. The main outcome of this study shows that there are many special grounds for intensifying the acquisition and utilisation of patent and market information in Finnish SMEs. This also holds true for the development and supply of information services. The analysis about the overlapping of research and development activities uncovered an important finding: 33% of Finnish patent applications between years 2000–2005 were not granted to patents because of obstacles for novelty, i.e. the patent application was filed for an already published invention. This duplication of effort could have been avoided by utilising already existing information. The same result may also be generalised to the whole innovation process. Thus, the topic of this study is a strategic issue for the national innovation policy. Other international studies about the amount of overlapping of research and development activities give similar results. The concrete recommendations of the study are aimed at systematically improving the utilisation of information as well as improving the production of services and dissemination of information.

The patent system is an information dissemination system which brings new technical information for the society to utilise. A patent is an exclusive right granted to the inventor for a given period of time; in exchange the inventor has to allow the publication of his invention. Patent documents are the most extensive global information resource of a uniform quality in technology and science. They give you global information about research results, new products and production methods and markets.

Many of the widely recognised success factors for new product performance share a common thread: capabilities for gathering and utilising market information. Market information means all the information that a company needs about its

operational environment, from trends in lines of business and developments in the markets up to profiles of customers, competitors and potential partners. Besides patent documents, there are a number of market information sources, both liable to charge and free-of-charge.

The background covers theoretical and empirical points of view about information and innovation. The following subjects are covered: economic grounds for innovation policy and public financing of research, evaluation of socially optimal investments in research, and hypotheses about under- or over-investment in research. Empirical studies support the hypothesis about under-investment – giving the society the right to finance research and development. The hypothesis about over-investment is linked to unhealthy overlapping of research and development activities. Overlapping research may be either healthy or unhealthy. It is unhealthy if resources are used for research already done, with the results being already freely available and exploitable. Investing in unhealthy research means wasting the resources of both enterprises and society as a whole.

How do small and medium-sized enterprises utilise existing information and information services? We searched for answers in two studies. One study was about acquisition, utilisation and impacts of patent and market information in the innovation activities of SMEs. In the other study we charted the services produced by domestic information services to support innovation, from the point of view of SMEs.

SMEs do not utilise external information systematically. They regard market information as important, but finding the right reliable information is difficult. SMEs do not see the patenting system as a system for disseminating information. They neither consider patent information important nor are able to utilise it. There are not many services specially targeted at SMEs – mainly due to poor demand – and productising services are still poor, too. The results show that SMEs mostly rely on public actors in searching for external information. It is very challenging to assess and analyse the impact of patent and market information as part of an innovation process.

The study raises important needs for future research. Innovation activities in enterprises are changing, due to the changing trends in innovation dynamics. The most important of these include the globalisation of research and innovation, the growing importance of co-operation and networking, and the openness of innovation. Future studies should aim at disentangling the impacts that such changes have on the companies' IPR strategies and practices. On innovation policy level, we need to examine changes in patenting and the whole IPR

system. The characteristics and contents of overlapping patent applications – an investigation which was started here – deserve a more detailed study in the future. The authors of this study suggest the following subjects: differences in branches of business and in lines of technology, profiles of the different groups of inventors, and special characteristics in the size of companies. Another important subject would be to find out if overlapping research is mainly done in companies which are not within public financing of R&D.

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Avainsanat patent and market information, innovation, innovation process, duplication of R&D

Tiivistelmä

Tiedosta on tullut yrityksille yhä tärkeämpi strateginen menestystekijä. Tutkimuksen päätulos on se, että suomalaisten pk-yritysten patentti- ja markkinatiedon hankinnassa ja hyödyntämisessä on runsaasti tehostamisen varaa. Sama pätee tietopalvelujen kehittämiseen ja tarjontaan. Tutkimus- ja kehitystoiminnan päällekkäisyyttä kartoittavassa analyysissä selvisi, että vuosien 2000–2005 kotimaisista patenttihakemuksista yli 33 % oli kaatunut uutuuden esteisiin: patenttia oli haettu jonkun muun aiemmin julkaisemalle keksinnölle. Päällekkäinen työ olisi voitu välttää hyödyntämällä olemassa olevaa tietoa. Patenttitoimintaa koskeva tulos päällekkäisyydestä voidaan yleistää laajemmin koko innovaatioprosessia koskevaksi. Patentti- ja markkinatiedon hyödyntämisen tehostaminen on strateginen kysymys kansallisen innovaatiopolitiikan näkökulmasta. Kansainväliset selvitykset päällekkäisen t&k-toiminnan määrästä antavat samansuuntaisia tuloksia. Tutkimuksen konkreettiset suositukset kohdistuvat tiedon hyödyntämisen, palvelujen tuottamisen ja tiedon levittämisen systemaattiseen kehittämiseen.

Patenttijärjestelmä on tekniikan kehittymistä edistävä tiedonlevitysjärjestelmä, joka tuo uuden teknisen tiedon yhteiskunnan hyödynnettäväksi. Patentti on keksijälle määräajaksi myönnetty yksinoikeus, jonka vastineeksi hänen on sallittava keksintönsä julkaiseminen. Patenttijulkaisut ovatkin maailman kattavin ja tasalaatuisin teknillistieteellinen tietovarasto, josta saa maailmanlaajuisesti tietoa tutkimustuloksista, kehitetyistä tuotteista, tuotantomenetelmistä ja niille kaavailluista markkina-alueista.

Yksi laajasti tunnistettu t&k-toiminnan menestystekijä on tehokas markkinatiedon hankinta, prosessointi ja hyödyntäminen. Markkinatieto on kaikkea sitä tietoa, jota yritys tarvitsee toimintaympäristöstään lähtien toimialojen trendeistä ja markkinoiden kehittymisestä aina asiakkaiden, kilpailijoiden ja potentiaalisten

partnerien profiileihin. Markkinatietoa löytyy patenttijulkaisujen lisäksi lukuisista maksuttomista ja maksullisista tietolähteistä.

Taustatutkimus käsittelee tietoon ja innovaatiotoimintaan liittyviä teoreettisia ja empiirisiä näkökulmia. Aluksi selvitetään innovaatiopolitiikan ja julkisen tutkimusrahoituksen taloudellisia perusteita, yhteiskunnallisesti optimaalisen tutkimusinvestoinnin arviointia sekä siihen liittyviä hypoteeseja tutkimukseen kohdistettavasta ali-investoinnista ja yli-investoinnista. Empiiriset tutkimukset antavat tukea ali-investoinnin olemassaolosta, mikä antaa yhteiskunnalle oikeutuksen rahoittaa tutkimustoimintaa. Yli-investoinnin hypoteesi liittyy epäterveeseen päällekkäiseen tutkimustoimintaan. Päällekkäinen tutkimustoiminta voi olla tervettä tai epätervettä. Päällekkäisyys on epätervettä silloin, kun resursseja käytetään sellaisen jo aiemmin toteutetun tutkimuksen tekemiseen, jonka tulokset olisivat olleet löydettävissä ja vapaasti hyödynnettävissä. Epäterveeseen päällekkäiseen tutkimukseen käytetty panostus on voimavarojen tuhlausta sekä yritysten että yhteiskunnan tasolla.

Miten pk-yritykset hyödyntävät olemassa olevaa tietoa ja tietopalveluja? Miten tehokkaasti innovaatiotoimintaa tukevat tietopalvelut toimivat? Näihin kysymyksiin etsittiin vastauksia kahdessa haastattelu- ja kyselytutkimuksessa. Ensimmäisessä tutkimuksessa selvitettiin patentti- ja markkinatiedon hankintaa, hyödyntämistä ja vaikuttavuutta pk-yritysten innovaatiotoiminnassa. Toisessa tutkimuksessa kartoitettiin innovaatiotoimintaa tukevien kotimaisten tietopalveluja tuottavien organisaatioiden palveluja pk-yritysten näkökulmasta.

Tulosten mukaan ulkopuolisen tiedon systemaattinen hyödyntäminen pk-yrityksissä on vähäistä. Markkinatieto koetaan tärkeäksi, mutta pk-yritykset kokevat luotettavan tiedon vaikeaksi löytää. Patenttijärjestelmää ei mielletä tiedonlevitysjärjestelmäksi, patenttitietoa ei koeta tärkeäksi eikä sitä osata hyödyntää. Pk-yrityksille kohdennettuja palveluja on niukasti tarjolla − pääosin vähäisen kysynnän vuoksi – ja palvelujen tuotteistaminen on vähäistä. Tulokset osoittavat, että ulkopuolista tietoa hyödyntävät pk-yritykset tukeutuvat pääosin julkisiin toimijoihin. Patentti- ja markkinatiedon vaikuttavuuden arviointi ja erittely osana monivaiheista innovaatioprosessia on haastavaa.

Tutkimuksesta nousee esille tärkeitä jatkotutkimustarpeita. Yritysten innovaatiotoiminta on muutostilassa innovaatiodynamiikan muutostrendien takia. Näistä tärkeimpiä ovat tutkimus- ja innovaatiotoiminnan globalisoituminen, yhteistyön ja verkottumisen kasvava merkitys ja innovaatiotoiminnan avautuminen. Jatkossa tulisi selvittää näiden muutosten vaikutuksia yritystason IPR-strategioihin ja -käytäntöihin. Innovaatiopolitiikan tasolla olisi oleellista tarkastella patentoinnin

ja koko IPR-järjestelmän muutostarpeita. Tässä tutkimuksessa aloitettua päällekkäisten patenttihakemusten sekä yleisemmin päällekkäisen tutkimus- ja kehitystoiminnan luonnetta ja sisältöä tulisi jatkossa selvittää yksityiskohtaisemmin. Tutkimuksen kohteita voisivat olla toimialoja ja teknologia-alueita koskevat erot, erilaisten keksijäryhmien profiilit ja yrityskokoon liittyvät erityispiirteet. Samoin olisi tärkeätä saada selville, tehdäänkö päällekkäistä tutkimusta pääasiassa yrityksissä, jotka eivät ole julkisen t&k-tuen piirissä.

Preface

The background for this study is in the efforts of the National Board of Patents and Registration (PRH) to deliver patent information for enterprises and innovators to improve their R&D activities, and to avoid duplication of R&D work. At VTT the starting point for the project was the need to know more about the impact of information on innovation processes for further development of the services of VTT's Knowledge Solutions.

It was clear from the very beginning of the project that effective and sophisticated innovation activities require the systematic acquisition, use and utilisation of information and related patent and market information services. Many large companies have specialised internal information service units and staff and, moreover, they can afford to use external information services as well. Small and medium sized enterprises however have more limited capacity and resources for these purposes.

Although the importance of the topic of this study; that is, the acquisition, use and utilisation of information in R&D and innovation work and the effectiveness of related information services; may sound self-evident, the research in this field is fragmented and relatively scarce from the particular angle of this study. Accordingly, the study attempts to contribute to the current discussion on the topic. The study also relates to topical issues such as "open innovation" and the impact of globalisation on R&D that raise new challenges to the traditional IPR approach.

An effective access to, and utilisation of, relevant information in the different phases of the innovation process can improve innovation activities on the micro level, especially in SMEs. If utilised effectively throughout the innovation system, it has a positive impact on the performance of the entire innovation system. Accordingly, the topic of this study is a strategic issue for the national innovation policy as well.

The research work in the project was divided among the participating organisations as follows. The teams from VTT's Innovation Studies and VTT's Knowledge Solutions prepared Chapters 1 to 2, and Chapters 4 to 5; the team from National Board of Patents and Registration (PRH) prepared Chapter 3; and Chapter 6 (Conclusions, Policy Implications and Further Research) was prepared as a joint effort of all three teams.

Finally, VTT and PRH would like to thank the Finnish Funding Agency for Technology and Innovation (Tekes) for providing funding for this study.

Contents

List of symbols

EPO	European Patent Office
IFIA	The International Federation of Inventor's Association
PCT	International patent application system, based on Patent Cooperation Treaty
PRH	National Board of Patents and Registration, Finland
WIPO	World Intellectual Property Organisation
VTT	Technical Research Centre of Finland
TE-Centres	The Employment and Economic Development Centres
IPR	Intellectual Property Rights

1. Introduction

1.1 Background and objectives

This study is about the acquisition, use, utilisation and impact of information and related information service providers in different phases of innovation processes. Knowledge and information are strategic assets for the success of enterprises and nations worldwide. Effective, target oriented and successful research and development require qualified and competent scientific staff and research facilities, comprehensive knowledge and information of the background and characteristics of the targeted research object, whether that is new technology, invention or any "potential" innovation.

The utilisation of, and access to, a versatile pool of information sources is necessary in developing unique and novel ideas or inventions that differ essentially from existing and already invented ones. The innovator shall be aware of whether corresponding work is ongoing or has been carried out elsewhere in order to avoid "reinventing the wheel", e.g. to avoid developing already patented ideas. Different market information, related for example to industry trends, the future needs of consumers, the size and development of markets, the profiles of competitors or potential partners is important in innovation development. Such information is available from different sources, for example, from data banks, market research reports, government officials, foresight studies and technology roadmaps, etc. However, the acquisition, refining and analysing of such information can be time-consuming and difficult. The costs of acquisition of information may range from free of charge to extremely expensive.

This study explores information and knowledge sources and services needed in different phases of the R&D and innovation process. Some of the knowledge which is needed in innovation activities is tacit expert knowledge that cannot be

presented, documented and disseminated in codified form, and some of it can be documented and transmitted in codified form (e.g. Gibbons et al. 1994; Machlup 1980)[1]. Ackoff (1989) makes a distinction between 'information' and 'knowledge' by elaborating that 'information' is data which is processed to be useful and provides answers to *who*, *what*, *where*, and *when* questions. 'Knowledge', on the other hand, is the appropriate collection of information, such that its intent is to be useful and it answers *how* questions (ibid.).

In colloquial language, information and knowledge are used often as synonyms. The scholars in the field propose to determine the content of these concepts in more detail according to the context in each question, and the previous research in the field indeed offers a variety of solutions. For example, according to Machlup "one may, with good reasons, insist on distinguishing 'information' from 'knowledge' by having information refer to the *act* or *process* by which knowledge (or a signal, or a message) is transmitted." (1980, p. 8). According to Dosi, information "entails well-stated and codified propositions about "states-of-the-world (e.g., "it is raining"), properties of nature (e.g., "A causes B") or explicit algorithms on how to do things". On the other hand, the definition Dosi suggests for knowledge, includes "(i) cognitive categories; (ii) codes of interpretation of information itself; iii) tacit skills; and (iv) problem-solving and search heuristics irreducible to well-defined algorithms" (1998)[2]. The definition of knowledge of Gibbons et al. (1994) is based on the perceived changes in the ways which scientific, social and cultural knowledge is produced. The new mode of knowledge production ("Mode 2") is replacing or reforming established institutions, disciplines, practices and policies. The traditional knowledge production of "Mode 1" is based primarily on the concept scientific and academic knowledge and the new knowledge production of "Mode 2" concept is broader and encompasses, for example, such issues as scientific transdisciplinarity, heterogeneity, social accountability and reflexivity (ibid.).

In conclusion, in innovation studies knowledge, information and related concepts are understood in several ways with contents and meanings depending on the contributors. Such knowledge or information may be codified and readily available, usable and useful for research and the development of enterprises. This study discusses services and service organisations that "inform" enterprises

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1 See Section 2.1.

2 See also many knowledge related articles in Neef et al. (eds.) 1998.

by delivering codified information supporting the R&D and innovation work of enterprises. In addition to delivering codified knowledge or information, these service organisations can offer more in-depth consulting services during which also tacit knowledge and information will be transferred between company and service organisation in a mutual and interactive information exchange and learning process. Such services may relate, for example, to foresight exercises in which e.g. the so-called SECI methodology developed by Nonaka can be applied (e.g. Nonaka 1991).

It is well recognised in this study that merely providing access for inventors and innovators to information sources and services is not enough for benefit to be derived from the available knowledge and information. The organisation must have sufficient absorptive capacity to utilise and reap benefits from the available information. As Cohen and Levinthal stress, "…while R&D obviously generates innovations, it also develops the firm's ability to identify, assimilate, and exploit knowledge from the environment – what we call a firm's 'learning' or 'absorptive' capacity" (1990). Accordingly, it is also about the knowledge management (or information management) strategy of an organisation which forms a context for acquiring, using and utilising knowledge and information in research and innovation activities (e.g. Bouthillier & Shearer 2002).

One point of departure for the present study is a concern about the duplication of research and innovation efforts, and the consequent dissipation of research investments. The duplication of research and innovation is one element of the theory of economic rationale on public intervention in private research and innovation activities. Empirical evidence of duplication of R&D and innovation efforts is available, especially from overlapping patent applications. This evidence refers to a minor use of patent documents as an information source in R&D work. Minor use of information in R&D work concerns other kinds of information as well. The utilisation of information services to provide information on industry trends, markets, competitors, potential partners and other market information is scarce. In particular, small and medium sized enterprises have limited capacity to use available information services as compared to large enterprises (Holappa and Kinnunen 1996). Large companies have for this purpose specialised internal information service units and staff (e.g. information service units, patent engineers, etc.) and they also can afford available external information services.

An effective access to, and utilisation of, relevant information and related information services in different phases of the innovation process can improve

innovation activities on the micro level of inventors in enterprises, especially in SMEs. If information is utilised effectively throughout the innovation system, ultimately this has a positive effect on the performance of the entire innovation system. Accordingly it is a strategic issue in the national innovation policy.

An additional motivation to explore this topic comes from the scarce research in this area nationally and internationally. Moreover, the topic interestingly relates also to certain topical issues of innovation activities, such as open innovation and impacts of the new phase of globalisation on global cooperation in S&T, challenging the traditional IPR approach (see e.g. Gurry 2007). The study aims to contribute to discussion among inventors and innovators in enterprises and research institutes, among policy-makers, and also in the innovation policy research community.

1.2 Structure of the study

The study is structured as follows. Chapter 2 briefly discusses theoretical and empirical aspects of the economic analysis of innovation policy, in which information and knowledge play key roles, and the background of duplication of research and innovation work. Chapter 3 presents the results of a study executed by National Board of Patents and Registration (PRH) indicating duplication of R&D work in Finland. Chapter 4 discusses the role, utilisation and impact of information sources and services in different phases of the research and innovation process, and surveys studies of the role and the impact of information sources in different phases of the innovation process. Chapter 5 presents two interview and survey studies on the acquisition, utilisation and impacts of patent and market information in innovation processes of SMEs. The first study examines the utilisation and impact of patent and market information sources in the innovation processes of SMEs. The second study examines the organisations delivering patent and market information to enterprises in order to support their innovation activities. Chapter 6 draws conclusions, discusses arising policy implications and recommendations, and makes suggestions for further topics to be studied in this research field.

2. Rationale of innovation policy and duplication of R&D

2.1 Introduction

Characteristics of knowledge, knowledge production, information and information asymmetries between economic agents are starting points in the economic theory of innovation policy and the rationale of innovation policy-making and public research funding. The traditional analysis of the economic rationale of innovation policy is based on the determination of socially optimal research investment and related market failures i.e. that the market invests too much (or too little) into research, as compared to the social optimum. This analysis is controversial and related e.g. to the principles of the equilibrium economics, the determination of the socially optimal level of R&D investments, etc. (see e.g. STI 1998; Research Policy 2000; Georghiou et al. 2003). Besides market failure, the discussion of the economic rationale of innovation policy consists also of other aspects and elements such as government failure or system failure, and the changes of the science system and community within the past two decades, that has also brought new elements to the analysis of the socio-economic rationale of innovation policy and public R&D funding (see e.g. Gibbons et al. 1994; Kutinlahti 2005).

In spite of the controversy over the traditional economic rationale of innovation policy and public R&D funding, the market failure and hypotheses as to whether markets invest too much or too little in research. as compared to the social optimum, are assessed as relevant starting points for this study. Section 2.2 gives a short overview of the economic rationale of innovation policy based on these two hypotheses. Empirical research gives support to "under-investment" i.e. research investments are less than the social optimum, which legitimates public research funding. "Over-investment" hypothesis relates to the

duplication of R&D work which is less examined issue in literature. Section 2.2 discusses different theoretical aspects, problems and evidence of duplication of R&D work.

2.2 Economic rationale of innovation policy and duplication of research

The economic rationale, as presented conventionally in the economic literature, is based on two assumptions related to imperfect markets, first on the assumption that markets allocate less-than-optimally to private R&D ("under-investment hypothesis"), and second on the assumption that markets allocate more-than-optimally to private R&D ("over-investment hypothesis"). These approaches will be discussed briefly below[3].

From society's perspective, the economic inefficiency of innovation markets emerges from sub-optimal investments in private R&D. Under-investment in R&D stems from the peculiar characteristics of the outcome of R&D, new knowledge and information, and associated uncertainties of investing in R&D, due to the problem of the appropriating of returns (see e.g. Nelson 1959; Arrow 1962). New knowledge and emerging benefits may leak to competitors which diminish private incentives to invest in R&D. Moreover, uncertainties concerning R&D investment may arise from moral hazards and the adverse selection of researchers in R&D work and organisations (Arrow 1962; Dasgupta 1987). Consequently, private investments in R&D may remain sub-optimal at a societal level. The solution in attaining societally efficient knowledge production is public intervention in the form of R&D subsidies, and through establishing a patent institution which grants a temporary monopoly for the original discoverer to exploit the benefits of invention.

According to the "over-investment hypothesis" (Dasgupta & Stiglitz 1980) the competition in industrial R&D may lead to R&D efforts being duplicated and the consequent dissipation of resources on a societal level. The proposed solution for over-investment is also government intervention, but this time taking a coordinating and reconciling role in private R&D investments to avoid

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[3] The controversy of two hypotheses and related market failures in economic literature is related e.g. to the principles of the equilibrium economics, the related determination of socially optimal level of R&D investments, and challenges of empirical measurement of private and "additional" public returns of R&D investments (see e.g. STI 1998; Research Policy 2000).

R&D being duplicated, and any consequent dissipation of R&D resources, and hence attains efficient R&D and knowledge production.

The under- and over-investment hypotheses have been developed within the welfare economic analysis, and a lot of controversy is given by literature of their relevance also from an empirical perspective. In the economic literature as well as among innovation policy documents, the hypothesis of under-investment gets support more than that of over-investment. For example, Martin and Scott stress that empirical evidence (for example, estimated rates of return on investment in R&D) suggest that on balance it is under-investment that is observed in practice (2000, p. 438). Griliches concludes that, although the theoretical possibility for excessive investment in R&D may be real and may actually occur in isolated cases, the available empirical evidence does not support the conclusion that this is true in general. On the contrary, both the estimates and the likely importance of spillovers suggest that the opposite is true (Griliches 1995).

The "Under-investment" hypothesis is supported by empirical observations in cases of basic research: Griliches (1986), Mansfield (1980) and Link (1981) found a significant 'premium' of basic research on the order of a factor of three or higher. This could imply that there may be even more under-investment in basic research in industry, and by implication, possibly also in science in general (cf. Griliches 1995, pp. 82–83). Moreover, the policy target in many industrialised countries of increasing both public and private R&D expenditures may refer also to the under-investment in R&D, as understood in comparison with leading R&D investors like Japan, Sweden and U.S. According to Hall and Van Reenen the projects that should be promoted from a social point of view are those with the largest gaps between the social and private returns (2000, 449). Metcalfe interestingly concludes that "private incentive is weakest precisely where the social gain is greatest" (1995, p. 421).

The over-investment hypothesis seems relevant from practical policy aspects as well because it refers to evident overlapping R&D efforts of enterprises, due to rivalry and confidentiality in competitive market conditions, the result of which may be resource dissipation. The duplication of R&D and consequent resource dissipation can be mitigated by coordination of R&D by enterprises themselves, by government or by any other institution. Economies of joint research and the related sharing of an R&D portfolio among several companies will decrease risks for individual companies and provide lower mutual learning costs. According to the analysis of Beath et al., if product differentiation and

product specific research paths are introduced to the model, the claim of needless duplication of research loses its force (1995, p. 134).

In conclusion, the theoretical background of the economic rationale of innovation policy is based on characteristics of production of knowledge and information flows and asymmetries between enterprises and other economic actors[4]. These issues are relevant for the consideration of knowledge and information needs of R&D and innovation in enterprises. The analysis of the economic rationale of innovation policy gives starting points for the consideration of the duplication of enterprise R&D as well, and the next sections provide an overview on the debate of the duplication of research from different perspectives.

2.3 Different aspects of the duplication of R&D

2.3.1 Introduction

The duplication of R&D and innovation work is discussed in literature mainly in the context of the economic rationale of innovation policy. In general the analysis of duplication is relatively scarce and empirical evidence is mainly from patenting. Because the analysis of duplication of research is not well-established, various interpretations can be presented of what it means, is it a problem or how serious the problem, and so on.

The duplication of R&D and innovation work can be considered from various perspectives. It can be considered as "a natural part" of a market economy where enterprises compete by selling products which fulfil customer needs. Overlapping production activities of enterprises is an "in-built" element of markets. When a strategic objective of R&D and innovation is to support the competitive power of companies in the same markets, related R&D work may also overlap. In the literature of evolutionary economics, the duplication of research is seen as an intrinsic characteristic of technical change; it is a component of technical change when seen as an evolutionary and collective process. The patent system was created in order to protect the rights of the original discoverer to benefit from innovation. The evidence of imitation of

[4] On precise definition of information asymmetry, see e.g. The New Palgrave, Volume 1.

patented inventions however indicates that duplication takes place even in spite of patenting (see Section 2.3.4 below).

In the literature of evolutionary economics, the duplication of research is seen as an intrinsic characteristic of technical change. As Silverberg (1991) argues, the acquisition of, and access to, versatile information are important to the innovation process, but technological change and related invention and innovation activities shall be understood as being collective and evolutionary processes. As he argues appropriability as such is a fascinating issue for the economist because it is an example of an externality, and thus poses a challenge to the optimum welfare implications of those styles of general equilibrium analysis which, at least in theory, fully reconcile individual and social interests. This has led to a sophisticated literature on whether too much or too little R&D will be conducted compared to some posited social optimum, due either to the inadequate private incentive or to the danger of redundancy and duplication of research efforts. Silverberg tries to demonstrate that both externalities and (near) duplication can be very useful, perhaps even necessary components of technical change when seen as being a collective evolutionary process. The key concept in his analysis is learning, which can take place within an individual, the organisation and collectively through a network of feedbacks unfolding over time between both co-operative and competitive agents (ibid.). In conclusion, in the evolutionary economics literature duplication of research is seen as intrinsic and natural phenomenon.

From the practical perspective, duplication of research and innovation work may be divided into “healthy” and “unhealthy”. For example, if research is carried out for already invented and even patented solutions, research work done may be termed “unhealthy” in a sense that inventor cannot reap the benefits of research work and R&D investments made, and thus there has been some dissipation of resources. On the other hand “near-overlapping” research work may be a positive thing, and also needed and should even be encouraged by public subsidies, for example, if the solution for a final research problem (e.g. developing a new drug) is searched for through several alternative methodological ways, approaches or schools of thought.

The following short analysis is an attempt to organise the analysis of the duplication of research from many different perspectives and vis-à-vis scarce material available from the literature of this issue and empirical evidence available from patenting and some related studies.

2.3.2 Proximity and duplication of R&D

Proximity, whether related to geographical or cultural proximity or proximity between research and innovation communities, is an important factor related to the duplication of research. Intuitively you may imagine that the wider, for example, the geographical proximity is (e.g. between continents), the more duplication of research exists. Duplication may also be specific and differ between scientific and technological fields or between industrial sectors.

Giuri et al. (2007) explored geographical proximity and the exchange of knowledge among inventors in their study on European innovation. The organisational proximity proved to be the most important category. Interactions in the same organization are on average more important than interactions with people in other organisations, especially when they are geographically close.

The relevance of the role of proximity is given also by the econometric study of patenting. One way to capture knowledge flows among firms and industries is to classify firms into different technological clusters according to the technological classifications of their patents (Fung 2004). Jaffe (1988), for instance, relies on the Patent Office's classification system to identify the proximity of firms in the technological space. Proximity between two firms measures the degree of overlap or duplication in their research interests. Hence, a relevant spillover pool pertinent to a firm can be constructed by summing up the R&D efforts of all the other firms weighted by their proximity. Although overlapping in research areas gives rise to a greater opportunity for knowledge spillovers to occur, Fung reminds us that cross-citations do not necessarily reflect research overlap because a firm conducting certain research may cite a patent originated from a totally different research area. For example, an automobile manufacturer may cite a patent owned by a computer chip maker (ibid.).

As this brief glance at the literature glance shows, proximity certainly plays an important role in the duplication of R&D and innovation work. Accordingly, the relationship between proximity and duplication of R&D should be explored in detail in Finland in the future as well.

2.3.3 Duplication of research and patenting

Patenting is used as a proxy indicating R&D and innovation performance in statistical and economic analyses. Patenting is a policy instrument aimed at affecting appropriability of the value of innovation. Patenting is also important

with respect to the topic of this study i.e. the acquisition, use and utilisation and impact of knowledge and information sources in the innovation process. Patents are an important part of information flows between competing enterprises, as shown by Cohen et al. (2002). Patents are seen to play a more central role in diffusing information across rivals in Japan than in the U.S. and according to Cohen et al. this appears to be a key reason for greater intra-industry R&D spillovers there, suggesting that patent policy can importantly affect information flows (ibid.).

One of the basic rationales of the patent system is to provide an incentive for the creation of new technology and inventions. The patent system does this by offering to inventors exclusive rights to commercially exploit patented inventions for a limited time, in return for the disclosure of the inventions to the public (WIPO and IFIA 1998). Patent information is believed to "provide a *unique* planning resource for managing a firm's technology or product development and for systematically evaluating its *competitive position relative to other companies* in a market area." (Ashton & Sen 1988).

The patent system has two interrelated functions, "the protection function" and "the information-function" (WIPO and IFIA 1998). According to WIPO and IFIA "the fact that a patent gives an inventor exclusive rights on a special field and by doing so limits the possibilities of access to this special technology for other enterprises is compensated by the information about the newly developed technology which is to be laid open by the inventor". This information function of the patent is not only the main impetus for the continuous development of the technology, but is also of increasing importance for industrial property offices. They well recognize that providing information to the public is of equal importance to the granting or registration of patents, trademarks and designs, and have created Internet and other ICT based information systems to offer access to patent databases (ibid.).

According to the White Paper from May 2003, prepared by Butler Group, the benefits from patenting are related to avoidance of unnecessary R&D costs, avoidance of litigation, maximisation of license management opportunities (both outgoing and incoming), reduction in product time-to-market, market intelligence, and targeting and evaluation of mergers and acquisitions.

Patenting naturally plays a different role in IPR and the innovation strategies of different companies and industries. For example, according to Cohen et al. semiconductor firms, as driven by a rapid pace of technological change and short product life cycles, tend to rely more heavily on lead time, secrecy, and

manufacturing or design capabilities than patents to recoup investments in R&D (see Cohen et al. 2002).

2.3.4 Duplication of R&D and imitation in patenting

Industrial property offices have developed information systems in order to avoid duplication of R&D work. Awareness of the state-of-the-art technology in a particular technical field can avoid duplication in research work by indicating that the desired technology already exists (WIPO and IFIA 1998). It can also provide ideas for further improvements, or can give an insight into the technological activities of competitors and, by reference to the countries in which patents have been applied for, the marketing strategies of competitors. A search for state-of-the-art technologies can also identify newly developing areas of technology in which future R&D activity should be monitored (ibid.).

However, WIPO and IFIA express their concern about the use of patent documents as a source of technological information which is unexpectedly low (1998). WIPO and IFIA refer to a relatively old survey from 1985, which dealt with the problem of technology and innovation in Austria. The survey found that only four percent of the enterprises used patent literature as an innovative instrument[5].

As WIPO and IFIA stress, the low utilisation of patent information is regrettable, because it is a fact that in the EC countries billions per year – the UK Patent Office spoke of about 20 billion Pounds – are wasted to develop things that are already developed and documented in the description of patent specifications (WIPO and IFIA 1998). WIPO and IFIA also refers to another study which confirmed that a large amount of redundant research takes place, since it was found that 30 percent of all R&D in Europe duplicates work already done (ibid.). WIPO and IFIA make proposals to industrial property offices in order to further develop patent information services in the future (ibid.).

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[5] According to the Austrian study the influence and use of patent information increases in relation to the size of the research and development institution or the enterprise; 18.5 percent of companies with more than 100 staff reported to actively use patent literature. Only 2–3 percent of enterprises with less than 100 staff use patent literature in the first stage of a R&D project. This result correlates with a much more intensive patent activity in larger enterprises. Only 5 percent of the enterprises in this study had 500 and more employees, but 55 percent of the patent applications originated from this group.

Imitation is, strictly speaking, not duplication of R&D but is, however, a related issue. First of all, there are a lot of studies of imitation and consequent successful science and technology policies e.g. from Japan and South-Korea in which a systematic imitation from western countries has played an important role (e.g. Freeman 1987). The aim of patenting is to guarantee that the discoverer company can be the only exploiter of the invention; at least during the period the patent is in force, and in this way to encourage innovation. There are, however, problems in protecting proprietary rights based on patenting due to imitation. For example, a study of nearly 50 product innovations in the electronics, chemicals, pharmaceuticals and machine tools industries shows that less than four years after they were marketed, some 60 percent of these innovations patented by their investors had been imitated, and, moreover, at a cost about a third lower than that which the innovating enterprise had spent on developing them (Mansfield et al. 1981). A report of the US International Trade Commission has estimated that American industry lost almost 24 billion dollars as a result of imitations in 1986 alone (US International Trade Commission).

The White Paper gives evidence from the survey of 261 companies by IRN Services. Over 70% of companies admit to investing in research that led to (or was leading to) a previously patented solution; the estimated cost of this averaged out at 30% of the total R&D spend. When one applies these findings to specific vertical market sectors, the true scale of ‘waste’ is obtainable. The top three vertical market sectors in terms of R&D spend are information technology with US$ 73 billion, automotive with US$ 46 billion, and pharmaceuticals with US$ 44 billion. Some simple mathematics allows us to gauge the wastage in hard cash (as opposed to percentages): information technology wastes US$ 15.3 billion, automotive wastes US$ 9.7 billion, and pharmaceuticals wastes US$ 9.2 billion. In total, across the top eight vertical market sectors (in terms of R&D spend), the estimated total wastage is US$ 48 billion.

There are several factors worth noting here; that this loss has a direct impact on the bottom line for every company, it does not include contributory losses due to increased time-to-market, it does not include contributory losses due to litigation, and a significantly high percentage of this waste in R&D could be avoided with access to patent publications, and an understanding of their true content (ibid.). Moreover, it is worth giving some additional thought to the last point above. Simply having access to patents is, by itself, of little benefit. Access to the meaning of the patent; what it exactly details, and the ability to discover that information easily and quickly are the key points.

As the short overview of duplication or R&D and imitation of patenting in this section indicates these are very complex issues that must be taken into account in R&D and IPR strategies of enterprises, as well as in IPR strategies of innovation policies and of related information service providers. Although services delivering market and patent information to customers should be developed to become more effective, the problem of the misuse these services, for example, in the form of illegal imitation and principles and measures to respond to this problem should be recognised as well.

2.4 Conclusions

In conclusion, duplication of research and innovation efforts is taking place for different reasons, as discussed above. Duplication is considered in the literature mostly as a negative phenomenon but not only as that. In evolutionary economics it is even considered as a necessary component of technical change when seen as an evolutionary and collective process. Empirical evidence of the extent of duplication of R&D and invention efforts is available from patenting, and from studies of imitating.

Duplication of research can be mitigated by efficient coordination of research and innovation efforts, stricter control of IPRs (e.g. in cases of imitation of patents), and by related more effective and efficient services delivering patent and market information. Co-ordination of R&D can be executed either by private or by public activities. Coordination is an inbuilt responsibility of public agencies granting public funding to enterprises, R&D institutes and universities. Coordination and reconciling of research efforts is however limited within publicly supported and promoted research and innovation activities. Evidence from overlapping patent applications indicates that coordination is not sufficient among patenting enterprises and inventors. Although there is not information available of the entire overlapping R&D and innovation efforts of national system of innovation, or from a European or global level, overlapping patent applications give a rough indication that duplication of research and innovation efforts is a real phenomenon, and that it should be put on the agenda of innovation policy.

Mitigation of the duplication of R&D and innovation efforts, whether explicitly or implicitly, has been taken into account in innovation policy practice, especially through networking and related promotion of collaboration of enterprises and other relevant private and public organizations in R&D and

innovation. One of the key strategic objectives of the Tekes programmes in Finland has been to network enterprises of different sectors and size, as well as with universities, R&D institutes and other relevant organisations related to innovation. Moreover, there are examples of innovation policy approaches aimed at avoiding duplication of R&D and innovation efforts, for example, from Japan and the European Union. According to Porter et al. (2000) the Japanese government has played a significant role in organising and financing cooperative R&D projects. The rationale was to spread the fixed costs of R&D among many participants and to avoid the wasteful duplication of effort by allocating research tasks among the participants. A celebrated example of government-sponsored cooperative R&D was the VSLI project, designed to help Japan catch up in semiconductor technology. Japanese leadership in this technology was however lost (ibid.). Another example of innovation policies aimed at avoiding duplication of R&D efforts is from the European Union.

3. Finnish patent applications and novelty examination by PRH[6]

3.1 Introduction

As Section 2.3 above argues, the duplication of research and invention work can be avoided by the acquisition and utilising different information in innovation process. Chapter 3, based on the study by National Board of Patents and Registration (PRH), provides empirical evidence of the duplication of invention in patent applications, and perspectives to avoid duplication by utilising patent information services.

3.2 The role of information in innovation process

As much as 80 percent of the value creation of companies is based on intellectual capital. However, the instruments concerning the management of this capital are poorly utilised. This especially concerns the protection of intellectual property and the usage of existing technical knowledge. The poor usage of the IP-system creates problems in R&D as well as in marketing and other areas of business. Besides protection, the Intellectual Property-system provides also a unique source of technical and competitor information for the use of marketing and product development.

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[6] Chapter 3 is prepared by the team of The National Board of Patents and Registration (PRH) led by Mr. Mika Waris.

According to Koen et al. (2001), the innovation process may be divided into three areas:

- the fuzzy front end
- the new product development process and
- commercialisation.

The first part, fuzzy front end, is generally regarded as one of the greatest opportunities for improvement of the overall innovation process. Attention is increasingly being focused on the front-end activities in order to increase the value, amount and success probability of high-profit concepts entering product development and commercialisation. Even 80% of the costs for the whole innovation process are committed at the very early phase of the project. Making a wrong choice in this phase means that all later decisions are made within the mistake.

Using relevant information in the beginning of the innovation process may significantly reduce the risks of the project. When the process proceeds, the possibility of influencing the total costs of the product diminishes rapidly. So it is important that all possible essential information is available at a very early phase of the development.

3.3 The patent system

The patent system is an information dissemination system; it exists for the purpose of promoting the technological progress, the prosperity of the nation. The essential thing in the pursuit of this goal is the stimulation of product development and the new technical information disclosed in patent publications.

The first prerequisite for an invention to be patentable is that it has to be novel. Exclusive right is not granted to old, previously known techniques. Secondly, besides being novel, the invention must also involve an inventive step. The third precondition for patentability is industrial applicability. Besides conventional industries, patents include solutions, methods and devices needed in commerce, building industry, farming, forestry, gardening, fishing, handicrafts etc. A patentable invention is a concrete embodiment of an idea: a technical solution, a device, a product, a process for making a product, for instance, or a new use for a previously existing product.

There are many prejudices concerning patents. One of the most common is the belief that patents are applied for and granted to complete new products or very

exquisite inventions. The reality is quite opposite, more than 80 percent of all patents relate to technical solutions. Complete patented products are rather rarities than mundane. On the contrary, a product very often contains several technical solutions protected by patent. For example, a typical mobile phone contains easily more than 1,000 patented solutions, and a modern car can include even 10,000 patents.

For every applied patent, there is a very detailed patent publication. Every patent publication describes the latest cutting edge developments in the sector, the existing problem and the discovered solution based on the invention. Thus, in conclusion, the information contained on patent documents is very detailed, applied technical information in a structured and formal form. Today, more than 60 million patent documents have been published world-wide. The information is increasingly available on the Internet, and also free of charge[7].

Patent documents are one of the largest public databases in the world. The European Patent Office (EPO) estimates that more than 80% of the technical information contained in a patent document is never published anywhere else.

According to the survey conducted by EPO in 2003, more than 80% of companies already using patent information considered the information in patents as very important or important. Patent information was considered to be most useful in early stages of product development; during pre-development and invention stage – so that is during the fuzzy-front-end phase.

3.4 Results of PRH study

The National Board of Patents and Registration (PRH) carried out a study of domestic patent applications and the findings based on the novelty examination made by PRH's examiner. The empirical data used is the novelty examination reports made by PRH of 11,775 patent applications in years 2000–2005. The amount of granted patents during the same time period was 5,144, which is 43.7 per cent of the respective applications.

[7] E.g. the Finnish site is available at http://fi.espacenet.com.

Table 1. Domestic patent applications in Finland between 2000–2005.

Appli-cations	*Examin-ations*	*Obstacle for novelty/ inventiveness*	*Granted*	*No references/ publications*	*References describing technological level*
14 398	11 775	3 906 (**33.2%**)			
			5 144 (**43.7%**)	537 (**10.4%**)	4 607 (**89.6%**)

According to results 33.2 per cent of patent applications were not granted to patents because of the references (obstacles) for novelty and / or inventiveness, i.e. the patent application was filed for an already published invention meaning that the inventive work done overlap with former invention efforts. In these cases there is:

- a risk of developing solutions to which someone else has exclusive rights, and
- a risk of wasting time and money.

Consequently, a use of patent information before or during the R&D phase these pitfalls could have been avoided.

Only 10.4 percent, or 537, of all granted patents were such solutions, where there was no reference publications found, in other words, they were completely new inventions. The radical inventions can be found among these patents. Still, using patent information in the early phases of the process gives you the certainty of the uniqueness of the invention.

Respectively in 89.6 percent, or 4 607, of the granted patents there were publications describing technological level and thus the use of patent information would have been useful in these cases. In these cases using patent information the advantages are:

- saving time to market
- better quality of the invention
- possibility to license technology (MOB)
- stronger protection of the invention
- useful knowledge of the competition in the field
- useful knowledge of state-of-the-art technological solutions.

3.5 Conclusions

The results of the PRH study showed that in Finland 33.2 percent of the domestic patent applications were filed for already published invention, meaning that the inventive work done was overlapping with former invention efforts. In 89.6 percent of the granted patents there were publications describing technological level and thus the use of patent information would have been useful in these cases. Respectively, only 10 percent of all granted patents were such solutions where there was no reference publications found. Still, using patent information in the early phases of the process gives you the certainty of the uniqueness of the invention.

It is known that in large companies patent information engineers can conduct patent searches and share the relevant information with the product development personnel in an organized manner, but regarding SMEs more effort is needed in order to determine how the use of patent information could be integrated and utilised in SME's innovation processes. Patent information analysis concerning product development is useful to:

- avoid duplication of R&D work
- to identify specific new ideas and technical solutions, products or processes
- to identify the latest developments in a specific technological field in order to be aware of the latest development
- to assess and evaluate specific technology and identify possible licensors (make-or-buy decisions)
- to improve an existing product or process
- to develop new technical solutions, products or processes
- to identify existing industrial property rights to avoid infringement actions
- to assess novelty and patentability of ones own research and development activities.

If we look at the patent information source, we notice that

- it is the largest, unique source of technical information in the world
- the information is very up-to-date, it is updated by the NPO authorities throughout the world

- it is very structured information, the structure has been defined similar in all countries using the patent system, so you can find certain information independent of the country of origin
- it is well classified, and
- the information is very detailed and reliable
- about 80% of all technical information is available only in this information source.

The main problem in the use of patent information reported earlier by SMEs is the lack of information about the methods and tools they could use to retrieve and analyze the patent information, the lack of internal resources that could be used for this analysis, and the lack of offering of adequate patent information services. The presentations of two case studies in the Chapter 5 of this report concentrate more closely to the challenges in the utilisation of information services in SMEs.

4. Information acquisition of R&D and innovation in enterprises

4.1 Introduction

Chapter 4 considers the need, acquisition and utilisation of information sources and services in R&D and innovation. Section 4.2 identifies different needs of external knowledge and information sources in different phases of innovation process. Section 4.3 makes a short overview of studies of the roles and impacts of information sources in research and innovation work of enterprises. Section 4.4 discusses the changes of global business and innovation environments, such as the emergence of global alliances, new innovation models and open innovation model. Section 4.5 draws conclusions from Chapter 4.

4.2 Information needs in innovation process

Different information and a number of information sources are needed in different phases of the innovation process. In fierce global competition the challenge to acquire and utilise information is constantly growing. As the mobility of information increases, a firm's competitive success critically depends on its ability to monitor and quickly seize external sources of knowledge (Iansiti 1997). A company can leverage basic or generic technologies developed elsewhere, which allows it to focus on developing unique applications that better suit the needs of specific overseas markets (Iansiti & West 1997).

The information needs in different phases of the innovation process can be illustrated by Chain-Link model of innovation developed by Kline and Rosenberg (1986) (Figure 1).

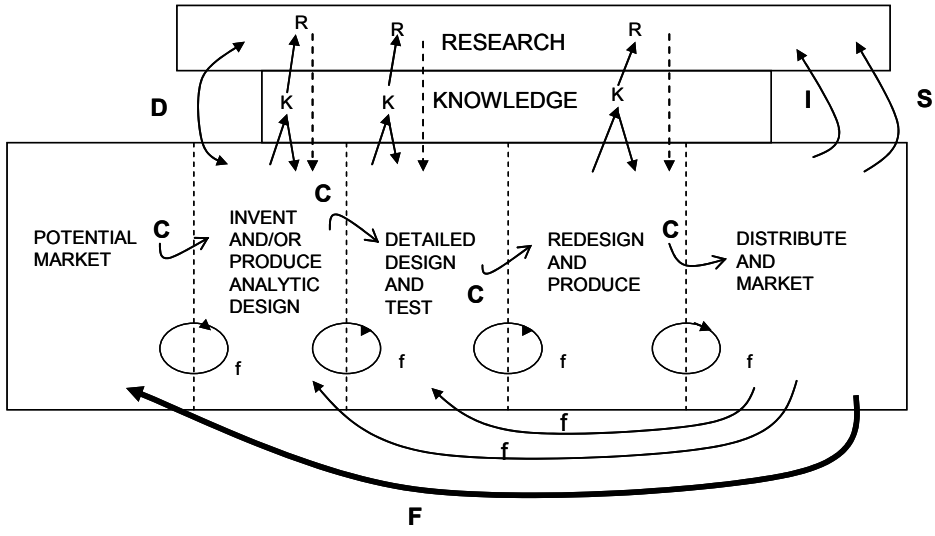

Figure 1. Chain-linked model of innovation process (Kline and Rosenberg 1986).

This complex, non-linear and dynamic model of innovation process is developed on a basis of long-lasting consultation of R&D activities of enterprises and related innovation studies, and this model is used as an analytical framework in innovation and innovation policy studies.

The chain-linked model of innovation process describes the flow paths of information and co-operation. Symbol C refers to central chain-of-innovation and F/f to feedback loops. K-R refers links through knowledge to research and related feedback loops. Symbol D illustrates influence from research to invention and design and again related feedback loops. Symbol I refers to the support of scientific research and S the support of research in the product area. The model attempts to illustrate the complex nature of innovation with feedback loops from markets and research back to invention and design in company.

The actors and institutions playing roles in different phases of the innovation process need relevant information from respective expert sources and services. Some examples of such information needs are illustrated in Figure 2.

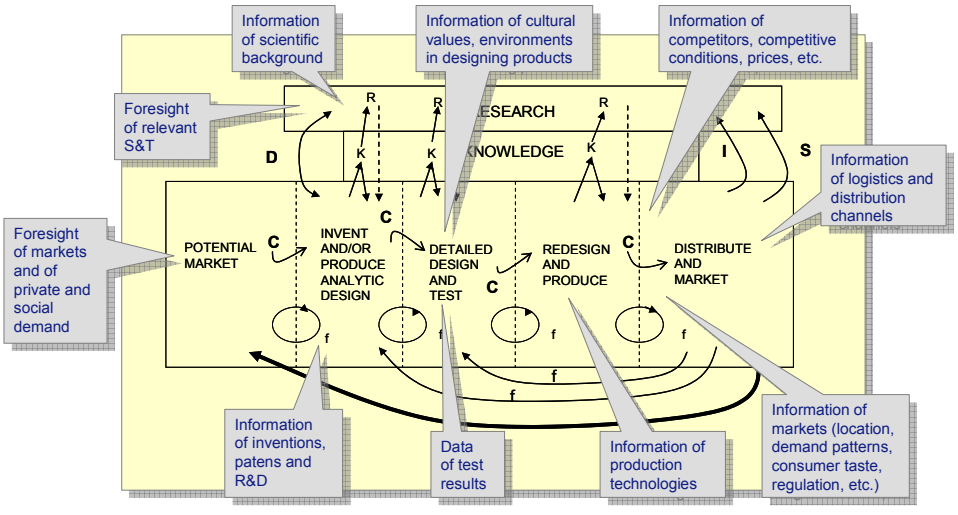

Figure 2. Examples of knowledge and information service needs in different phases of innovation process.

In the phases of innovation process they need information on the future trends and market potentials, required technologies (roadmaps) and services (consumer preferences, intermediate products, etc.) and new business opportunities. This information may be based on the examinations and surveys of private and social needs and demand in the future, i.e. of private consumers and companies as well as of needs for regulation.

In the phases of research and invention, as well as in the later phases of design, piloting and prototyping, it is important to have information on previous or on-going studies in other companies or research institutions. In the later stages of the innovation process, in approaching the commercialisation or innovation and markets, it is important to have information about distribution, markets etc. It is important to have a different sort of information available to companies and other participants in the beginning of the innovation process in order to avoid overlapping or doubling efforts and any ensuing dissipation of resources.

Figure 2 is for illustrative purposes only. A more detailed description of information source needs could be illustrated in the case of each actor, organisation and instruction (inventors, enterprises, R&D organizations, etc.). As Cohen and Levinthal (1989) argue, what is important is also that while R&D obviously generates innovations, it also develops the firm's ability to identify, assimilate, and exploit knowledge from the environment – what we call a firm's

'learning' or 'absorptive' capacity. While encompassing a firm's ability to imitate a new process or product innovations, the absorptive capacity also includes the firm's ability to exploit external knowledge of a more intermediate sort, such as basic research findings that provide the basis for subsequent applied research and development. Also, in light of the dependence of industrial innovation upon extramural knowledge, absorptive capacity represents an important part of a firm's ability to create new knowledge. In this regard, the exercise of absorptive capacity represents a sort of learning that differs from learning-by-doing, the focus of industrial economists' work on firm learning in recent years (e.g., Spence 1981; Lieberman 1984). Learning-by-doing typically refers to the automatic process by which the firm becomes more practiced, and, hence, more efficient at doing what it is already doing. In contrast, with absorptive capacity a firm may acquire external knowledge that will permit it to do something quite different.

Ottum and Moore summarize (1997) that although no single variable holds the key to new product performance, many of the widely recognised success factors share a common thread: the processing of market information. Understanding customer wants and needs ultimately comes down to company's capabilities for gathering and using market information.

As emphasised e.g. by WIPO and IFIA, the successful marketing of inventions and technology means to marry a new invention to a real existing need, and it demands an extensive and very close collaboration and cooperation between three groups of people: those who create inventions and technology, those who explore and create markets and those who use inventions and technology (WIPO and IFIA 1998). Such cooperation depends to a large extent on their capacity to actively collect, select, analyse and exchange information (ibid.).

4.3 Studies of information sources of innovation

This section gives a short overview of studies of the roles and impacts of information sources in different phases of the innovation process. In the literature of industrial innovation and innovation policy the role of knowledge and information have been discussed from multiple points of view.

One essential issue here is from where and how companies acquire their required new technological knowledge. Granstrand et al. suggest a typology of technology

acquisition and exploitation strategies of companies, presented in Figure 3 (Granstrand 1999, Granstrand et al. 1990).

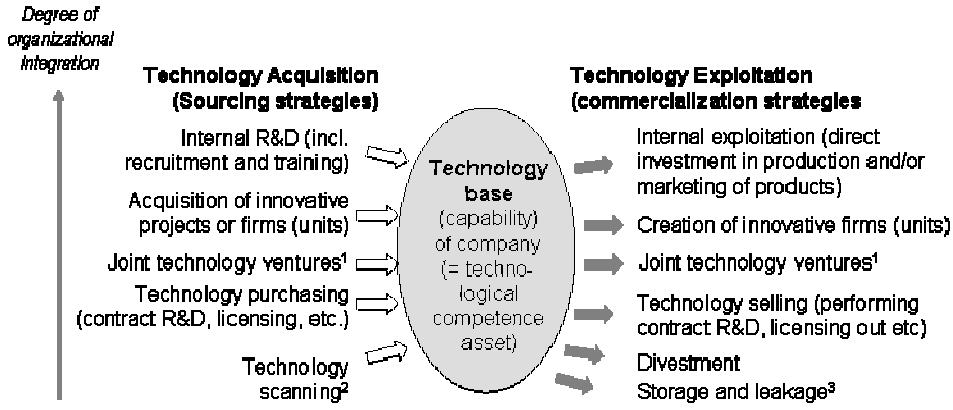

Figure 3 Generic strategies for acquisition and exploitation of technology (Granstrand 1999; Granstrand et al. 1990). (Notes: [1]Joint ventures refer to inter firm R&D cooperation in general, not necessarily formalized, for example with subcontractors. [2]Scanning includes legal and illegal forms of acquiring technological know-how from outside with no direct purchasing from its original source. [3]This is not a strategy for exploitation but a kind of residue of unappropriated technology, possibly leaking to competitors through their technology scanning efforts.)

The in-house R&D activities of companies can be supported by acquiring R&D from external sources. Typical technology sources are, for example, the acquisition of innovative firms which have competitive technology, innovative cooperation with other companies, recruitment of technological experts, follow-up or scanning of technological development, and the purchasing of new technology in the form of patents and licensing. The ways of acquisition of new technologies vary in enterprises in different countries (e.g. Granstrand 1999).

In technology acquisition also the importance of external contract research has increased in the U.S., Sweden and Japan (Granstrand et al. 1990). One reason is related to a changed R&D and innovation strategies of corporations. To a certain extent corporations have dispersed their R&D activities to subsidiary level, or increased flexibility by increasing the acquisition of external R&D services and correspondingly decreased permanent in-house R&D personnel. Such trends give opportunities for private and public R&D and consulting firms to enlarge their services. Nevertheless, in many cases corporations still keep on executing their strategic product and process technology R&D in-house.

External information sources for companies include public universities and R&D institutes both of which are in most industrial countries an important part of the national innovation infrastructure.

Cohen et al. (2002) explore the role that public research plays in industrial R&D, and the pathways through which that effect is exercised. The study is based on data from the Carnegie Mellon Survey on industrial R&D. They evaluate the influence of "public" (i.e., university and government R&D lab) research on industrial R&D in the U.S. manufacturing sector. The results indicate that the key channels through which university research impacts industrial R&D include published papers and reports, public conferences and meetings, informal information exchange, and consulting.

Nivala (1994) is among relatively few studies carried out in Finland on external information sources of enterprise innovation. Nivala studied the knowledge acquisition of small and medium-sized industrial enterprises to their development work from institutes of technology and other information channels (Nivala 1994). Among the main results of the study are the following: The importance of external information and know-how to enterprise development grows with the enterprise size and investment in developing functions. The companies have experienced as most profitable the kind of information channels that are connected to the enterprise's daily functions. The importance of customers has been great but contributions of the so-called technology-issuing information channels (research institutes, universities and educational establishments) were significant only for few enterprises.

The recent survey of PricewaterhouseCoopers (PwC 2009) in Finland to CEOs of the 100 largest companies, of the 100 biggest R&D investors and of the 200 innovative SMEs enquired about the importance of public- and university research in the innovation activities of companies (PwC 2009). According to the results this type of research collaboration is of minor importance for companies today. The survey concludes that companies are trying to do basic research related activities by themselves. In SMEs the importance of this particular item is estimated to decrease during the next two years, but large firms consider the future outlook to be more positive. The results indicate however differences among companies operating in different industries.

As a short overview on selected studies indicate, the roles and impacts of information sources in different phases of the innovation process vary. In the future more systematic examinations should be executed in order to better

understand and make consequent policy conclusions on the roles played by external information sources in industrial innovation.

4.4 Changing global landscape of innovation

Paced by information and communication technologies the global economy has shifted to a new phase characterised by international capital, production, knowledge and labour markets. The growth of BRIC countries and particularly of emerging Asian countries such as China and India has an influence worldwide on the economic, scientific and technological development (e.g. Gurry 2008).

The globalisation of innovation activities and related organisational and local changes, accelerating mobility of labour force and increasing pace of change in general create new challenges and opportunities for enterprises. They cannot mobilise all resources, competences and capabilities required by effective knowledge production by themselves internally, but are increasingly dependent on external sources, networks and cooperation (Chesbrough 2003; von Hippel 2005; R&D Management 2006; Torkkeli et al. 2007). The innovation model according to which the majority of knowledge was created internally will be replaced by a model according to which majority of knowledge will be acquired from external sources. Empirical evidence of increased collaboration in innovation is available, for example, from patent applications. By the OECD cross-border collaboration on inventions (sharing patents among inventors from two or more countries) almost doubled as regards to global volume (from 4%: to over 7% from 1991–1993 to 2001–2003) (OECD 2007). Increasingly effective ICT improves the access to sources of science, patents and related information which also decreases the need to own basic or applied R&D but, on the other hand, necessitates additional investments in product development and the acquisition of knowledge and competences worldwide (Chesbrough 2003; Gurry 2007).

Along with increasing globalisation, innovation activities of enterprises face different challenges. Competition for highly skilled but affordable labour force increases in narrow niche areas requiring special competencies. Business models of companies must effectively adjust to the new requirements of global markets. In addition to own R&D, the pressure increases to utilise licensing in business i.e. commercialise IPR property and technology acquired from external sources. As Grindley and Teece emphasise, this should, however not jeopardise absorptive capacity to develop core competencies and the capability to utilise

external knowledge (1997). Different aspects described above give new challenges to "IPR-regime" and related rationale of innovation policy as well (e.g. Dosi et al. 2006).

The development of knowledge and competences on a basis of external sources, networks and collaboration change IPR strategies, principles and practices of enterprises, as well as traditional ways of thinking, private and public interests of patenting and its incentive effect to innovation (Gurry 2008; von Hippel and von Krogh 2006; Dosi et al. 2006). von Hippel has explored how and why users, individually and in firms and in communities, develop and freely reveal innovations, and argues that there is a general trend towards an open and distributed innovation process driven by steadily better and cheaper computing and communications. The net result is an ongoing shift toward the democratisation of innovation (von Hippel 2005). As von Hippel accentuates, this welfare-enhancing shift is forcing major changes in user and manufacturer innovation practices, and is creating the need for changes in government policies (ibid.).

According to Chesbrough, rather than restricting innovations to a single path to the market, open innovation inspires companies to find the best business model – whether that model exists within a firm or with an external one (2006). It is increasingly the university systems which will be the locus of fundamental discoveries, and industry will need to work with universities to transfer those discoveries into innovative products, commercialised through appropriate business models (ibid.). Boldring and Levine question the traditional IPR thinking: "IP is not like ordinary property at all, but constitutes a government grant of a costly and dangerous private monopoly over ideas. We show through theory and example that intellectual monopoly is not necessary for innovation and as a practical matter is damaging to growth, prosperity and liberty" (Boldring & Levine 2008). Although Boldring and Levine represent a kind of extremist critical approach vis-à-vis traditional thinking in IPR, the open source approach in innovation activities seems to be an increasing trend in many innovation development platforms.

4.5 Conclusions

A number of different information and information sources are needed in different phases of the innovation process. Companies need information about the future trends and market potential, required technologies (roadmaps) and services (consumer preferences, intermediate products, etc.) and new business opportunities. In the phases of research and invention as well as in later phases of design, piloting and prototyping, it is important to have information on previous or on-going studies in other companies or research institutions. In the later stages of the innovation process, in approaching the commercialization or innovation and markets, it is important to have knowledge of distribution, markets etc. What is important is also a firm's ability to exploit (*absorptive capacity*) outside knowledge (of a more intermediate sort), such as basic research findings that provide the basis for subsequent applied research and development. Compared to so-called 'learning-by-doing', with absorptive capacity a firm may acquire external information that will permit it to do something quite different.

The global economic and innovation environment is also in a dynamic change which has numerous impacts on innovation, IPR and the knowledge exchange strategies of companies, as well as on innovation policies. Increasingly new knowledge is created and R&D labs are established in emerging Asian countries, such as China and India. In addition, an increase in the acquisition of information from external sources in product development – whether this information originates from research organisations, company networks or user communities – challenges the traditional way of thinking private and public interest of patenting and its incentive effect on innovation.

5. Case studies on information services supporting R&D in SMES

5.1 Introduction

Chapter 5 examines the use of patent and market information, as well as the supply of information services in innovation production. In order to deepen the picture in Finland, two surveys targeted to Finnish SMEs and information service providers were carried out. In addition, interviews were conducted with four SMEs, two large corporations and two experts in the field of innovation development. Section 5.2 presents the study on the utilisation and impacts of information services to SMEs. Section 5.3 presents the interview and survey study made to organisations supplying information supporting R&D and innovation activities. Section 5.4 concludes the results of both case studies.

5.2 The use of information services in R&D and innovation of SMEs

Section 5.2 presents the interview and survey study on the use, utilisation and benefits of information services to SMEs. The SME survey and the interviews were utilised to elaborate what kind of information services SMEs use, when they use them, and what kind of services they would need in innovation development. In addition, SMEs were requested to assess what kind of positive impact the use of services might have generated for the company and how applicable or usable the existing services are for the companies. The interviews with large corporations and experts were utilised to construct an outlook of best practices in information utilisation. Both of the large corporations were selected for the interview on the basis that they are model examples of effective utilisation of technical market information in innovation development.

In the survey, targeted companies were selected on the basis that they were (1) SMEs (companies employ maximum of 250 people); (2) and they utilise IPR in their business activities and therefore they would be potential users of patent and market information. The survey was carried out using a web-based evaluation solution[8]. The survey was sent to 726 respondents (CEO or other key person in the company) via email, from which 73 answered the questionnaire. The response rate does not allow us to make conclusions based on statistical significance, but it will give us an indication of the state of information utilisation in Finnish SMEs.

The systematic utilisation of external information in innovation activities is remote. Only 29.4 percent of the respondents indicated that they use systematically external information in innovation activities; 63.2 percent indicated that they do not use it; and 7.4 percent of the respondents indicated that they have considered a change in their customs related to the use of external information. Although, 42.4 percent of the respondents indicated that their company has delegated the responsibility of acquiring and disseminating relevant information related to innovation activities to a certain employee. However, as the interviewed SME representatives indicated, the responsibility for acquiring suitable and adequate information in small companies belongs to everyone who is involved in product development, and often in small and micro sized firms, every employee is somehow involved in the process.

When we asked respondents to identify the different information channels they utilise in innovation activities, personal or professional networks, as well as customers or contractors are the most utilised channels for SMEs when they require external information (see Figure 4).

[8] More about Zef Solutions Ltd. evaluation tool see: http://www.zef.fi.

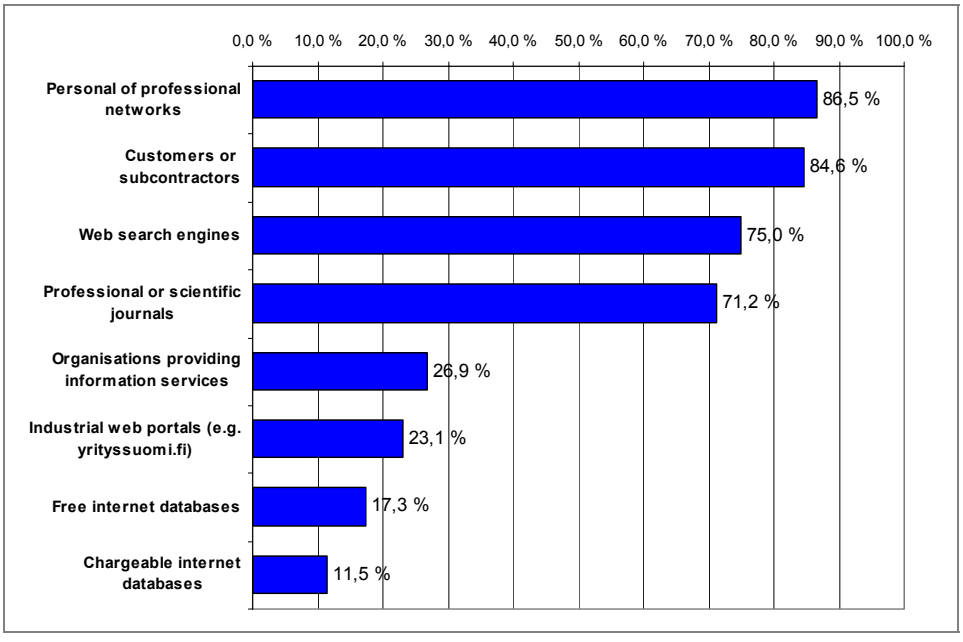

Figure 4. The use of different information channels in innovation activities (n = 52).

One of the objectives this study was to elaborate more precisely the different phases and decision points within the innovation process where SMEs need external information. Therefore, we asked the respondents to identify in which particular phases companies usually utilise or have utilised external information (Figure 5).

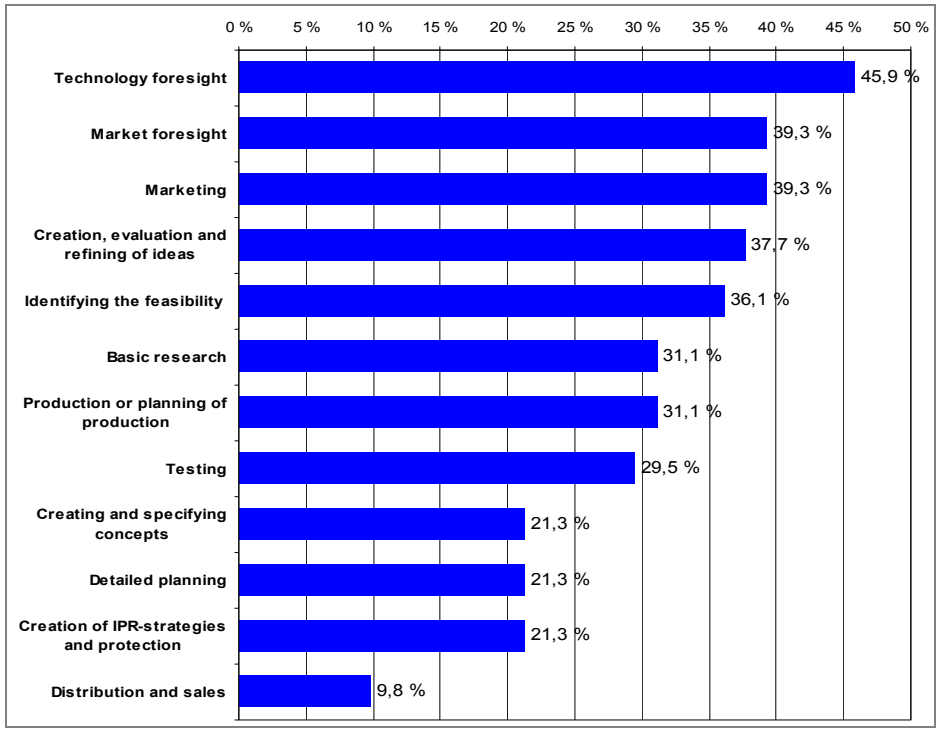

Figure 5. The use of external information in different phases of the innovation process (n = 61).

The results show that when engaging technology foresight; market foresight; and marketing activities, companies often need to rely on external information. On the other hand, distribution and sales; creation of IPR strategy; detailed planning; and creating and specifying concepts are activities where companies seem to rely more on internal information and their own competence. The interviewed company representatives emphasised that the most crucial decision-making point in the innovation process is the beginning of the development project. Before making the final decision to start a new development projects, a lot of information is needed. This situation is often referred to the concept of 'fuzzy-front-end' which is defined by those (often chaotic and unpredictable) activities that come before the formal and well-structured product development process (Koen et al. 2001) (see also Chapter 3).

In order to get a more specific picture of the particular knowledge needs in the SMEs, we asked the respondents to assess the possible benefits of different forms of information to the company, as well as the challenges that may exist in

acquiring the information. The respondents were asked to evaluate the aforementioned aspects in a two-dimensional table. In this way we were able to identify at the same time, each type of information and the challenges that may exist in acquiring the particular information (Figure 6).

Numbers in the table indicate the position regarding each information type and the circles around the number indicate the mathematical deviation of the responses. The upper-right corner of the table shows directly the areas where development efforts in information services should be targeted[9]. The results show that information about potential new markets (5) and information about competitors (7) are most beneficial for the SMEs, and moreover they are the most difficult to acquire. On the other hand, SMEs feel that scientific (basic) research has the lowest benefit for the company's business. Information regarding potential collaborators and financial sources seem to have the lowest benefit and at the same time the information seems to be quite easily available. The interviewed company representatives highlighted that the information available on patent or other technical documents do not fulfil the information needs related to e.g. competitor or market analyses. For example, a small company might need information about end-products that are already available in the market, but often technical and scientific documents tend to hide such information.

1. Scientific research
2. Inform. on the level of technology
3. Inform. solving technical/practical problems in product development
4. Inform. assessing the novelty of the invention or idea
5. Inform. about potential markets
6. Inform. about the development of industry
7. Competitor analyses
8. Inform. about legal framework, regulations, orders or standards
9. Inform. scanning potential collaborators, or financial sources
10. Inform. scanning marketing, sales or distribution channels

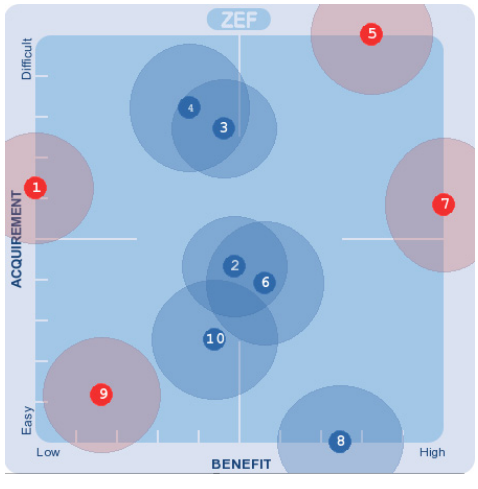

Figure 6. The benefit of different forms of information and challenges in acquiring the services (n = 54).

[9] The results have been calculated by using relative method (z-scoring).

Respondents were also requested to identify what organisations they have utilised in information acquisition related to innovation activities (Figure 7). Universities and polytechnics seem to be the most obvious organisations which SMEs turn to in case they need information in innovation activities. This result seems to be a little asymmetric with previous results presented in this chapter, which indicated that basic research and scientific knowledge do not have a significant role in SMEs innovation activities. However, the result should be interpreted in the context where Finnish university and polytechnic students often carry out academic theses commissioned by SMEs. In addition, the question itself and the answers are difficult to interpret, since it is difficult to establish whether respondents have utilised research services (contract research or joint studies), information service units of the universities/polytechnics, or university/polytechnic originated publications. Moreover, the use of universities' information services can be indirect; there may be a joint research project between the university and industry where the university commissions their own information services to carry out information search and analyses, and which are utilised by the participating companies (which can be unaware of the origin of the information). In any case, the role of public organisations, including research organisations, TE-centres, and PRH, is very important in SMEs innovation activities. The use of specific information service consultants was low.

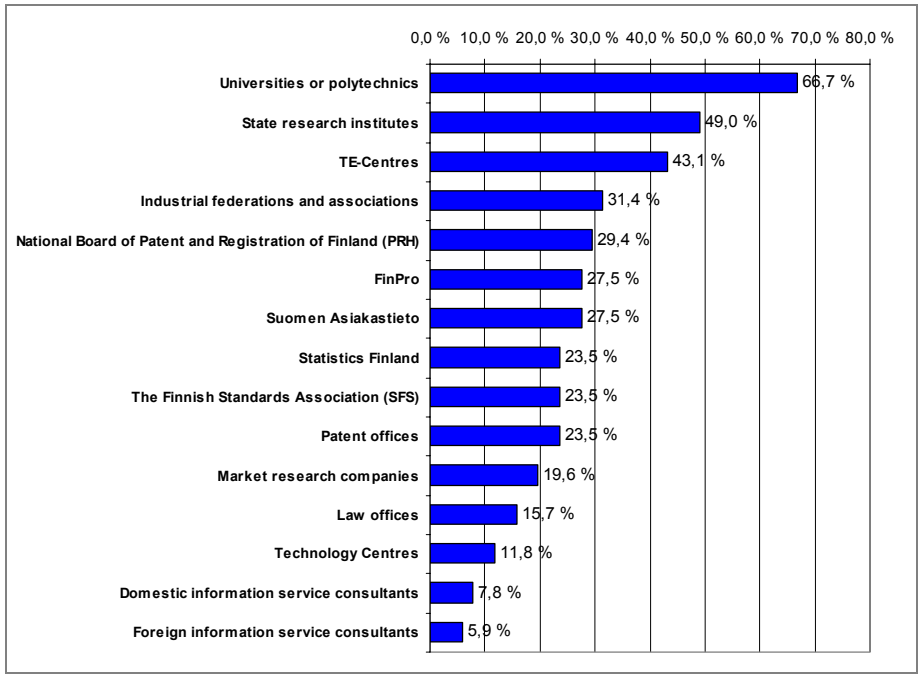

Figure 7. The use of different organisations in information acquisition related to innovation activities (n = 51).

Another objective of this study was to clarify what kind of benefits the use of external information might bring to SMEs' innovation activities. An interesting result was (Figure 8) that 50 percent of the respondents that have utilised the services of the above-mentioned organisations considered that the services prevented duplication in the product development process. In general, the concrete benefit of the information services is hard to identify. More or less, the external information that is fed to the company's innovation process functions as a small component, and it is difficult to segregate its unique impact from the final innovation. As the interviewed company representatives expressed, the role of external information is to provide confidence in decision making and to prevent possible patent violations or investment losses.

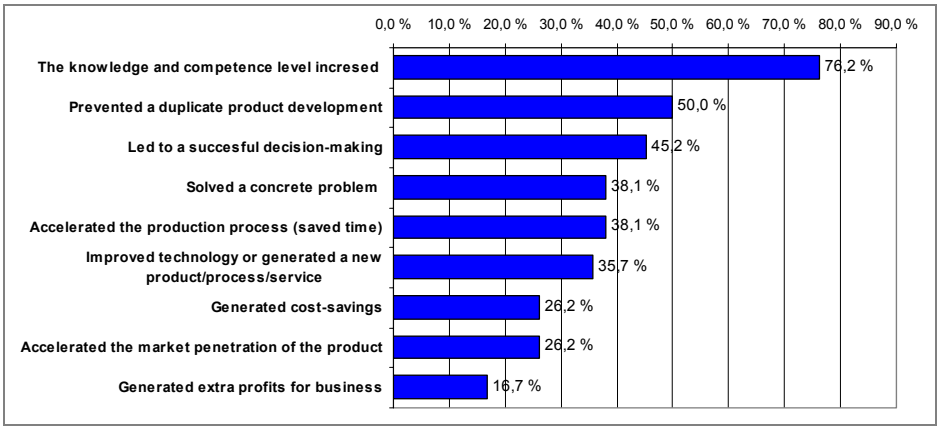

Figure 8. The benefits of the use of external information (n = 42).

In order to figure out the current state of the information services in the eyes of SMEs, we asked the respondents to assess the usability of the information services in the market through a list of propositions. The respondents were asked, in the scale of 1 to 5, either to disagree or agree with the presented propositions (Figure 9). The propositions related to the relevance of the information, keeping the schedule, and the quality of the services received highest scores (mean over 4.0). The lowest scores related to the exploitability of the information, and to the proactive way of delivering the services. The interviewed company representatives emphasised that the cost of the services is important in any case. In addition, open communication between service providers and companies through the process is important; it prevents over-budgeting and enables the information to be as accurate and relevant as it should be.

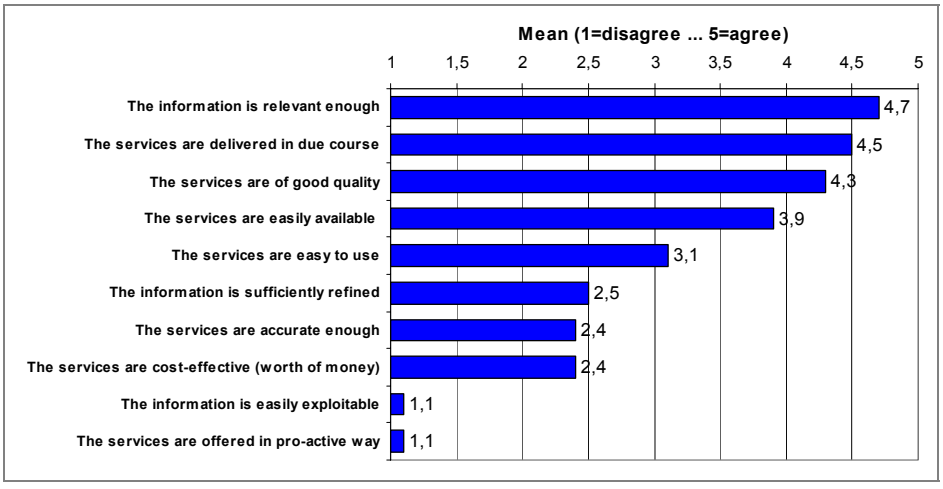

Figure 9. The assessment of the usability of services (n = 49).

5.3 The impact of information service providers supporting innovation activities

Section 5.3 presents the interview and survey study made to organizations supplying information supporting R&D and innovation activities.

In order to see how the information needs of SMEs' are met, a survey was carried out targeting the information service providers in Finland. The aim of the survey was to map the information providers in Finland and their possible cooperation during the assignments, and find out the services provided. The survey was carried out with the same web-based evaluation solution as the survey for the SMEs.

The survey was sent to 61 respondents and 34 answers were received. The respondents can be divided into six groups by the type of the organisation. Seven (7) of the respondents were companies specialising in information services. Six of them replied (7/6). Five of the respondents were patent agencies (6/5), seven research centres and governmental agencies (8/7), five libraries of universities (7/5) and nine libraries of polytechnics' (28/9). All the respondents provide services for customers from more than one industry, 45% for any desired industry. The amount of employers providing information services in organisations is quite varied. Some 46% of the respondents have from two to five employers handling the work, 10% only one and 21% more than 25.

The questions in this survey were constructed to correspond to the questions directed at the SMEs. Although the main aim of the survey was to achieve an understanding of how the information needs of SMEs are met, we sent the survey also to respondents who have only a few or no SME clients.

The survey described in the former chapter established that less than one third of SMEs utilise information services during their innovation process. We had a preconception that, for example, libraries of universities have reduced information services provided for SMEs due to the low demand. This was affirmed by discussions with distinguished information professionals. By including the organisations with no SME clients we wanted to see the potential of meeting the hopefully increasing needs of services for SMEs.

Most of the respondents (77%) have less than quarter of SME-customers in their total customer base. For only 9% of the respondents SME-customers are the majority customer group. The distribution of the SME customers is; libraries of Universities and Polytechnics have no SME-customers, and the respondents in other groups are quite varying according to the profile of their customers.

With the survey sent to Finnish SMEs we tried to get a specific picture of their particular information needs. With the survey sent to information services we wanted to find out the supply of the needed service. The results can be seen in Figure 10.

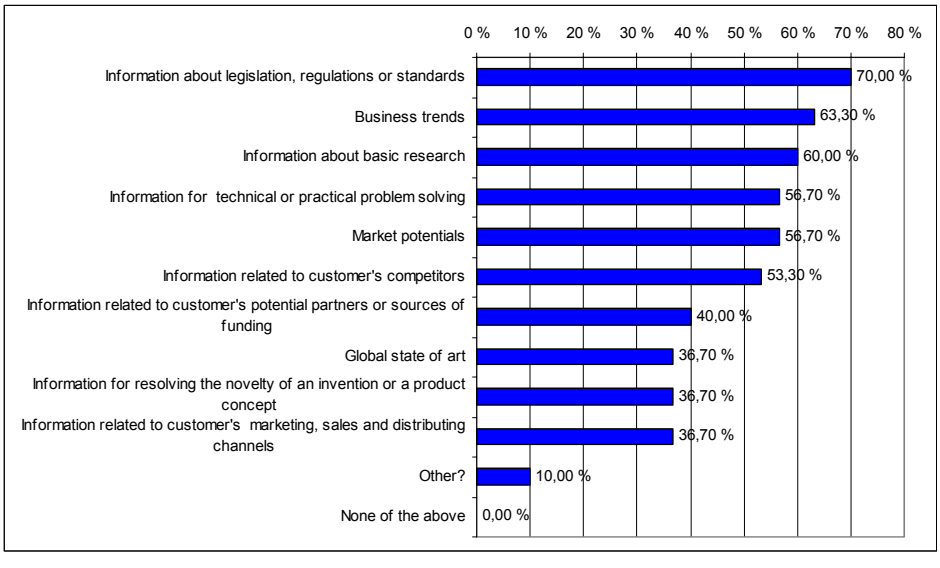

Figure 10. Supply of information, services and analyses.

The survey for SMEs indicates that the greatest demand of information is for *Market potential*, *Business trends*, *Competitor analyses* and *Information about the legal framework, regulations, orders or standards*. It can be seen from the answers that more than 50% of the respondents have services responding to the highest needs of the SMEs.

Most of the services provided by the organizations aren't productised. Almost half of the respondents have productised less than a quarter of their services. Highest frequency of productisation is among companies and patent agencies.

Most of the respondents retrieve the information on-demand within the limits of the supported industries, although most of them also provide pre-selected material. We also asked if the respondents mostly deliver the information to their customers as such, or value-added. The answers divide the groups notably into two clusters. Libraries of universities and polytechnic provide mostly information as such whereas the companies, patent agencies and research centres and governmental agencies provide mostly value-added service.

Figure 11 shows the distribution of different information sources used by the respondents. Mostly used sources are journals and the Internet. Chargeable databases are also used among all of the respondent groups.

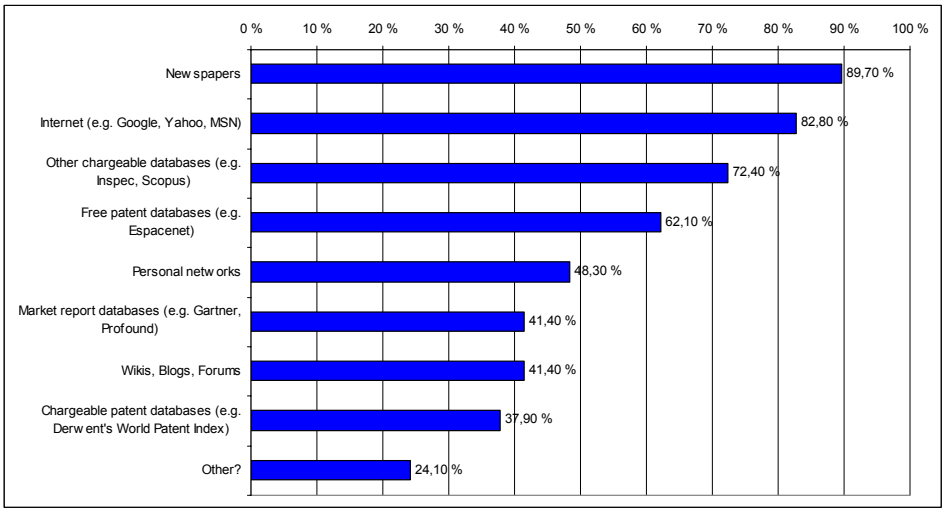

Figure 11. Information sources.

In order to sketch a picture of possibly existing network of information providers in Finland the respondents were asked about their cooperation with other service providers during assignments. Figure 12 shows the results.

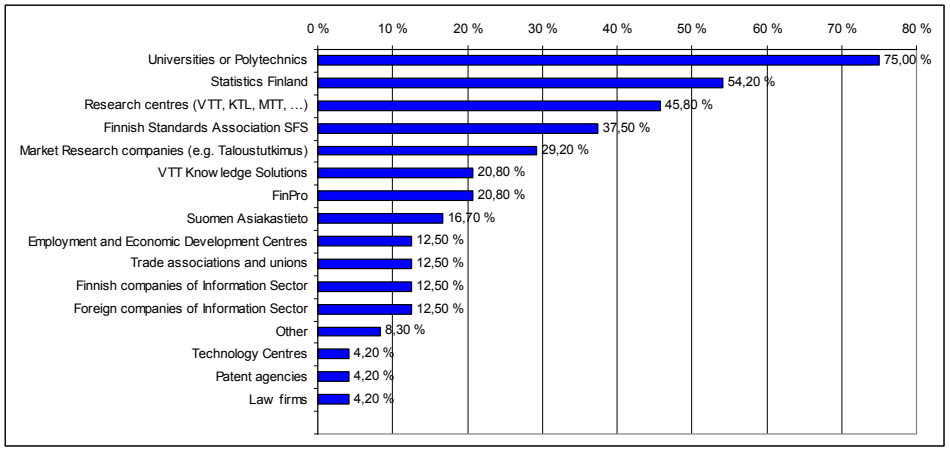

Figure 12. Cooperation with other service providers.

Great differences can be seen between the respondent groups. Respondents in the research centres and governmental agencies group were the most active collaborators in all of the instances listed. Universities and polytechnics had collaboration with each other as well as with research centres and governmental agencies. On the other hand, they had very little cooperation with other information providers. Companies didn't identify any collaboration with other service providers and patent agencies, almost only with the Finnish Patent Office.

One aim of this study was to find out the impact goals of Finnish information service providers and how the realisation of them was evaluated. The answers of the respondents can be seen in Figure 13. The results constitute the only surprising fact arising from this survey; more than one third of the respondents don't claim to have any of the listed impact goals in their operation. The evaluation methods of the realisation of the effectiveness goals are quite varied. Some of the respondents have systematic processes for evaluation; it is part of their strategy or reporting. The most used method is collecting feedback from customers. Some of the respondents have developed barometers for evaluation or compile statistics.

Respondents were also requested to give suggestions how the information service business should be developed for the benefit of SMEs. The ideas and the results of the survey support the prediction we had made concerning the demand and supply of information services for SMEs in Finland.

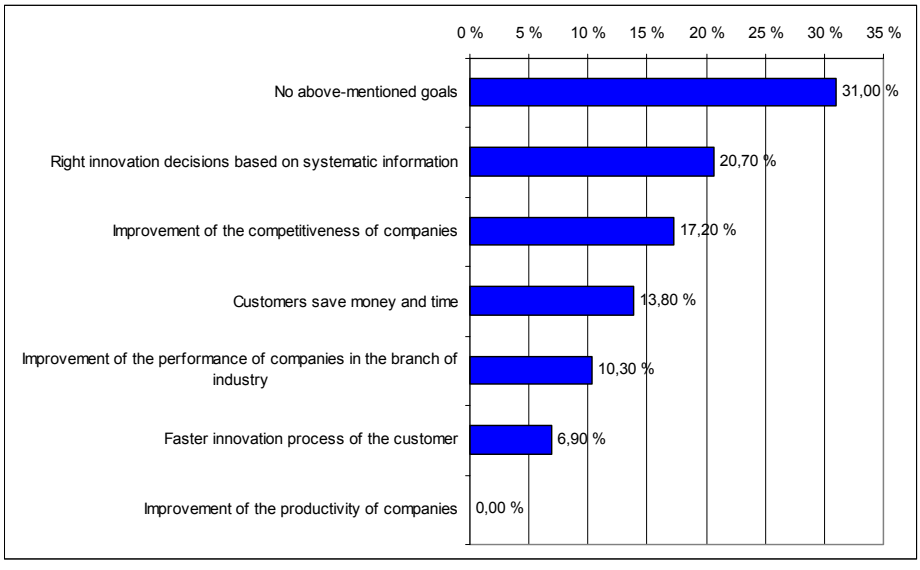

Figure 13. Effectiveness goals of the respondents.

In conclusion, it could be stated that there are plenty of supply of information services in Finland to fulfil the needs of SMEs, professional providers and services alike. Two major problems in the utilisation of the services by SMEs can be seen. The first problem is the lack of consciousness of the need of information in the innovation process. The other problem is the difficulty of finding the right service provider, even if the need has been identified. The development ideas of the respondents were mostly related to the latter problem;

- increasing communication of the impact of the utilisation of quality information in the competitiveness of companies
- integrating the information into the processes of the financiers
- productisation of services
- increasing the marketing of information services
- web forms for requesting information services.

5.4 Conclusions

The results of two case studies presented in this chapter demonstrate that systematic utilisation of external information in SMEs innovation activities is rare. On the one hand, companies are hesitant to use services, or are unaware of the potential gains of using external information in innovation processes. On the other hand, information services targeted to SMEs are scarce (due to lack of demand) and productisation of "SME–friendly" services has not progressed far among service providers. Therefore, raising the awareness of the gains related to using patent and market information among service providers and buyers is crucial. In addition, creation of value-adding information services and combining different types of data-sources is fundamental since often technical and scientific documents, as such, tend to hide important information. The service providers should concentrate on creating services that are value-added and offered pro-actively (in interaction with users) and are easily exploitable. The most potential areas (where the acquirement of information is challenging but the benefits are the highest) of information service development includes; information about market potentials, business trends, competitor analyses and information about legal frameworks, regulations, orders or standards.

The results also indicate that those SMEs who use external information in their innovation activities tend to rely on public organisations; namely research organisations, TE-centres, industrial associations and PRH. Half of the service users considered that using the information services prevented duplication in their product development processes. In general, the concrete benefit of the information services is hard to identify – this is also reflected on the setting of operational goals by information service providers. More or less, the external information that is fed to the company's innovation process functions as a small component and it is difficult to separate its "unique impact" from the final innovation. Regarding the interviewed SMEs, the role of external information is to provide confidence in decision making and to prevent possible patent violations or investment losses. There is plenty of supply of information services to fulfil the needs of SMEs, professional providers and services alike. However, for creating sufficient demand for such services the communication and marketing of the potential gains of the utilisation of quality information in the innovation processes should be increased; integrating the information utilisation into the processes of public R&D financiers should be considered; and productisation, as well as the delivery and distribution of such services should be developed further (e.g. web forms for requesting information and services).

6. Conclusions, policy implications and further research

6.1 Conclusions

The main outcome of this study is that the acquisition and utilisation of external information in R&D, invention and innovation activities of SMEs is relatively scarce, and a lot of room exists for developing these activities internally within SMEs and in organisations delivering information services. The conclusions of the study as well as arising policy implications and recommendations are related to the improvement of access of SMEs and other relevant actors and institutions in the national innovation system to different information sources and services. The more effective utilisation of available external information and the use of related information sources can decrease the duplication of R&D, invention and innovation work and save resources on the company level as well as in the whole society. Because the acquisition and utilisation of external information in innovation relates closely to issues of intellectual property, accordingly the awareness of IPR shall be enhanced as well.

In the delivery of information to SMEs, or for that matter to any companies, for supporting their R&D and innovation, it is important to note that the question is not about the "mechanistic" transmission of information from a service provider to customers. The challenge is to create continuous platforms for mutual learning on individual, organisational and collective levels through promoting networking and feedback unfolding over time between both co-operative and competitive agents. Only the access of inventors and innovators to information sources and services is not enough for them to benefit from the information, but the organisation must have sufficient absorptive and learning capacity to use, utilise and reap benefits from available information. Accordingly

it is the knowledge management strategy of organisation which forms a context for acquiring and utilising information in research and innovation activities.

6.2 Policy implications

The policy implications of this study are related to improving the access of inventors, innovators and any relevant actors and institutions of the national innovation system into relevant knowledge sources and related information services, which also can mitigate the observed duplication of invention and innovation work. This can be done by a systematic development of information services producing and delivering market, patenting and other required relevant knowledge to innovation processes especially of SMEs and other organisations performing R&D. Another related area is the improvement of coordination of R&D and innovation activities among all relevant organisations promoting, funding and carrying out R&D which also can mitigate the duplication in R&D, invention and innovation and improve the performance of the whole innovation system. This report has also emphasised the importance of raising the awareness of the information value of patents for all relevant actors within innovation system – not only the conventional protective or restrictive aspect of patenting.

The following concrete proposals are aimed to improve the acquisition and utilisation of information in innovation activities. Although this study was carried out in Finland, these recommendations may have relevance also in other knowledge-based societies. The proposals are targeted at research organisations, R&D financiers, policy makers and public services, SMEs and information service providers:

Education and research organizations

The awareness of intellectual property issues should be raised by increasing related education and training in universities and polytechnics, especially as a part of the studies in business and engineering education tracks. In addition teaching staff should be trained to tackle IP related issues and to realise the potential gains of using patent and market information in innovation related activities.

The utilisation of patent and market information should be integrated in joint research projects with SMEs. Using relevant information during the project planning and implementation reduces the risk for investment losses and refines the project.

R&D funding organisations

The role and training of IP issues should be increased in the organisations funding and coordinating R&D. Comprehensive information of on-going R&D, invention and innovation work is an important condition for effective coordination of public R&D funding. Moreover, research funding applications supplied by private and public R&D organisations shall consist of sufficient surveys on past and ongoing research work in order avoid the duplication of R&D, invention and innovation work.

Information services adding value to R&D, invention and innovation work shall be integrated into decision-making processes of organisations funding and coordinating R&D. Surveys of IP and market information (patent surveys, overviews on technologies, analyses of competitors and competition environment, novelty examinations, etc.) shall be provided to and used in decision-making when applicable.

Policy makers and public services

The awareness of the general importance of the IP system as well as its related avoidance of duplication of R&D, invention and innovation work shall be increased among public policy-makers (ministries, agencies, intermediary organisations, etc.). In addition, international collaboration on the development of IP services and IP system should be enhanced, for example, by exploring good or best practices of IP management and services in other countries.

The utilisation of patent and market information services in SMEs should be encouraged by public innovation service providers. For example, in introducing service vouchers or respective instrument to SMEs in order to facilitate the “first purchase” could pave the way for a wide-spread use of such services.

The raising of awareness of the utilisation of patent and market information by training among business service experts and advisers can improve their ability to serve SMEs in innovation related information needs. The utilisation of patent and market information services shall be integrated in the processes of the services that are especially targeted to internationalisation efforts of SMEs.

SMEs

SMEs shall develop their awareness, abilities and tools of patent and market information in order to improve the utilisation of related services in their innovation processes. This would significantly reduce the risk of investment losses and patent violations and make the use of SMEs's limited R&D resources more effective and enhance the productivity of their research and development work.

The understanding of the IP related issues and the use of patent and market information should be integrated within the innovation process of the company. Utilisation of such information in the early phase of the development project, in the 'fuzzy front end', gives the greatest opportunity for improvement of the overall innovation process. Integrating the information utilisation also in the later stages (e.g. testing, prototyping, production, marketing etc.) gives opportunities to redirect, accelerate or refine innovation process.

Information service providers

Information service providers shall create and productise value-adding information services and service packages targeted especially to the needs of SMEs' innovation activities.

Information service providers and business management consultants shall join forces in order to develop services and consulting activities targeted at SMEs, taking into account the potential gains in utilising information services. Likewise, the utilisation of new ICT solutions in delivering and processing such services effectively shall be considered in the future.

A quality certificate shall be introduced to patent and market information provision which helps their customers, in this context the innovative SMEs, to better assess the relevance and the quality of available services offered to improve innovation processes.

6.3 Further research

From this study various needs arise for further research in this area. Innovation activities of enterprises, related to patenting, IPR strategies and operations, are changing because of changes in innovation dynamics due e.g. to the globalisation

of innovation activities, related to the opening up of innovation and to increasing the pressure to co-operate and network because of increasing R&D costs, etc. As Gurry argues, as a consequence of all these changes traditional IPR policy is expanding towards a comprehensive knowledge policy. It is important to be aware of this, and to examine these changes on a level of enterprises to their R&D, innovation and IPR strategies and operations, as well as on the level of innovation policy-making with respect to policies of patenting, IPRs and the entire knowledge system. No comprehensive studies consisting of IPR strategies, practices and related challenges to enterprises and to innovation system and innovation policy have been conducted in Finland, and accordingly they should be explored in detail in the future.

The examination of overlapping patent applications and more broadly, the duplication of R&D, as started in this study, should be deepened in further research efforts. The detailed research topics are related e.g. to more in-depth exploration of the characteristics of the duplication of research in different industrial sectors, in different technology areas, profile of inventors, enterprises having and not having public R&D subsidies, etc. As the literature indicates, proximity in geographical and related forms plays an important role in the duplication of R&D and innovation work. Accordingly the relationship between proximity and the duplication of R&D should be explored in detail in Finland in the future. As the overview of duplication of R&D and imitation of patenting in this study indicates, these are very complex issues that must be taken into account in R&D and IPR strategies of enterprises, as well as in IPR strategies of innovation policies and of related information services as well. Although services delivering patent and market information to customers shall be developed to become more effective, the possible problems of misuse these services (e.g. as illegal imitation), as well as principles and measures to respond to this problem shall be studied as well.

Also the external innovation sources of enterprises should be explored in more detail, i.e. the impact of such private and public sources on enterprise innovation. The relevant questions in this respect are e.g. what is the impact of university and government R&D laboratory research on industrial R&D, or of private knowledge intensive service activities (KISAs), what are the key channels through which university research impacts industrial R&D (published papers and reports, public conferences and meetings, informal information exchange, consulting etc.)?

Definitions

Codified knowledge	"Knowledge which need not be exclusively theoretical but needs to be written down and stored. As such, it is available to anyone who knows where to look." (Gibbons et al. 1994, p. 167).
Informational asymmetries	Differences among individuals in their information, especially when this information is relevant to determining an efficient plan or to evaluating individual performance.
Open innovation	The central idea behind open innovation is that in a world of widely distributed knowledge, companies cannot afford to rely entirely on their own research, but should instead buy or license processes or inventions (e.g. patents) from other companies. In addition, internal inventions not being used in a firm's business should be taken outside the company (see e.g. Chesbrough 2006).
Tacit knowledge	"Knowledge not available as a text and which may conveniently be regarded as residing in the heads of those working on a particular transformation process, or to be embodied in a particular organisational context." (Gibbons et al. 1994, p. 168).
Patent information	Technical and legal information in patent documents or literature
Market information	Information about the business environment: future trends, market potentials, lines of business, customers, competitors, partners, new business opportunities etc.

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Author(s)
Torsti Loikkanen, Jari Konttinen, Jukka Hyvönen, Laura Ruotsalainen,
Kirsi Tuominen, Mika Waris, Veli-Pekka Hyttinen & Olli Ilmarinen

Title

Acquisition, Utilisation and the Impact of Patent and Market Information on Innovation Activities

Abstract

Knowledge and information are ever increasing strategic assets for enterprises. The main outcome of this study shows that there are many special grounds for intensifying the acquisition and utilisation of patent and market information in Finnish SMEs. This also holds true for the development and supply of information services. The analysis about the overlapping of research and development activities uncovered an important finding: 33% of Finnish patent applications between years 2000–2005 were not granted to patents because of obstacles for novelty, i.e. the patent application was filed for an already published invention. This duplication of effort could have been avoided by utilising already existing information. The same result may also be generalised to the whole innovation process. Thus, the topic of this study is a strategic issue for the national innovation policy. Other international studies about the amount of overlapping of research and development activities give similar results. The concrete recommendations of the study are aimed at systematically improving the utilisation of information as well as improving the production of services and dissemination of information.

The patent system is an information dissemination system which brings new technical information for the society to utilise. A patent is an exclusive right granted to the inventor for a given period of time; in exchange the inventor has to allow the publication of his invention. Patent documents are the most extensive global information resource of a uniform quality in technology and science. They give you global information about research results, new products and production methods and markets.

Many of the widely recognised success factors for new product performance share a common thread: capabilities for gathering and utilising market information. Market information means all the information that a company needs about its operational environment, from trends in lines of business and developments in the markets up to profiles of customers, competitors and potential partners. Besides patent documents, there are a number of market information sources, both liable to charge and free-of-charge.

The background covers theoretical and empirical points of view about information and innovation. The following subjects are covered: economic grounds for innovation policy and public financing of research, evaluation of socially optimal investments in research, and hypotheses about under- or over-investment in research. Empirical studies support the hypothesis about under-investment – giving the society the right to finance research and development. The hypothesis about over-investment is linked to unhealthy overlapping of research and development activities. Overlapping research may be either healthy or unhealthy. It is unhealthy if resources are used for research already done, with the results being already freely available and exploitable. Investing in unhealthy research means wasting the resources of both enterprises and society as a whole.

How do small and medium-sized enterprises utilise existing information and information services? We searched for answers in two studies. One study was about acquisition, utilisation and impacts of patent and market information in the innovation activities of SMEs. In the other study we charted the services produced by domestic information services to support innovation, from the point of view of SMEs.

SMEs do not utilise external information systematically. They regard market information as important, but finding the right reliable information is difficult. SMEs do not see the patenting system as a system for disseminating information. They neither consider patent information important nor are able to utilise it. There are not many services specially targeted at SMEs – mainly due to poor demand – and productising services are still poor, too. The results show that SMEs mostly rely on public actors in searching for external information. It is very challenging to assess and analyse the impact of patent and market information as part of an innovation process.

The study raises important needs for future research. Innovation activities in enterprises are changing, due to the changing trends in innovation dynamics. The most important of these include the globalisation of research and innovation, the growing importance of co-operation and networking, and the openness of innovation. Future studies should aim at disentangling the impacts that such changes have on the companies' IPR strategies and practices. On innovation policy level, we need to examine changes in patenting and the whole IPR system. The characteristics and contents of overlapping patent applications – an investigation which was started here – deserve a more detailed study in the future. The authors of this study suggest the following subjects: differences in branches of business and in lines of technology, profiles of the different groups of inventors, and special characteristics in the size of companies. Another important subject would be to find out if overlapping research is mainly done in companies which are not within public financing of R&D.

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Torsti Loikkanen, Jari Konttinen, Jukka Hyvönen, Laura Ruotsalainen, Kirsi Tuominen, Mika Waris, Veli-Pekka Hyttinen & Olli Ilmarinen

Nimeke

Patentti- ja markkinatiedon hankinta, hyödyntäminen ja vaikuttavuus innovaatiotoiminnassa

Tiivistelmä

Tiedosta on tullut yrityksille yhä tärkeämpi strateginen menestystekijä. Tutkimuksen päätulos on se, että suomalaisten pk-yritysten patentti- ja markkinatiedon hankinnassa ja hyödyntämisessä on runsaasti tehostamisen varaa. Sama pätee tietopalvelujen kehittämiseen ja tarjontaan. Tutkimus- ja kehitystoiminnan päällekkäisyyttä kartoittavassa analyysissä selvisi, että vuosien 2000–2005 kotimaisista patenttihakemuksista yli 33% oli kaatunut uutuuden esteisiin: patenttia oli haettu jonkun muun aiemmin julkaisemalle keksinnölle. Päällekkäinen työ olisi voitu välttää hyödyntämällä olemassa olevaa tietoa. Patenttitoimintaa koskeva tulos päällekkäisyydestä voidaan yleistää laajemmin koko innovaatioprosessia koskevaksi. Patentti- ja markkinatiedon hyödyntämisen tehostaminen on strateginen kysymys kansallisen innovaatiopolitiikan näkökulmasta. Kansainväliset selvitykset päällekkäisen t&k-toiminnan määrästä antavat samansuuntaisia tuloksia. Tutkimuksen konkreettiset suositukset kohdistuvat tiedon hyödyntämisen, palvelujen tuottamisen ja tiedon levittämisen systemaattiseen kehittämiseen.

Patenttijärjestelmä on tekniikan kehittymistä edistävä tiedonlevitysjärjestelmä, joka tuo uuden teknisen tiedon yhteiskunnan hyödynnettäväksi. Patentti on keksijälle määräajaksi myönnetty yksinoikeus, jonka vastineeksi hänen on sallittava keksintönsä julkaiseminen. Patenttijulkaisut ovatkin maailman kattavin ja tasalaatuisin teknillistieteellinen tietovarasto, josta saa maailmanlaajuisesti tietoa tutkimustuloksista, kehitetyistä tuotteista, tuotantomenetelmistä ja niille kaavailluista markkina-alueista.

Yksi laajasti tunnistettu t&k-toiminnan menestystekijä on tehokas markkinatiedon hankinta, prosessointi ja hyödyntäminen. Markkinatieto on kaikkea sitä tietoa, jota yritys tarvitsee toimintaympäristöstään lähtien toimialojen trendeistä ja markkinoiden kehittymisestä aina asiakkaiden, kilpailijoiden ja potentiaalisten partnerien profiileihin. Markkinatietoa löytyy patenttijulkaisujen lisäksi lukuisista maksuttomista ja maksullisista tietolähteistä.

Taustatutkimus käsittelee tietoon ja innovaatiotoimintaan liittyviä teoreettisia ja empiirisiä näkökulmia. Aluksi selvitetään innovaatiopolitiikan ja julkisen tutkimusrahoituksen taloudellisia perusteita, yhteiskunnallisesti optimaalisen tutkimusinvestoinnin arviointia sekä siihen liittyviä hypoteeseja tutkimukseen kohdistettavasta ali-investoinnista ja yli-investoinnista. Empiiriset tutkimukset antavat tukea ali-investoinnin olemassaolosta, mikä antaa yhteiskunnalle oikeutuksen rahoittaa tutkimustoimintaa. Yli-investoinnin hypoteesi liittyy epäterveeseen päällekkäiseen tutkimustoimintaan. Päällekkäinen tutkimustoiminta voi olla tervettä tai epätervettä. Päällekkäisyys on epätervettä silloin, kun resursseja käytetään sellaisen jo aiemmin toteutetun tutkimuksen tekemiseen, jonka tulokset olisivat olleet löydettävissä ja vapaasti hyödynnettävissä. Epäterveeseen päällekkäiseen tutkimukseen käytetty panostus on voimavarojen tuhlausta sekä yritysten että yhteiskunnan tasolla.

Miten pk-yritykset hyödyntävät olemassa olevaa tietoa ja tietopalveluja? Miten tehokkaasti innovaatiotoimintaa tukevat tietopalvelut toimivat? Näihin kysymyksiin etsittiin vastauksia kahdessa haastattelu- ja kyselytutkimuksessa. Ensimmäisessä tutkimuksessa selvitettiin patentti- ja markkinatiedon hankintaa, hyödyntämistä ja vaikuttavuutta pk-yritysten innovaatiotoiminnassa. Toisessa tutkimuksessa kartoitettiin innovaatiotoimintaa tukevien kotimaisten tietopalveluja tuottavien organisaatioiden palveluja pk-yritysten näkökulmasta.

Tulosten mukaan ulkopuolisen tiedon systemaattinen hyödyntäminen pk-yrityksissä on vähäistä. Markkinatieto koetaan tärkeäksi, mutta pk-yritykset kokevat luotettavan tiedon vaikeaksi löytää. Patenttijärjestelmää ei mielletä tiedonlevitysjärjestelmäksi, patenttitietoa ei koeta tärkeäksi eikä sitä osata hyödyntää. Pk-yrityksille kohdennettuja palveluja on niukasti tarjolla − pääosin vähäisen kysynnän vuoksi – ja palvelujen tuotteistaminen on vähäistä. Tulokset osoittavat, että ulkopuolista tietoa hyödyntävät pk-yritykset tukeutuvat pääosin julkisiin toimijoihin. Patentti- ja markkinatiedon vaikuttavuuden arviointi ja erittely osana monivaiheista innovaatioprosessia on haastavaa.

Tutkimuksesta nousee esille tärkeitä jatkotutkimustarpeita. Yritysten innovaatiotoiminta on muutostilassa innovaatiodynamiikan muutostrendien takia. Näistä tärkeimpiä ovat tutkimus- ja innovaatiotoiminnan globalisoituminen, yhteistyön ja verkottumisen kasvava merkitys ja innovaatiotoiminnan avautuminen. Jatkossa tulisi selvittää näiden muutosten vaikutuksia yritystason IPR-strategioihin ja -käytäntöihin. Innovaatiopolitiikan tasolla olisi oleellista tarkastella patentoinnin ja koko IPR-järjestelmän muutostarpeita. Tässä tutkimuksessa aloitettua päällekkäisten patenttihakemusten sekä yleisemmin päällekkäisen tutkimus- ja kehitystoiminnan luonnetta ja sisältöä tulisi jatkossa selvittää yksityiskohtaisemmin. Tutkimuksen kohteita voisivat olla toimialoja ja teknologia-alueita koskevat erot, erilaisten keksijäryhmien profiilit ja yrityskokoon liittyvät erityispiirteet. Samoin olisi tärkeätä saada selville, tehdäänkö päällekkäistä tutkimusta pääasiassa yrityksissä, jotka eivät ole julkisen t&k-tuen piirissä.

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Knowledge and information are ever increasing strategic assets for enterprises. The main outcome of this study shows that there are many special grounds for intensifying the acquisition and utilisation of patent and market information in Finnish SMEs. This also holds true for the development and supply of information services. The analysis about the overlapping of research and development activities uncovered an important finding: 33% of Finnish patent applications between years 2000–2005 were not granted to patents because of obstacles for novelty, i.e. the patent application was filed for an already published invention. This duplication of effort could have been avoided by utilising existing information. The same result may also be generalised to the whole innovation process. Thus, the topic of this study is a strategic issue for the national innovation policy. Other international studies about the amount of overlapping of research and development activities give similar results. The concrete recommendations of the study are aimed at systematically improving the utilisation of information as well as improving the production of services and dissemination of information.

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