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INNOVATION COMMERCIALISATION PROCESS FROM THE 'FOUR KNOWLEDGE BASES' PERSPECTIVE

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ABSTRACT

In this dissertation, the innovation commercialisation process is studied from the perspective of four knowledge bases in product innovation: the technology knowledge base, end-user knowledge base, brand knowledge base, and business-logic knowledge base. In all, the doctoral dissertation consists of five substudies appended in full, and an introductory text integrating these substudies.

Substudy 1 develops the ‘four knowledge bases and four knowledge levels’ perspective in order to analyse the product innovation as a micro-strategy. Innovation-based diversification was found to be a very important reason to use the micro-strategy perspective. Substudy 2 describes the perfect technology syndrome and its solutions. The one-sided interest in technological development led to serious difficulties but was also solved by some companies. Substudy 3 analyses barriers in the innovation commercialisation process. The research results are summarised as seven hypotheses. Substudy 4 uses a multidimensional product-concept model that can enhance cross-functional knowledge creation in the product innovation process. Substudy 5 further develops the ‘four knowledge bases’ perspective by adding the consumer knowledge base and implementing this extended approach in the form of the Consumer Learning Roadmap. This substudy includes two case studies.

An important contribution of the present dissertation with its substudies is a deeper understanding of the innovation-based diversification. On the one hand, innovation-based diversification process can open to the company new successful markets. On the other hand, it can lead the company into unanticipated difficulties. In addition, the dissertation provides new insight into how the innovation commercialisation process can be developed by means of utilising the innovation-based micro-perspective.

TIIVISTELMÄ

Väitöskirjassa tutkitaan innovaatioiden kaupallistamisprosessia neljän tietämysperustan näkökulmasta, jotka ovat teknologiatietämysperusta, loppukäyttäjätietämysperusta, branditietämysperusta ja liiketoimintalogiikkaa koskeva tietämysperusta. Väitöskirja rakentuu viidestä liitteenä esitetystä osatutkimuksesta ja kyseiset osatutkimukset integroivasta johdanto-osasta.

Osatutkimuksessa 1 kehitetään neljään tietämysperustaan ja neljään tietämystasoon perustuva näkökulma, jotta innovaatioita voitaisiin analysoida mikrostrategiana. Johtopäätöksenä oli, että innovaatioista aiheutuva diversifikaatio on tärkeä syy käyttää mikrostrategista lähestymistapaa. Osatutkimuksessa 2 kuvataan täydellisen teknologian syndroomaa ja sen välttämistä. Yksipuolinen kiinnostus teknologiaa koskevaan kehittämistyöhön johti vakaviin vaikeuksiin, mutta muutamat yhtiöt ratkaisivat tämän ongelman. Osatutkimuksessa 3 analysoidaan esteitä innovaatioiden kaupallistamisprosessissa. Tutkimustulokset on tiivistetty seitsemään hypoteesiin. Osatutkimuksessa 4 käytetään moniulotteista tuotekonseptimallia, jolla voidaan tehostaa eri funktioiden keskinäistä uuden tietämyksen kehittämistä tuoteinnovaatioprosessissa. Osatutkimuksessa 5 kehitetään edelleen neljän tietämysperustan näkökulmaa lisäämällä siihen kuluttajatietämysperusta ja soveltamalla tätä laajennettua lähestymistapaa kuluttajan oppimistiekartassa. Tämä osatutkimus sisältää kaksi tapaustutkimusta.

Väitöskirjan tärkeänä kontribuutiona on, että se syventää innovaatioista aiheutuvaa diversifikaatiota koskevaa ymmärtämystä. Yhtäältä innovaatioista aiheutuva diversifikaatio voi avata yhtiölle uusia menestyksekkäitä markkinoita. Toisaalta innovaatioista aiheutuva diversifikaatio voi johtaa yhtiön odottamattomiin vaikeuksiin. Lisäksi väitöskirja antaa uutta tietoa siitä, miten innovaatioiden kaupallistamisprosessia voidaan kehittää innovaatioperustaisesta mikronäkökulmasta.

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PART 1: OVERVIEW OF THE DISSERTATION

1 INTRODUCTION

1.1 Background

The topic of the present doctoral dissertation is the innovation commercialisation process from the ‘four knowledge bases’ perspective. The knowledge intensity of innovation process has been discussed by several researchers (Cohen and Levinthal, 1990; Leonard-Barton, 1992). Typically the innovation-based business is changing ever faster. Consequently a better understanding of the innovation commercialisation process and of the factors affecting this process is needed.

The dissertation is based on the five partly overlapping substudies on the topic. The dissertation analyses the innovation commercialisation process from the perspectives of product innovation as a micro-strategy (Substudy 1), solutions of the perfect technology syndrome (Substudy 2), barriers to commercialisation (Substudy 3), cross-functional knowledge creation (Substudy 4) and consumer learning roadmap (Substudy 5). Each substudy is included in the dissertation as a separate article, which has been accepted for publication in a peer-reviewed international academic journal. The theoretical framework of this dissertation is built on the resource-based view (Wernerfelt, 1984) in general and especially on the knowledge-based view of the company (Grant, 1996; Spender, 1996).

At the beginning, an overview of the knowledge-intensive perspective in the innovation research is given. Some areas previously not researched are identified and elaborated on.

1.2 Recent knowledge-intensive perspectives on the innovation research

In general, innovation development is a knowledge-intensive process. The discussion of the innovation-related knowledge bases has usually been limited to one or two knowledge bases (Cohen and Levinthal, 1990; Leonard-Barton, 1992). A knowledge base consists of both explicit and tacit knowledge stored in organisational routines, stories and files.

A second knowledge-intensity problem is the perspective level. In view of the macro-perspective, an innovation is an objective of the project team, the company or the economy. Less has been discussed about the innovation-based micro-perspective. From the perspective of an innovation, new challenges are expected to be found. Building the bridge from the micro-perspective to the macro-perspective is encouraged by Nieto (2003).

A third challenge concerning innovation research is on the strategic level. In general, an innovation strategy is a result of a group of innovations fitting the company strategy. However, the strategic management literature has also discussed emerging strategies and the bottom-up perspective in the strategy formulation process as strategising and as the micro-strategy (Johnson, Melin, and Whittington, 2003; Mintzberg and Waters, 1985). An emerging strategy of a company is opportune and something unexpected.

A fourth problem concerning innovation research is that the perspective of the innovation process is mostly in technological knowledge and its problems. However, the innovation commercialisation process is wider in perspective. Typically, the

perspective of the innovation commercialisation process is in launching, finding customers or in barriers of commercialisation (Bond, 2003; Sandberg, 2005). This means that commercialisation is the last phase of the innovation development (Cooper, 1975). The complete approach from the fuzzy front-end to the commercialisation process of the next generation innovation is less discussed.

A fifth area insufficiently studied in the innovation commercialisation process theory is the way cross-functional knowledge creation is measured in the innovation research studies. Scaled opinions about cross-functional knowledge creation in the innovation development process give a general perspective, which can also indicate something other than the innovation-development related issues that are studied. Utilising the product-concept questions as a questionnaire implements the innovation-based micro-perspective in knowledge creation.

All in all, the popular macro-perspective of the innovation commercialisation process is used very much in the innovation literature. However, a new approach based on the innovation-based micro-perspective needs to be explored more. A better, wider understanding can increase the success rate of innovations and innovative products.

2 RESEARCH OBJECTIVES AND OUTLINE OF THE DISSERTATION

2.1 Research objective of the dissertation and the substudies

The present dissertation argues that the knowledge base of the company should be enlarged to the four knowledge bases and that enhancing the four knowledge bases increases validity for the innovation commercialisation process better than utilizing the one knowledge base especially in the new companies such as the technological start-up companies.

The objective of the present dissertation is to deepen the understanding of the innovation commercialisation process from the 'four knowledge bases' perspective. It has been divided into five sub-objectives, each addressed in a separate substudy.

The sub-objectives of the present dissertation are:

1. to deepen the understanding of product-innovation-based diversification as a corporate micro-strategy (covered in Substudy 1)
2. to deepen the understanding of the dominance by the technological knowledge base with reference to the sources, consequences and solutions of this over-emphasis (covered in Substudy 2)
3. to deepen the understanding of barriers to commercialisation by investigating the effect of the four knowledge bases on publicly-funded innovation projects (covered in Substudy 3)
4. to present and analyse a novel multidimensional product-concept model enhancing cross-functional knowledge creation in product innovation development (covered in Substudy 4)

5. to evaluate the usability of a consumer learning roadmap (CLR) for high tech marketing (covered in Substudy 5)

2.2 Outline of the dissertation

The dissertation consists of two parts. Part I, *Overview of the Dissertation*, describes the objectives of the present dissertation as well as research methods used, reviews the results from the five substudies included in the present dissertation and relates the results of the substudies to the common themes of the dissertation. Part II, *The Substudies*, consists of five substudies, which have been accepted for publication as articles in peer-reviewed journals presenting different research efforts in addressing the objective of the dissertation. The order of the substudies does not represent the chronological order of the research projects: instead, it follows the order of the theoretical view presented in Part I.

The first substudy, *Product innovation as a micro-strategy* (Hänninen and Kauranen, 2007), describes innovation-based diversification and its consequences. The diversification strategy discussion has focused relatively little on such unintentional diversification caused by a product innovation that does not match the existing business strategy of a company. The substudy deepens the understanding of product-innovation-based diversification as a corporate micro-strategy. A new framework for product innovation was developed based on the innovation management, brand management, marketing and strategy literature. This framework has four strategic dimensions defined by their respective knowledge bases. The substudy offers a summary of the literature on these four strategic dimensions of

product innovation. The theoretical approach is illustrated by a case study of a consumer electronics product innovation.

The second substudy, *The 'perfect technology syndrome': sources, consequences and solutions* (Hänninen, 2007), analysed a major barrier in the commercialisation process of innovations. Recent literature has paid attention to the fact that the technological discipline can lead to dominance by one knowledge base. Publicly supported information and communication technology projects were studied, and the 'perfect technology syndrome' was identified in some start-up firms. In the 'perfect technology syndrome' firms invest their resources in developing the technology beyond customer needs or demands.

The third substudy, *Barriers to commercialisation from the 'four knowledge bases' perspective: A study of innovation in the software development sector* (Hänninen, Kauranen, Serkkola and Ikävalko, 2007), looks into the barriers in the innovation commercialising process in the software sector from the perspective of the four knowledge bases approach: technology knowledge base, end-user knowledge base, brand knowledge base and business-logic knowledge base. The theoretical approach was tested with a study of Finnish information and communication technology (ICT) innovation projects developed under a publicly-funded technology programme.

The fourth substudy, *A multidimensional product-concept model enhancing cross-functional knowledge creation in the product innovation process. The case of the Suunto t6 training wrist computer* (Hänninen and Kauranen, 2006), proposes that a product-concept model built on a limited number of well-selected, mutually complementary knowledge bases of product innovation can enhance cross-functional knowledge creation in the product innovation process. A product-concept model

based on four knowledge bases was tested by means of a study on a high-technology company.

The fifth substudy, *Consumer learning roadmap: a necessary tool for new products* (Hänninen and Sandberg, 2006), enlarges the four knowledge bases approach with the knowledge base of the consumer in order to cope with the increasing competition of high tech firms and to continuously launch new products. The adoption of new products may require substantive cognitive efforts from consumers. Therefore, companies should be able to monitor and influence their consumers' knowledge bases. The substudy evaluated the usability of a consumer learning roadmap for high technology marketing. A tentative framework was built based on the previous literature on innovation adoption and consumers' knowledge development. The usability of this framework was then evaluated based on case studies.

3 METHODOLOGY

3.1 Research approach

The main research approach of the present dissertation is the case study. The case study approach is used for the constructive nature of testing new models. The research methods include literature study, cognitive model formulation and interview with open-ended questions gathering qualitative information.

3.2 Case selection

Various case selection approaches were utilised in the present dissertation. In the Substudy on the Cross-Functional Knowledge Creation, the case product innovation was selected based on recommendations by technology experts, who were given the criteria that the case should meet. The technology experts used here were from the Finnish Funding Agency for Technology and Innovation, TEKES, and they all had a wide and deep knowledge about similar inventions. Additional advice for the case selection was given by the technology director of the company who has a doctoral degree in technology.

In the Substudy on Product Innovation as a Micro-Strategy, the case study was so selected that an in-depth analysis of the four knowledge bases and four knowledge levels of the present framework was possible. Accordingly, a very representative example of a semi-incremental product innovation, which had resulted in product-innovation-based diversification in the company, was identified with the help of technology experts. The technology experts used here had over ten-years of professional experience in the company.

In the Substudy on the Cross-Functional Knowledge Creation and in the Substudy on Product Innovation as a Micro-Strategy, the framework developed in the respective substudy was assessed by comparing it with one instrumental case (cf. Stake, 1995). In order to evaluate the viability of the preliminary framework presented, an explorative analysis of the case was conducted. In the Substudy on the Cross-Functional Knowledge Creation, the case was selected to represent successful cross-functional knowledge creation. In the Substudy on Product Innovation as a Micro-Strategy, the revelatory case was an opportunity to observe and analyse a phenomenon previously inaccessible to scientific investigation (Yin, 1989) and the selected case represents behaviour where the micro-strategy development of the company had been partly successful.

In the Substudy on Barriers to Commercialisation, in the Substudy on the Perfect Technology Syndrome and the Substudy on the Consumer Learning Roadmap, the cases were selected through literal replication logic, that is, on the prediction that they would support the a priori framework (cf. Yin, 1989). In the first two substudies mentioned, the selected cases represent behaviour where the technology development has been both successful and unsuccessful. The technology programs used as cases in the two first substudies were recommended by technology experts from the Finnish Funding Agency for Technology and Innovation, TEKES. These experts had a wide knowledge about similar technology programmes. The eight individual case companies picked from the two technology programs were the only companies in the programs that already had a commercialised product innovation. In the last of the three substudies mentioned, the selected cases represent behaviour where the introduction of successive product generations has been successful. These

two cases were recommended by a technology expert who has wide industry knowledge about technological innovations. The same cases have been used for another case study concerning radical innovations.

3.3 Data collection

The triangulation approach was utilised in the data collection process. The objective of the triangulation approach is to increase the reliability of the qualitative data by using multiple data collection methods. Triangulation methods vary from the typical use of qualitative and quantitative data with literature to the within-method triangulation using multiple techniques within a given method which take, for example, the form of participant observation reflected in multiple comparison groups. (Denzin, 1978.) In the substudies of the dissertation, the iterative triangulation method, for example, utilised by Lewis (1998) was based on interviews, secondary data, literature review and intuition.

The case material was collected mainly by means of personal interviews. In the Substudy on the Cross-Functional Knowledge Creation, several key people within the case company were interviewed. These were the managing director, marketing director, technological director, technical manager and project manager. Similarities and differences between each respondent's answers were investigated, since every interviewee had to answer the same questions about the case product innovation. In the Substudy on Barriers to Commercialisation Innovations and in the Substudy on the Perfect Technology Syndrome, the project liaison officer or the company's technology or research manager was interviewed. In each case, the interview subject considered that he or she was more familiar with the project than

anyone else in the company. Open-ended questions were used in the interviews. In the Substudy on Product Innovation as a Micro-strategy, the material was collected by means of personal interviews within the company. All those interviewed had followed the respective product innovation development processes in their company from start to finish. In the Substudy on the Consumer Learning Roadmap, data for the case studies was collected in the Suunto case mainly through interviews. However, the data for the Microsoft Explorer case was collected via secondary sources, which were plentifully available.

In all substudies, the interviews were recorded and the responses then content-analysed and compared. The interview data was supplemented by information obtained, for example, through the Internet and from written sources. In the Substudy on Product Innovation as a Micro-strategy, the interview data was also supplemented by information obtained from discussions with competitors, suppliers, retailers and end-users. In each substudy the supplementary data must be considered almost as important as the interview data.

4 REVIEW OF THE RESULTS

The present dissertation argued that the knowledge base of the company should be enlarged to the four knowledge bases and that enhancing the four knowledge bases increases validity for the innovation commercialisation process better than utilizing the one knowledge base especially in the new companies such as the technological start-up companies. The four substudies developed and used the ‘four knowledge bases’ approach. The four knowledge bases were the technology knowledge base, end-user knowledge base, brand knowledge base, and business-logic knowledge base. The fifth substudy enlarged the perspective with the knowledge base of the consumer. The results of the substudies are as follow.

4.1 Substudy on Product Innovation as a Micro-Strategy

The first substudy described innovation-based diversification and its consequences from the perspective of the four knowledge bases and four knowledge levels. The objective of the first substudy was to deepen the understanding of product-innovation-based diversification as a corporate micro-strategy. The conceptual analyses of the substudy were made by studying a semi-incremental *Product Innovation T* in the *Company C* that had resulted in product-innovation-based diversification. There were some reasons why *Company C*’s knowledge concept for *Product Innovation T* was strategically problematic. The main question was why *Product Innovation T* had not grown to be a mass-market product. The four knowledge levels, that is the driver knowledge level, the concept knowledge level, the systemic knowledge level and the strategic knowledge level were used in the analyses.

The results of the knowledge level analyses of *Product Innovation T* are summarised in Table 1.

Table 1 The knowledge bases and knowledge levels of *Product Innovation T*

Knowledge base					
		Technology	End-user	Brand	Business logic
Knowledge level	Driver	Added-value technology for everyone	Added-value technology for professional users	Create more value for the brand	Business-logic drivers
	Product concept	Added-value technology options	Professional user parameters	High-end brand identity	Only for niche market
	Systemic	Explore the added-value technology on highest levels	Test <i>Product Innovation T</i> only with professional users	Brand advertising to teenagers without a teenager version of <i>Product Innovation T</i>	Typical sales channel
	Strategic	Test the added-value technology with <i>Product Innovation T</i>	Serve the professional users	Expand the brand to professional target group	Stay in the product group and in the business logic, do not create a new product group

The adopted solution limited strategic end-user learning. Learning to use consumer electronics with value-added technology prepares the end-user for the next evolutionary phase of applications based on the same technology. It could be expected that end-user learning will be a slow mass process. Potential end-users perceived the evolutionary phase as a revolutionary learning experience, because they had no earlier experience with this value-added technology and no relationship to any manufacturer representing a next technology generation.

The features of *Product Innovation T* were not optimally geared to reach critical mass. *Company C* had only a limited interest in building a market for its value-added technology products. The strategy of building a new market was an alternative to the strategy of imitating, when both end-users and the required company's capabilities are new.

4.2 Substudy on the Perfect Technology Syndrome

The second substudy analysed a major barrier in the innovation commercialisation process. The objective of the second substudy was to deepen the understanding of the dominance by the technological knowledge base with reference to the sources, consequences and solutions of this over-emphasis. Technology development in product innovation encourages developers to aim for the ultimate frontiers. This aim can lead to the perfect technology syndrome. In the case companies, the perfect technology syndrome was solved successfully in three basic ways: by facilitating alliances with organisations having complementary capabilities, with tailored

products and with close co-operation with key partners. Each of these solutions facilitates the product innovation process.

The solution of facilitating alliances with organisations having complementary capabilities was used by Sunit Mobile. This Finnish software company specialises in professional drivers' knowledge management needs. The advantages for Sunit Mobile were commercial. The company gained a highly significant reference and experience in co-operation with a major European truck manufacturer, Scania. As a result a customer who invested in a Scania truck always got his or her truck already fitted with the Sunit equipment. This lowered the barrier to make a decision to purchase compared with the other alternative that the customer needs to make a separate investment decision to purchase the Sunit equipment. At the same time, the Scania truck gained added value through the Sunit unit. One additional advantage was that the Sunit solution could be made a European standard.

The solution with close co-operation with key partners fitted the Nokia Multi-User Publishing Environment case. This is an open-source software platform for mobile telecommunication services, such as virtual spaces, role games and GPS satellite positioning services. The main target of MUPE was to facilitate software developers' projects to create commercial services for third-generation mobile telecommunication consumer markets. MUPE could also be utilised in GPRS and EDGE telecommunication networks. The main objective of Nokia Research Center was to support the growth of telecommunication service consumption and to eliminate barriers limiting the commercialisation of value-added services.

The solution with tailored products was chosen by Suunto. This company plans and markets wrist computers and GPS-based wrist products. The Suunto approach had three advantages. Firstly, the project group was forced to keep in mind the final target group for the future product, even during the technology development phase. Secondly, the technology was evaluated against real-life demands, not the optimistic fantasies of technology specialists. Thirdly, the success probability of the project was higher, since the technology had a functional value to serve project objectives. All these advantages were founded on tailoring the technological products to special target groups.

4.3 Substudy on Barriers to Commercialisation

The third substudy looked into the barriers in the innovation commercialising process in the software sector from the perspective of the four knowledge bases. The objective of the third substudy was to deepen the understanding of barriers to commercialisation by investigating the effect of the four knowledge bases on publicly-funded innovation projects. The potential barriers to commercialisation taken into consideration included both those relating to product innovation in general and those specifically affecting software innovations. From the resource-based perspective, any lack of resources also causes a barrier to commercialisation (Wernerfelt, 1984). In the information and communications industry, innovations were subject to network effects, which might be technological, social or business-based in character. A central concept in such a network effect was that the more members a network has, the greater the network's value (Katz and Shapiro, 1985).

An important result of the Substudy on Barriers to Commercialisation was the following seven hypotheses:

Hypothesis #1:

Concentration of resources on technology development instead of a wider spread of resources results in a slower commercial implementation and, thus, in a barrier of commercialisation.

Hypothesis #2:

Intellectual property rights do not promote and may constitute a barrier to, commercialisation.

Hypothesis #3:

Initiating marketing of an innovation in parallel with its technological development alleviates barriers of commercialisation.

Hypothesis #4:

The added value recognised in an innovation by the potential customer has a greater impact on lowering barriers of commercialisation than the added value predicated by the manufacturer.

Hypothesis #5:

In eliminating barriers of commercialisation a brand is a significant asset to a start-up company.

Hypothesis #6:

Greater the quantity and density of contacts with stakeholders outside the company is in positive correlation with avoiding barriers of commercialisation.

Hypothesis #7:

Any product innovation creates to the company a situation that a new business logic is required which creates often an anticipated barrier for commercialisation.

4.4 Substudy on the Cross-Functional Knowledge Creation

The fourth substudy proposed that a product-concept model built on a limited number of well-selected, mutually complementary knowledge bases of product

innovation could enhance cross-functional knowledge creation in the product innovation process. The objective of the fourth substudy was to present and analyse a novel multidimensional product-concept model enhancing cross-functional knowledge creation in product innovation development. This substudy produced some expected results, as well as some real surprises. As expected, the divisions knew their respective specific knowledge bases well. This result was almost too trivial to be presented.

Most of the results, however, were unexpected: First, the divisions also knew each other's fields very well. For example, the interviewees with marketing background demonstrated a profound understanding of technical issues. On the other hand, interviewees with a technical background were able to answer in-depth about the brand identity of the *Suunto t6*.

Second, the nicknames suggested spontaneously in the interview differed considerably from each other. The following nicknames were proposed: Personal Trainer, Training Partner, Training Effect, Virtual Trainer, Personal Coach and a playful nickname which does not translate into English.

The technical solutions were strongly related to design features. For example, the *Suunto t6* had to be built using a plastic case although plastic did not give as chic a look for the wrist unit as was desired. Data transmission by radio waves to the wrist unit from the adjacent body band was not technically possible if a metal cover was used.

Top athletes were typically identified as users. Consumer experience was defined very similarly by different respondent groups. It was not expected that the answers would be so similar, as indicated in the responses.

Hardware-related brand indicators of the *Suunto t6* included the round shape and the five buttons' logic. Software-related brand indicators were, for example, the usage logic and information display. Responses conveying a surprise component varied considerably. Using the *Suunto t6* has in some cases resulted in very positive experiences and in some bitter disappointment, as indicated by the respondents.

The company launched the *Suunto t6* at a new target group, with which its sales organisation was previously unfamiliar. The managing director and the product manager both mentioned, as an effect of diversification, the longer predicted payback time for this product. Apart from these respondents, the other persons interviewed did not bring up diversification effects.

4.5 Substudy on the Consumer Learning Roadmap

The fifth substudy enlarges the four knowledge bases perspective with the knowledge base of the consumer in order to cope with the increasing competition of high tech firms and to continuously launch new products. The objective of the fifth substudy was to evaluate the usability of a consumer learning roadmap (CLR) for high technology marketing. It seemed that at least two companies had actively tried to utilise a consumer learning roadmap in increasing their consumers' knowledge base. The case studies increased the understanding of the specific tools utilised in triggering, monitoring and guiding. The Microsoft Explorer case revealed that in order to *trigger* consumers to become familiar with a completely new kind of a product it may be necessary to give them the first product for free. In both cases the Internet discussion groups seem to have played a key role in *monitoring* the

knowledge base. They provided an easy and cost-effective way to follow the communication between consumers. However, they might also give a distorted picture of the whole market since it was likely that the technology enthusiasts were keen to comment on the product and participate very actively in those discussions, whereas the mainstream customers might not be willing to spend their time in online discussions (Moore, 1999). It was thus important not to be blind-sided by the enthusiasm and ease with which the former might use the product. The *guiding* in both cases rested heavily on product features instead of consumer education. It might work fine with the technology enthusiasts but it might not be sufficient for mainstream customers.

5 CONCLUSIONS AND IMPLICATIONS

5.1 Conclusions

The conclusions of this dissertation are based on the five substudies. Several important conclusions are made for the innovation commercialisation process.

In general, innovation development is a knowledge-intensive process. Typically, the discussion of the innovation-related knowledge bases has been limited to one or two knowledge bases. This dissertation enlarged the knowledge bases approach of the innovation to the four knowledge bases, which are the technology knowledge base, end-user knowledge base, brand knowledge base, and business-logic knowledge base. It is important to develop and utilise at least these four knowledge bases.

The perspective of the innovation commercialisation process has been in launching, in finding customers, or in barriers of commercialisation. This dissertation had a complete approach from the fuzzy front-end to the commercialisation process of the next generation innovation. Enlarging the innovation commercialisation perspective is necessary for long-term success.

The macro-perspective has not been very knowledge intensive for understanding the commercialisation innovation process. This dissertation and its substudies utilised the innovation-based micro-perspective. This micro-perspective provides opportunities for analyses, which have not been available with the macro-perspective such as innovation-based diversification.

The innovation strategy is in general a result of a group of innovations fitting the company strategy. The innovation-based micro-strategy is a modern management tool which can cut the time to market success.

Scaled opinions about cross-functional knowledge creation in the innovation development process give a general perspective that can also indicate something other than the innovation-development related issues studied. Utilising the product-concept questions as a questionnaire as in this dissertation implements the innovation-based micro-perspective in knowledge creation.

All in all, the popular macro-perspective of the innovation commercialisation process can be compensated for by the innovation-based micro-perspective to increase the success rate of innovations and innovative products.

5.2 Implications

This dissertation presents recommendations utilising the following implications for a more successful innovation commercialisation process.

In order to achieve rapid commercialisation, resources need to be deployed in a wide range of ways. All relevant knowledge bases, not just one, need to be fully deployed as early as possible, starting from the early technology research phase. Companies should utilise the four product innovation knowledge bases throughout the entire innovation development process.

Companies should develop product-innovation-based strategies. The business logic of each product innovation should be carefully studied and deeply understood. The business logic appropriate to the innovation needs to be identified and recognised, accordingly the company's resource needs must be evaluated realistically.

Companies should allocate resources to the needs of product-innovation-based diversification. Such diversification cannot be avoided, but what is crucial is how

prepared the organisation is for the consequences of this diversification. Often as a result of the diversification inherent in a product innovation the company is confronted with a new unfamiliar business logic.

The product development group members of the company should define their personal product concepts in advance of group discussions. This can allow a fuller utilisation of the creative power of the organisation and secure a greater variety of inputs to the cross-functional knowledge creation.

From the institutional financiers' perspective in publicly-funded technology development projects, steering resources need to be made available for the commercial implementation of a diversifying innovation. It is not enough merely to engage in technological development: one needs to conceptualise and explore the potential applications. This extending of the innovation-based knowledge bases that are utilised needs to be done at the earliest stage possible. Start-up companies need to be encouraged to form alliances with appropriate partners.

5.3 Limitations of the dissertation and further research suggestions

The present dissertation has some limitations. One limitation of this dissertation is that it addresses only a limited number of knowledge bases. The first four substudies discuss four knowledge bases of the product innovation: the technological knowledge base, end-user knowledge base, brand knowledge base, and the business-logic knowledge base. The theoretical approach was enlarged by the fifth substudy to include, in addition, the knowledge base of the consumer.

Another limitation is that the discussion concerning the relationships between the knowledge bases is nearly non-existing in the research report. Only a preliminary

visual presentation is included. This illustrates the practical level questions such as barriers of commercialization. In further research concerning the relationships between the knowledge bases quantitative research method including multi-variable analysis tools should be used, for example factor analysis.

Some reasons for the methodological limitations of the substudies are as follows. The substudy on micro-strategy has a constructive approach. It focuses on one case study only. In further studies, collecting a larger number of similar semi-incremental innovation cases would facilitate theory development. The substudy on perfect technology and the substudy on barriers in commercialisation focus on one technology programme only. Making comparisons with cases taken from other technology programmes would increase the reliability of the observations, in accordance to suggestions on increasing reliability of research by Denzin (1978). The substudy on cross-functional knowledge creation focuses on one case study. The product-concept model that has been developed could be utilised in other product-development case studies to test the validity of the presented approach. The substudy on consumer learning roadmap utilised a short time period in data collection. A longitudinal analysis with several product generations could give a deeper insight in the consumer learning process.

To measure even more deeply various organisational capabilities, the future development of the 'four knowledge bases' model with the extension of the customer knowledge base could further be expanded to include additional knowledge bases, such as the marketing and manufacturing knowledge base. Furthermore, it would be useful to test the models of this dissertation through large qualitative studies and if possible through large quantitative surveys.

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