TAMPERE UNIVERSITY OF TECHNOLOGY

EMIL ACKERMAN

CONCEPT DESIGN FOR IMAGE ANALYSIS SERVICES

Master of Science Thesis

Prof. Miia Martinsuo has been appointed as the examiner at the Council Meeting of the Faculty of Business and Technology Management on March 9th, 2011.

ABSTRACT

TAMPERE UNIVERSITY OF TECHNOLOGY
Master's Degree Programme in Industrial Engineering and Management
ACKERMAN, EMIL: Concept design for image analysis services
Master of Science Thesis, 100 pages, 6 appendices (14 pages)
November 2011
Major: Industrial management
Examiner: Professor Miia Martinsuo
Keywords: Service concept, new service development, image analysis

This study was conducted in order to support the commercialization efforts on image analysis in the Computational Systems Biology (CSB) Research Group at Tampere University of Technology. The research question of this study was the following: How should the CSB research group utilize its image analysis expertise in order to meet the needs of the potential customers via service? The objective was to provide the CSB research group recommendations as to how their image analysis expertise could be harnessed into a service. Fulfilling the objective was done by designing a service concept and service resource structure based on the needs of potential customers.

Literature review revealed that despite the claimed importance of service concept for new service development no significant research on designing a service concept exists. For this constructive single case study, a multi-method qualitative approach was chosen to discover and understand the needs of potential customers before designing the service concept. The perspective of the study was that of pre-commercial professional B2B services relying heavily on technological expertise. A questionnaire was sent to 229 companies of pharmaceutical industry in Finland, Sweden, Norway, and Denmark to gather information from potential customers. After that, 11 semi-structured interviews were conducted with pharmaceutical companies and health care laboratories in Finland to explore their research and operations related needs. Tools created for understanding customer value were utilized to analyze the information collected and models of service concept from service literature were taken advantage of in the design phase. Moreover, the designed service concept was tested by interviewing potential customers.

It was discovered that the companies participating in the study ultimately value high quality, reliability, and speed of research. Moreover, a continuum of image analysis related needs was observed, namely, documentation, image analysis, and data analysis needs. The service concept was designed to meet these three classes of needs of the preclinical side of pharmaceutical industry and health care laboratories by offering customers a customized image documentation system combined with external image and data analysis services. The designed ideal resource structure included elements such as relationships with imaging equipment manufacturers and image analysis expertise fit for commercial needs. The CSB research group can utilize the recommended service concept in commercializing their image analysis expertise. Further areas for development for the group include the details of service operations and extensive commercial analysis of the service concept. Alongside meeting its objective, this study empirically elaborated the creation of a service concept and its respective resource structure including e.g. customer value exploration and designing service offering based on the needs of potential customers. Nevertheless, more research is needed to develop best practices for service concept development.

TIIVISTELMÄ

TAMPEREEN TEKNILLINEN YLIOPISTO
Tuotantotalouden koulutusohjelma
ACKERMAN, EMIL: Kuva-analyysipalveluiden palvelukonseptin suunnittelu
Diplomityö, 100 sivua, 6 liitettä (14 sivua)
Marraskuu 2011
Pääaine: Teollisuustalous
Tarkastaja: professori Miia Martinsuo
Avainsanat: Palvelukonsepti, uusien palveluiden kehittäminen, kuva-analyysi

Tämän tutkimuksen tarkoituksena oli tukea Tampereen teknillisen yliopiston laskennallisen systeemibiologian (CSB) tutkimusryhmän kuva-analyysin kaupallistamispyrkimyksiä. Tutkimuskysymyksenä oli: Kuinka CSB-tutkimusryhmän tulisi hyödyntää kuva-analyysiosaamistaan vastatakseen potentiaalisten asiakkaidensa tarpeisiin palvelulla? Tutkimuksen tavoitteena oli antaa CSB-ryhmälle suositukset sen suhteen kuinka heidän kuva-analyysiosaamisensa voitaisiin valjastaa palveluksi. Tavoitteeseen vastattiin suunnittelemalla palvelukonsepti ja sitä vastaavan palvelun resurssirakenne potentiaalisten asiakkaiden tarpeiden pohjalta.

Kirjallisuusselvitys osoitti, että huolimatta palvelukonseptin väitetystä tärkeydestä uusien palveluiden kehittämiselle, merkittävää tutkimusta palvelukonseptin suunnitteluun liittyen ei ole tehty. Tätä konstruktiivista tapaustutkimusta varten käytettiin kvalitatiivista ja monimenetelmäistä lähestymistapaa, jonka avulla potentiaalisten asiakkaiden tarpeet selvitettiin ennen palvelukonseptin suunnittelua. Tutkimuksen näkökulmaksi otettiin kuva-analyysiteknologiaa hyödyntävät, esikaupalliset B2B-asiantuntijapalvelut. Tiedonkeruu potentiaalisilta asiakkailta toteutettiin lähettämällä kysely 229:lle lääketeollisuuden yritykselle Suomessa, Ruotsissa, Norjassa ja Tanskassa. Tämän jälkeen tehtiin 11 puolistrukturoitua haastattelua lääketeollisuuden yritysten ja terveydenhuollon laboratorioiden edustajille Suomessa. Haastattelujen avulla kartoitettiin yritysten tarpeita. Asiakasarvon ymmärtämistä helpottavia työkaluja käytettiin kerätyn tiedon analysoinnissa, ja kirjallisuudessa esiintyviä palvelukonseptimalleja hyödynnettiin konseptin suunnitteluvaiheessa. Lisäksi, suunniteltu palvelukonsepti testattiin haastattelemalla potentiaalisia asiakkaita.

Tutkimukseen osallistuneiden yritysten havaittiin arvostavan pohjimmiltaan lääketutkimuksen korkeaa laatua, luotettavuutta ja nopeutta. Lisäksi havaittiin, että yritysten kuva-analyysiin liittyvät tarpeet muodostavat jatkumon, joka koostuu dokumentaatio-, kuva-analyysi- ja data-analyysitarpeista. Palvelukonsepti suunniteltiin vastaamaan kyseisiin prekliinisen lääketeollisuuden ja terveydenhuollon laboratorioiden tarpeisiin tarjoamalla asiakkaille räätälöityjä kuvadokumentaatiojärjestelmiä yhdistettynä ulkoisiin kuva- ja data-analyysipalveluihin. Palvelukonseptin ihanteellinen resurssirakenne sisältää muun muassa suhteita kuvantamislaitteiden valmistajiin ja kaupallisiin tarpeisiin soveltuvaa kuva-analyysiosaamista. CSB-tutkimusryhmä voi hyödyntää suositeltua palvelukonseptia kuva-analyysin kaupallistamispyrkimyksissään. Jatkokehityksen tulisi keskittyä palvelutoimintojen yksityiskohtien kehittämiseen ja syvempään kaupalliseen analyysiin. Tämä empiirinen tutkimus kuvasi yksityiskohtaisesti palvelukonseptin ja sitä vastaavan resurssirakenteen suunnittelua sisältäen muun muassa asiakasarvon tutkimista ja palvelutarjooman suunnittelua potentiaalisten asiakkaiden tarpeiden pohjalta. Palvelukonseptin suunnittelun yleisiä käytäntöjä tulisi kuitenkin tutkia jatkossa enemmän.

PREFACE

Conducting the study and writing this thesis has been challenging but at the same time rewarding. In this study, I have been able to take advantage of what I have learned in my studies at Tampere University of Technology and test that knowledge in practice. In addition, this research allowed me to deepen my understanding of image analysis and its potential in biology related research.

This study, however, would have never started, continued, nor ended without invaluable help and support from several people. First, I would like to thank everyone who invested his or her time in this study for an interview and the survey. I would also like to express my gratitude to Professor Miia Martinsuo for her indispensable guidance and feedback during the research process. In addition, I would like to thank Olli Pasanen, Antti Niemistö, Jyrki Selinummi, and Olli Yli-Harja for their valuable contribution during the whole project.

Lastly, I would like to thank my loved ones in my native language. Haluan kiittää Äitiä, Papaa, Annaa ja isovanhempiani tuesta ja neuvoista, joita olen teiltä saanut niin tutkimuksen aikana kuin ennen sitä. Lopuksi haluan sydämeni pohjasta kiittää Krisseä kaikesta avusta ja tuesta, joita ilman ei työstäni olisi tullut mitään.

Tampere, 25th of September 2011

Emil Ackerman

TABLE OF CONTENTS

1. INTRODUCTION

The introductory chapter of the thesis addresses first the background and context of the study. After that, the research problem and objectives alongside research limitations are presented. Moreover, the research methodology is shortly discussed before going through the thesis structure.

1.1. Background

In the background section, service economy is discussed shortly and is followed by a short introduction to Imacom project, in which the study takes place.

1.1.1. Service economy

The importance of services for societies, especially in developed countries, is growing constantly. It affects several aspects of economies and every-day lives of all of us. The term service economy can refer to two recent economic developments:

a) Increased importance of the service sector in industrialized countries.
b) Increased relative importance of service in product offerings. (Wikipedia 2011b.)

The former economic development can be witnessed in a myriad of statistics. In OECD economies for example, service sector accounts already for about 70 percent of aggregate production and employment and further growth is inevitable (Wölfl 2005, p. 6). Also, in the biggest consumer market of the world, the US, the projections for the year 2014 show that the manufacturing sector will experience further decrease in wage-and-salary employment whereas services are increasing in all subsectors (Bureau of Labor Statistics 2006). This so-called labor migration from agriculture and manufacturing to services is driven by global communications, business and technology growth, urbanization, and low-cost labor (Fitzsimmons & Fitzsimmons 2008, p. 3).

The latter economic development is usually referred to as servitization of products. Basically, it means that even in manufacturing sector more and more offerings have a growing amount of services bundled to the actual products sold. In Mathieu's (2001a) classification, these types of services are called services supporting the client's product. However, these kinds of services are not the only cause for the 'service revolution'. In fact, knowledge-based, professional services sector has experienced one of the highest

growth rates in terms of economic growth and new employment (de Brentani & Ragot 1996, p. 518). Moreover, in terms of wage-and-salary employment, professional and business services are projected to grow twice as fast as the average for all industries in the US (Bureau of Labor Statistics 2006, p. 35).

However, many of the new professional services developed fail (de Brentani & Ragot 1996, p. 518). Moreover, "when compared to tangible products, services are generally under-designed and inefficiently developed" (Froehle et al. 2000, p. 5). The reasons for these observations vary but one possible explanation for the failures in services and especially in new professional services might be research-related. Despite the undisputed growth and importance of service sector, the research in the area of services is falling behind. The majority of research is still manufacturing-related and degree programs are mainly in traditional disciplines that were established before the World Wars (Tien, Berg 2006, p. 258).

In service research, in general, many papers have been written about new service development (NSD) which is an important area to master in order to create successful services (for review see e.g. Johne & Storey 1998). Still, until the 21st century, most empirical research into NSD focused only on one type of professional services, the financial services sector (Johne & Storey 1998, p. 219). Recently, other research areas and terms have emerged, e.g. knowledge intensive business services (KIBS) (see e.g. Miles et al. 1995) but the research on services is still in the need for rapid development.

1.1.2. Imacom project

Acknowledging the growth and importance of services, the Finnish Funding Agency for Technology and Innovation, Tekes, started the 'Serve' program in order to promote the development of service innovations in Finnish companies. The focus groups of the program are industrial services, trade services, and KIBS. (Tekes 2011.)

The Computational Systems Biology (CSB) Research Group in the department of Signal Processing at Tampere University of Technology is also attending the 'Serve' program. Among other things, the researchers in the CSB group have expertise in the challenging field of image analysis, especially microscope image analysis (Niemistö et al. 2010). In short, "image analysis is the extraction of meaningful information from images; mainly from digital images by means of digital image processing techniques" (Wikipedia 2011a). It is the expertise of the researchers that the CSB group is trying to utilize in the purpose of creating a service oriented business model. This is called the Imacom project.

There are three external consultancy studies included in the Imacom project (Niemistö et al. 2010). The first two studies concentrated mainly on analyzing the expertise, competencies and previous work of the researchers in the CSB research group. They

also gathered signals of potential needs for image analysis expertise by arranging meetings with various university groups and companies. The previous work of the CSB group researchers was presented to the audiences in those meetings (Pasanen 2010; Imacom project 2011).

1.2. Research problem and objectives

By far, the main conclusion of the earlier consultancy studies has been that there are image analysis related needs among research groups and companies, but the question remains as to how to address those varying needs. This thesis is a part of the third consultancy study whose purpose is to take advantage of the earlier studies and eventually design a concept for image analysis services.

In the first consultancy study, it was stated that some of the potential customers are in the broad industry of pharmaceuticals including not only 'the Big Pharma' but also smaller, often biotechnology related firms involved in drug discovery and development (Pasanen 2010). What the companies of this industry have in common is that they analyze and make use of biological information in their research. Also, it was revealed earlier that one of the competencies of CSB group researchers is in utilizing image analysis to analyze biological information (Pasanen 2010), hence making the pharmaceutical industry a natural focus of this study.

In addition, the geographical focus of the study is limited to Finland, Sweden, Norway, and Denmark. These countries are a fertile ground for the study as Nordic countries have been observed to be among the best performing countries in the field of biotechnology. For instance, Sweden leads in terms of the number of dedicated biotechnology firms and Denmark is the top-performing country in terms of drug approvals and US patents. (Nesta et al. 2003.)

Given the limitations, the research question and its sub-questions are the following:

- How should the CSB research group utilize its image analysis expertise in order to meet the needs of the potential customers via service?
    a. What kind of concept for image analysis services should be developed to serve customer needs?
        i. What are the needs of the potential customers?
        ii. How should the future service provider tackle the needs of the potential customers?
    b. How, through what kind of a service resource structure can the service be delivered?

In a broader context, this development of the service concept and resource structure based on image analysis expertise is seen as the concept and resource structure development for professional services. Hence, in addition to answering the research question, this study provides new empirical insight into new service development of professional services. The study empirically elaborates the most crucial part of NSD, service concept creation and also the development of its respective service system in the context of high technology field, image analysis.

The objective of the study is derived from the research question in a straightforward manner. Consequently, the main objective is to provide recommendations for the CSB research group as to how their image analysis expertise could be harnessed into a service. These recommendations are presented in the form of service concept and service resource structure, and the creation of the concept and the structure is the so-called sub-objective of the study. It should be explicitly noted, that this study does not address the subjects of business model and business logic as a whole even though they are closely related to the study.

1.3. Research methodology

All in all, this study is very customer-oriented. Many companies do not pay enough attention to the customers' real wants and needs. They might produce excellent products and services with one problem, and a barrier to be successful, which is they do not match up with customers' actual needs. (Doole et al. 2004, p. 164.) Edvardsson (1997, p. 33), too, underlined the importance of customer orientation: "Customer orientation should be a central point of departure for all service development."

This in mind, the research methods of the study are linked to potential customers. Two different qualitative methods were used to reveal the actual needs of potential customers. First, an Internet-based questionnaire was sent to pharmaceutical industry companies analyzing biological information in their operations in Finland, Sweden, Norway, and Denmark. The information gathered through the questionnaire was used not only to analyze the needs of potential customers but also as one of the inputs to create relevant themes for semi-structured interviews.

Second, semi-structured interviews were conducted with the staff of different Finnish companies of the pharmaceutical industry. The interviewees were selected to be responsible or familiar with the research of the respective organization. In addition, due to information received from the interviews, staffs of certain Finnish health care laboratories were interviewed as well.

The information from the survey and interviews were used to analyze the actual needs of the potential customers. This was a prerequisite to define how the needs should be

tackled, i.e. what the service offer should contain. The methods used alongside the information from the previous consultancy studies made the service concept and resource structure development possible. Lastly, the designed service concept was tested by interviewing potential customers. The methodology of the study will be discussed in further detail in its own chapter.

1.4. Thesis structure

Since there are many different steps in this study and sometimes multiple inputs to different steps, a clarifying input-output scheme is provided in figure 1.1. In the scheme, arrows represent inputs and outputs to different steps in the study. All the steps inside the circled area receive input from the literature review. However, earlier consultancy studies offer input mainly to the steps of service offer and resource structure development.

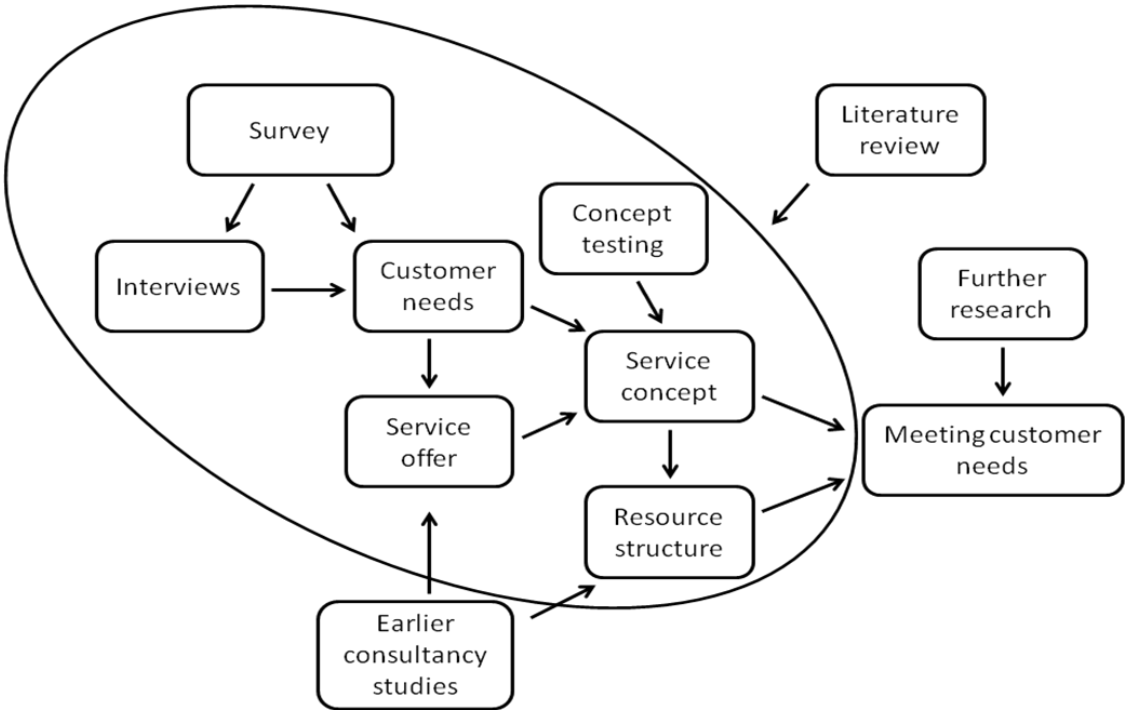


Figure 1.1. *Input-output scheme of the study.*

The structure of this thesis is the following. In chapter 2, after the introductory chapter, a literature review is conducted addressing the relevant aspects of services and their development. Chapter 3 describes the case by going through the context of the study in detail. Chapter 4 elaborates the methodology used in the study. In chapter 5, the results of the methods are presented. In chapter 6, the service concept and the service resource structure are created based on the results, earlier consultancy studies, and literature review. In chapter 7, the limitations of the study are presented alongside further development and research recommendations. Lastly, in chapter 8, the conclusions are presented. The references and appendices can be found at the end of the thesis.

2. LITERATURE REVIEW

To compile this literature review many articles and books have been reviewed from different areas of business science, e.g. marketing and operations. By going through the basic terms and concepts related to services, one can understand the later chapters of this study in a more comprehensive way.

This study is all about services, hence the literature review deals with various aspects related to services. First, services in general are discussed. After that, the concept of new service development (NSD) is introduced. Lastly, various elements of service concept and service resource structure are discussed.

2.1. Services

Media and various statistics show that industrialized countries are constantly developing into more and more service-driven economies (see e.g. Wölfl 2005 and Bureau of Labor Statistics 2006). In other words, the importance of services for countries, societies, and people in general is ever growing. However, when media and researchers talk about services it is not always unambiguous as to what people mean by services. In general, the term ‘services’ is used in many different contexts (Brax 2007, p. 9). In spoken language, services can mean e.g. something that is different from products. But what are services exactly? The following subchapters discuss services as a phenomenon and after that continue to the characteristics and typologies of services.

2.1.1. Services as a phenomenon

One possible description of services is the following: Service is a complex phenomenon. The meaning of the service can relate to personal service or service as a product. Moreover, the term ‘service’ can be used in a wider context: any machine or almost any product can be called service, if it has been highly customized to meet all the possible details of customer specifications. In this case, the machine itself is still a concrete product but the way in which a highly customized machine is developed and delivered for the customer can be called service. (Grönroos 1998, pp. 49-50.) Brax (2007) further clarifies this description by stressing that in the core of any service, the customer is offered some sort of an execution or an act in exchange for money. In this study, afore described broader view of ‘services’ is adopted. By adopting a narrower definition, one would needlessly limit the possible service concept solutions, which, naturally, is not desirable.

Even though services are generally considered different by nature compared to products, oftentimes services and products go hand in hand, at least to some extent, as could be seen in Grönroos's (1998) definition for services. Mathieu (2001b) discusses the relationship between products and services by analyzing service specificity in manufacturing companies. Service specificity is divided into customer service, product services and service as a product.

Customer service is probably easiest to comprehend. It is tightly linked to selling products and there are usually no service fees, e.g. the assistance during the purchase of the product. Product services are dependent on the amount of products sold as well. On the other hand, product services do not make the purchase of the product possible, as is the case with customer service, but they complement the product sold and bring more value to the customer, e.g. delivery and installation of the product. Lastly, service as a product is in contrast to the last two as it is completely independent of products sold by the company. (Mathieu 2001b.) Any consultancy service is an example of a service as a product. The last of the three, service as a product is actually the main option offered in so-called service companies.

When discussing service product or service as a product, regardless the industry, one can imagine them as service packages that consist of core services and supplementary services (Grönroos 1998). In a gym, for example, the core service can be the possibility to use clean and effective equipment whereas supplementary service could be a personal trainer. Lovelock (1992a, p. 26-27), too, describes services to be "a bundle of activities consisting of the core product…plus a cluster of supplementary services" (by product in this context, Lovelock refers to service product or service as a product).

Lovelock further divides supplementary services into three generic, industry-independent, categories of information based, people based and value based supplementary services. Information based supplementary services contain tasks as offering advice or taking orders; people based include general hospitality by the staff in contact with the customers; and lastly, value based services are services that can add value to customers, e.g. warranty or storage of goods. (Lovelock 1992a.)

When comparing Mathieu's (2001b) typology of services linked to products which was described earlier, and Lovelock's (1992a) description of what constitutes a service, one can notice that they have many similarities with each other, only the perspective is different. This is actually not strange to service literature. There are many different definitions and classifications of services but they all have certain elements in common. For example, according to Fitzsimmons & Fitzsimmons (2008, p. 4) various definitions of service all contain common themes of intangibility and simultaneous consumption.

2.1.2. Service characteristics

Even though it was discussed how services and products go hand in hand, the characterization of services is often based on comparing services to products and finding out what are the distinguishing factors between them. It is also worthwhile to mention that unique characteristics of services are interrelated (Fitzsimmons & Fitzsimmons 2008, p. 18). Cowell (1984, p. 23) stated the characteristics of services to be the following:

a) intangibility
b) inseparability
c) heterogeneity
d) perishability
e) ownership

Intangibility is first in the list because it is probably the most distinguishing factor between services and products. Services are essentially ideas and concepts whereas products are plain things (Fitzsimmons & Fitzsimmons 2008, p. 20). You cannot take service to your home or factory; you cannot touch, grab or smell it. Hence, services are intangible by nature. Due to intangibility, the customer value proposition of the service has to be designed carefully in order to attract customers.

Many services are also inseparable by nature. While products are first manufactured, then sold and lastly consumed, services are often sold first followed by (at least partially) simultaneous production and consumption (Cowell 1984, p. 25). This inseparability of production and consumption also means that customer participates in the service process, which is not distinctive to manufacturing process. This combined with the intangible nature of services result in variation of service from customer to customer (Fitzsimmons & Fitzsimmons 2008, p. 20). In other words, variation in the process of service production leads to heterogeneity of service outcome. Heterogeneity has implications on customers as well, since it is difficult to judge the quality of the service before the actual purchase (Cowell 1984, p. 25). Consequently, it may be challenging for marketing to prove customers the quality of service in advance of purchase, especially if the service is completely new and no customer references exist, e.g. in the case of a start-up company.

Perishability is another characteristic of many services. In other words, services cannot be stored and for example, an empty hotel room represents a service capacity lost forever. However, not all companies ‘suffer’ from the perishable nature of services. The last service characteristic stated by Cowell (1984), ownership, underlines the fact that a customer cannot own services; services can only be accessed or used. Needless to say

that due to the non-ownership characteristic of services the revenue models of services can differ from the revenue models of selling products considerably.

It should be noted, however, that these characteristics are not all adaptable to services, especially when dealing with the broad definition of services. For example, inseparability is hardly present in the case of delivering a highly customized machine to the customer, as was discussed in Grönroos's (1998) description of services. Also, not all services are heterogeneous by nature. Take for example automatic car wash: Even though cars and drivers differ, they all get the same standardized service that has minimal variation in the output. In this case, the service has been designed to be robust enough to give consistent output although the input, cars and drivers, differ from each other. Indeed, certain disadvantageous characteristics of services can be overcome by thorough service design.

After Cowell, many researchers have stressed some of the service characteristics described and even introduced new ones. Grönroos (1998, p. 53), for example, brought out the characteristics of intangibility, simultaneity, customer participation in the production process (co-production), and the fact that services are essentially processes in contrast to 'things'. The debate continues as to which characteristics describe services best, and many of the service characteristics mentioned have been questioned by researchers. All in all, certain distinguishing service characteristics are important to understand as they create new challenges and opportunities compared to manufacturing industry. These characteristics have several implications for companies on e.g. development and marketing of services, and quality control as already noted in the examples above.

A completely different perspective from Cowell's (1984), Grönroos's (1998) and Fitzsimmons & Fitzsimmons's (2008) approach on the nature of services is provided by Edvardsson (1997). It is worthwhile to introduce this perspective as well since certain elements of it are utilized in this study. Edvardsson, who has conducted extensive research on services in Sweden, explains the nature of services not via characteristics different from products but as service as a concept (not to be confused with service concept).

Service as a concept is build from three distinctive elements: customer outcome, customer process, and prerequisites for the service. The customer outcome highlights the fact that the customer is ultimately the recipient and judge of the service in terms of value added and quality. Hence, it is not enough if only the service providers feel they did a great job. The customer process points out that the customer participates and has an effect on the results and quality of the service (compare to Grönroos's 1998 co-production). Both the customer outcome and customer process are based on customer perspective while the last element, prerequisites for the service, takes the perspective of

the service provider. In fact, the first two elements are dependent on the third element in the form of resources, which exist to provide the service. (Edvardsson 1997.)

The prerequisites for the service are service concept, service system (service resource structure), and service process. They are the end result of the service development process. Together they make the service possible. (Edvardsson 1997.) Service system and service resource structure will be dealt in further detail later as they are essential elements of this study. Service process, in turn, is "the chain of activities which must function in order to produce the service". However, the process normally requires customer participation. (Edvardsson 1997, p. 35.) It is owing to this reason and to the fact that no 'Imacom company' exists (no customers, routines or clear resources whatsoever), that the design of the process is excluded from this study.

In summary, customer outcome, customer process and prerequisites for the service constitute the service as a concept. The desired customer outcome places demands on the customer process, which in turn places demands on the prerequisites for the service. (Edvardsson 1997). Figure 2.1 illustrates the concept of service as proposed by Edvardsson & Olsson (1996).

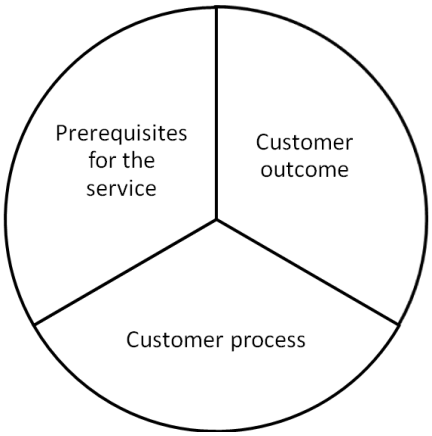


Figure 2.1. *Service as a concept (adapted from Edvardsson & Olsson 1996, p. 146).*

As can be seen from earlier discussion, services are indeed complex by nature. Hence, they can be studied in multiple ways and perspectives, and oftentimes all of the approaches are valid in their own context. By classifying services, one can ease the task of studying them. This is the subject of the next subchapter.

2.1.3. Service typologies

A central challenge in discussing services is that there is a variety of them and by "services" one still usually means all of them as one homogeneous group (Brax 2007, p. 11). To analyze services as one group only might not always be the best solution since different services can be very distinctive from one another. Menor et al. (2002) view that this kind of aggregation of services may create a bias that limits the predictive and external validity of research findings. In manufacturing industry, for example,

distinctions made between e.g. durable and nondurable goods have led to different types of marketing strategies directed at each of these groups (Lovelock 1992b, p. 51). By classifying things, it is possible to understand them better and develop class-specific solutions in the field of marketing, for example.

Still, classification is not beneficial only for marketing but other company operations can take advantage of it as well. If it can be shown that tentatively different looking services do share certain relevant characteristics, then the stage may be set for cross-sectional generation of concepts and strategies (Lovelock 1992b, p. 51). It can also be viewed that classification of services is a prerequisite to find out which techniques or strategies e.g. in new service development are suitable for which kind of services.

Several typologies and classifications of services have been developed, in the areas of service marketing and service operations management. Sometimes distinctions are made only between business-to-business (B2B) and business-to-customer (B2C) services or between everyday services (e.g. barber services) and professional services (e.g. medical doctor). (Brax 2007.) Indeed, probably one of the most straightforward ways of classifying services is based on the questions of who the customers are and what the organization providing the service is. Johnston & Clark (2005) use this approach to make a distinction between five broad sectors of service economy: B2B services, B2C services, internal services, public services (government-to-consumer, G2C) and not-for-profit services. As the aim of the Imacom project is to commercialize image analysis expertise, and as the survey and interviews were targeted to companies, the perspective is obviously B2B-related.

Another classification of services relevant to this study is related to the classification of new services compiled by Johnson et al. (2000) which can be seen from table 2.1. Menor et al. (2002, p. 138) stress that it is important to specify the type of new service to be studied in order to frame the implications of research findings. In this study, a completely new service concept is developed for a market, which utilizes certain analysis services but not image analysis based services. Moreover, if a promising service concept is created, it could lead into founding of a new company. Hence, according to Johnson's et al. (2000) classification in table 2.1., the services developed in this study would be classified best as radical innovations and start-up business.

Table 2.1. *Classification of new services (adapted from Johnson et al. 2000).*

New Service Category	**Description**
Radical Innovations	
Major innovation	New services for completely new markets.
Start-up business	New services for markets served by existing services.
New services for the market presently served	New services to existing customers of an organization. Services may be available from other companies as well.

Incremental innovations	
Service line extensions	Augmentations of the existing service line (e.g. new menu item in a restaurant).
Service improvements	Changes in features of services currently offered. (e.g. head massage before haircut)
Style changes	Modest visible changes that affect only the appearance (e.g. glow bowling)

In service operations management, a rather different approach has been taken in order to classify services. In this case, the perspective is naturally operational. Silvestro et al. (1992) studied the relationship of the number of customers processed by a typical unit per day with six different dimensions of services, which had been derived from the literature. Those dimensions were equipment/people focus, customer contact time, degree of customization, degree of discretion, value added front office/back office, and product/process focus. What Silvestro et al. (1992) found out is that as the number of customers processed per day increased when moving from one service company to another, the general trend seemed to be the following:

- Focus moves from people to equipment;
- Length of contact time decreases;
- Degree of customization decreases;
- Level of employee discretion decreases;
- Value added moves from front office to back office;
- Focus moves from a process to a product orientation.

Based on these observations it was concluded that services can be classified into three, partially interrelated categories of professional services, service shops and mass services. Professional services and mass services are at the different ends of the spectrum in terms of the six dimensions; service shops are somewhere in between the other two. (Silvestro et al. 1992.) Schmenner (1992), on the other hand, used two variables in categorizing services: degree of labor intensity and degree of interaction and customization ending up in four different service categories, three of which being the same as Silvestro et al. (1992) described. The fourth category, the service factory, has low degree in both the labor intensity and degree of interaction and customization. An example of a service factory could be a fast food restaurant whereas the examples of professional service, service shop and mass service are lawyer, car repair, and a school respectively (Verma 2000, pp. 13-14).

Moreover, services have also been distinguished from one another by the degree of routinization. A rigid service process can be characterized, among other things, by the following attributes: low level of task variety, high volumes, and few judgmental decisions by service workers. A fluid service process, on the other hand, exhibits high

level of workflow uncertainty, low volumes, and need for several judgmental decisions by service workers. (Wemmerlöv 1990, p. 31-32.) In figure 2.2 Silvestro's et al. (1992) and Wemmerlöv's (1990) views are combined and presented. In the figure, on the left hand side, the dimensions with ordinal nature (can have e.g. low or high levels) are presented whereas on the right hand side the dimensions with nominal nature (descriptive data) are presented.

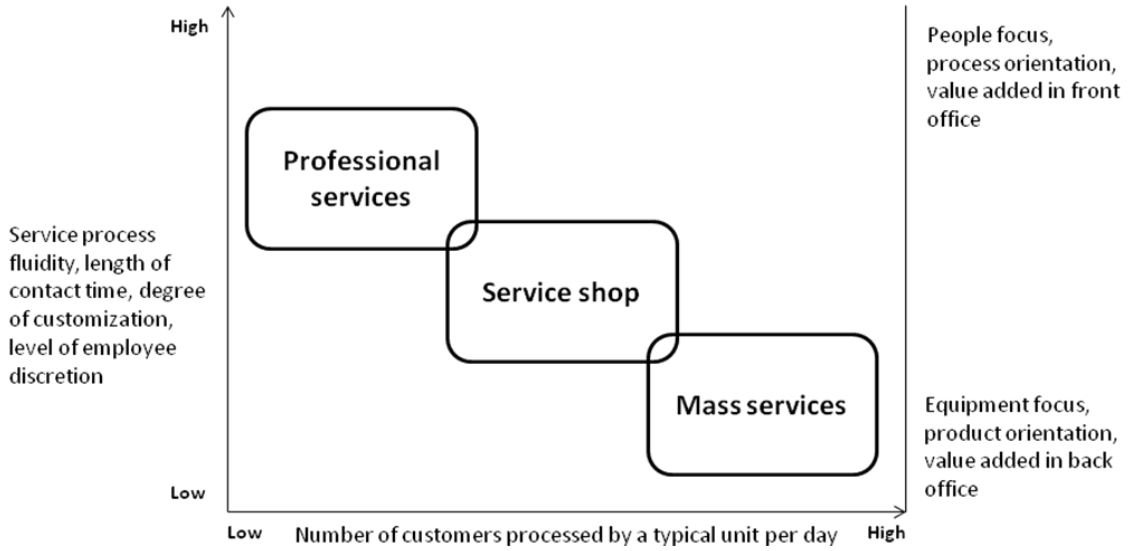


Figure 2.2. *Service categories in operational perspective (modified from Silvestro et al. 1992 and Wemmerlöv 1990).*

Professional services and KIBS

Since the perspective of this study is service concept and resource structure development for professional services, they are now discussed in further detail. From figure 2.2. one can generalize that professional services have a fluid service process and the length of contact time is high. Also, the degree of customization and the level of employee discretion are high. Moreover, professional services are people focused, process oriented and the value for the customers is usually added in front office. In addition, there are many other dimensions, attributes and definitions for professional services in service literature.

Nachum (1999, p. 923) described professional services to have professional knowledge as their core resource. He also pointed out that the clients of professional service firms are other firms and organizations who use the output of professional services as an intermediate input in their own production processes. Not all probably would agree with Nachum's (1999) definition since it would basically exclude e.g. private clinics with medical doctors from the list of professional services. Nevertheless, this definition is analogous with de Brentani's & Ragot's (1996, p. 517) definition for professional business-to-business services which they describe to be "industrial services that involve highly specialized skills and are of an advisory nature".

Løwendahl (2005) provides a detailed list of professional service characteristics, some of which have already been mentioned. Professional services:

a) are highly knowledge intensive and often linked to scientific knowledge development within the relevant area of expertise
b) involve a high degree of customization
c) involve a high degree of discretionary effort and personal judgment by the person providing the service
d) typically require substantial interaction with the client
e) are delivered within the constraints of professional norms of conduct (e.g. Hippocratic Oath vowed by doctors) (Løwendahl 2005, p. 22.)

However, another, newer, service category has emerged from the service literature, which has a lot in common with the category of professional services. Actually, Nachum's (1999) definition was already close to what nowadays are called knowledge intensive business services (KIBS). Muller & Doloreux (2007, p. 5), for example, stressed that "KIBS are mainly concerned with providing knowledge-intensive inputs to the business processes of other organizations". Miles et al. (1995, pp. 28-30) elaborated the linkage between professional services and KIBS by stating that many of the new KIBS can actually be identified as new professional services. In addition, they divided KIBS into two groups: traditional professional services (e.g. legal, marketing, and management consultancy services) and new technology-based KIBS (e.g. R&D consultancy, technical engineering, and software services).

An interesting KIBS definition, particularly relevant to this study, is the one described by Den Hertog (2000): KIBS are private companies or organizations, which rely heavily on professional knowledge, i.e. "knowledge or expertise related to a specific (technical) discipline or (technical) functional domain", and they supply intermediate services and products that are knowledge intensive. Image analysis expertise, as will be seen later in chapter 3. "Case description", can be described as "expertise related to a specific technical discipline". However, the reason why this study is not about service concept and resource structure development for KIBS but professional services is that KIBS definitions differ greatly and "comparing different studies of KIBS is thus like comparing apples and bananas" (Nählinder 2005, p. 68). Hence, in order to avoid the controversy as to whether the resulting service concept and resource structure are KIBS related or not, this study takes a wider and more established perspective of professional services. More precisely, the perspective is professional business-to-business services relying heavily on expertise related to a specific technical discipline – image analysis.

2.2. New Service Development

Developing new services can seem to be very easy if it is not done correctly. Not surprisingly, a large proportion of NSD projects in different companies have failed due to inadequate efforts to NSD. (Johne & Storey 1998, p. 185.) In general, for many companies, NSD is more or less a haphazard process, which simply happens in a laissez-faire manner (De Jong et al. 2003, p. 27). For example, Kelly and Storey (2000), while studying UK service companies in the sectors of banking, telecommunications, insurance, transportation, and media, found out that companies usually do not have formal mechanisms to generate new ideas. In addition, they observed that only a half of the companies in their sample had a formal NSD strategy. This is somewhat alarming, as it has been observed that successful firms, in general, establish systems and procedures for continuous idea development and innovation (de Brentani 2001; Robinson & Stern 1998). In fact, it has been stated that due to poor understanding of NSD, services are generally under-designed and inefficiently developed when compared to products (Froehle et al. 2000, p. 5). In general, the advancement of understanding in NSD through research requires empirical effort (Menor et al. 2002, p. 137).

Considerable amount of earlier research has concentrated on developing new services for already existing firms, particularly product-based companies (see for example Kindström 2010). Less focus has been put on research concentrating on new service development for start-up companies, in which the whole business of the company could be based on the results of new service development. In this case, NSD would not result in a mere extension or modification to the current offering of the company. Instead, the resulting new services would be rooted in the business model of the company. This business model perspective has been seen to be helpful in creating sustainable advantage by reducing imitability: “Competitors will find it more difficult to isolate and copy individual elements of an integrated and inter-functional business, which is particularly pertinent in reference to services” (Kindström 2010, p. 481).

Even though this thesis focuses on NSD in the context of a start-up or even a pre-commercial professional service company, certain lessons can be learned from the literature about NSD for manufacturing firms. Gebauer et al. (2005), for instance, have stressed that extending the service business via NSD requires organizational rearrangements as well. In other words, organizational arrangements are a necessity in order for firms to be successful in creating new services. The linkage between organizational arrangements and NSD, especially service concept creation, will be dealt in further detail in the chapter discussing service resource structure.

Two broad categories of NSD have emerged in service literature: one concentrates on studying what kind of environment should there be in a firm in order to enable and promote NSD and innovation; the other pays attention on what the actual process of

NSD should be like. Froehle & Roth (2007, p. 170) describe the former category as resource-oriented NSD practices and the latter as process-oriented NSD practices. These categories will be discussed in their own subchapters but first new service development is defined and the implications of service characteristics to NSD will be analyzed.

2.2.1. Defining new service development

Simply, new service development means "the development of service products which are new to the supplier" and it is the "overall process of developing new service offerings" (Johne & Storey 1998). In addition to NSD, service literature uses the terms of service design and service innovation as well. These terms are interconnected and are sometimes even used as synonyms to NSD. Hence, it is relevant to clarify what NSD means in this study.

The idea of service development originates from the service management and marketing literature. It focuses especially on the idea of service quality. Service innovation, on the other hand, originates from the economics and business strategy literature that focuses more on technology development and entrepreneurship. (Menor et al. 2002, p. 139.) In fact, the resource-oriented NSD research has a lot in common with service innovation literature; to some extent they can be considered interchangeable. Service innovation can be considered to be at the earlier stages of NSD forming an input for later stages.

Contrary to service innovation, service design can be related to later stages of NSD. Goldstein et al. (2002, pp. 121-122) describe service design as "defining an appropriate mix of physical and non-physical components" in order to make service possible. Service design is about designing how the different elements of service, e.g. people, equipment and physical environment, should function together in order to make high quality service possible (Zeithaml et al. 1990, pp. 157-158). It should be noted, however, that narrower and wider definitions for service design and service innovation exist. Narrower definitions usually constitute a certain part of NSD while wider definitions can be used interchangeably with the whole concept of NSD. (Goldstein et al. 2002, pp. 122-123.)

Coming back to NSD, Edvardsson (1997, pp. 32-34) provides a comprehensive definition for it: NSD is the whole process from idea to the market introduction of a new service. He further continues that NSD's main task is to create the prerequisites for service (those being service concept, service system, and service process), i.e. to create the conditions for the right customer outcome (Edvardsson 1997). Edvardsson & Olsson (1996) too, stress the need for customer orientation in NSD. Also, Kindström (2010, p. 488) points out that in developing services, firms have to be more conscious about the customers' and even their customers' customers' processes. He further noted that managers need to be able to design a dynamic service portfolio which would be adaptable to differing customer needs. It has indeed been noticed that successful NSD,

among other things, has a strong customer involvement and uses information about the customers in all stages of NSD (Martin Jr & Horne 1995). De Brentani (2001), while studying new B2B service projects through a survey to company managers, observed that ensuring an excellent fit between what is offered and what the customers need, is actually one of the "global" success factors which affect the outcome of new services. This study, also, has a strong customer orientation and the service concept developed is ultimately led from the needs of the potential customers.

2.2.2. The implications of service characteristics to NSD

In manufacturing, a systematic process for new product development (NPD) has been prevalent for many years. Already in 1968, Booz, Allen & Hamilton (1968), empirically revealed a six-step NPD process which was later, in 1982, updated into a seven step process (Scheuing & Johnson 1989). Many other, partly similar models have followed afterwards. Figure 2.3 illustrates the seven-step process of NPD by Booz, Allen & Hamilton (1982).

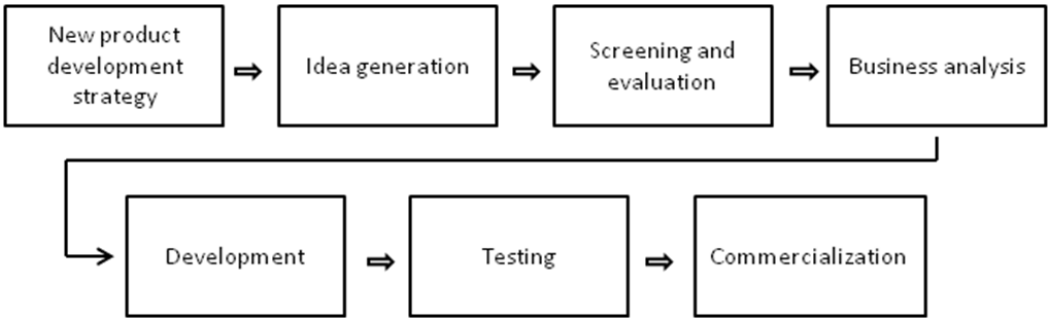


Figure 2.3. *Seven step process of NPD by Booz, Allen & Hamilton (adapted from Scheuing & Johnson 1989, p. 26).*

However, utilizing models developed for NPD in developing new services is not quite straightforward, as the distinct characteristics of services have to be taken into account in NSD as well. In order to be effective, NSD has to be different from NPD at least in some aspects (Menor et al. 2002, p. 144). Especially service characteristics of intangibility, heterogeneity, simultaneity, and perishability have implications on new service development.

The intangibility of services needs to be "tangibilized" via service concept so that all the people taking part in the development process would have a similar understanding of what the service should be like (Menor et al. 2002). Moreover, when discussing intangible products, they prove to be especially difficult to test in concept. Testing processes (i.e. services) as opposed to physical entities (i.e. products) is far more challenging. Another challenge brought by intangibility is the fact that the results of NSD, the actual services, can be quite easily copied by competitors. (Johne & Storey 1998.) The main reason for easier imitability of services is the transparency of service systems (Fitzsimmons & Fitzsimmons 2008, p. 65). Consequently, since services are

not patentable, the developers have to put extra effort to developing services that are not easily copied by competitors, e.g. the service could require certain rare resources that the competitors would not have access to.

NSD requires considerations on service heterogeneity as well. The developers need to decide on how much variation they allow into the service process. The degree of variation can be affected by means of standardization of the service and applying technology at the customer interface (Johne & Storey 1998, p. 188). The example of a car wash described earlier serves as an example of high degree of service standardization and technology at the customer interface, which leads into low degree of variation in service outcome. In addition, emphasis has to be put on specifying how trained should the service staff be in order to provide the desired level of service outcome variation (Johne & Storey 1998, p. 188).

Lastly, (partial) simultaneity of production and consumption combined with perishable nature of services brings yet another challenge for service developers. You cannot have a buffer inventory for services as you could for products. Hence, the developers of services have to pay extra attention to capacity planning of services. In airline industry, for example, the concept of yield management was introduced to tackle the service characteristics of simultaneity and perishability (Fitzsimmons & Fitzsimmons 2008, p. 257).

2.2.3. NSD environment

Froehle and Roth (2007, p. 170) describe resource-oriented NSD practices to concentrate on "cultivating, motivating and developing the intellectual organizational, and physical resources that support and enhance the firm's NSD capability". By physical resources they mean employees, information, and facilities, for instance. A continuous stream of innovations increasing the competitive advantage of a firm can only be achieved by creating an innovative climate inside a firm (De Jong & Vermeulen 2003). A fertile environment for NSD has been studied to consist of various elements, some of which are introduced below.

Not surprisingly, according to many studies, managing people is one of the most important elements in providing a fertile environment for NSD (see e.g. De Jong & Vermeulen 2003). Among other things, it is beneficial for a company that its staff has certain degree of autonomy in innovation. A flexible bottom up approach in which management receives ideas from employees can be useful at the beginning of an NSD process. However, the implementation of the idea should not be on the shoulders of an employee. (Nijhof et al. 2002.) Hence, employees need something to support their ideas and develop them further.

The long-term innovation potential among staff can also be increased by effective internal communication (Lievens et al. 1999). Innovations are rarely made by one person only. Enhancing collaboration in idea generation via means of e.g. internal communication may prove to be extremely beneficial for a firm. However, idea generation is only a starting stage for NSD. Something else is needed to escort the idea through NSD process.

The internal organization of the company can support the further development of ideas. Sundbo (1997) observed that some of the top service firms in his study had an innovation department. The role of these innovation departments, however, was not to introduce new ideas themselves. Instead, they induced ideas throughout the organization, collected them, and also coordinated their further development. In general, companies can be organized in many ways but it is important to pay attention to the effects which internal organization may have on promoting innovation and supporting NSD in a firm.

Last but not least, the strategy related to innovation and NSD is of great importance. In order to make innovation efforts successful, the management of a firm needs to have a clear direction as to where the innovations are aiming to (Johne & Davies 2000). In fact, it has been observed that at least in financial services one of the barriers to rapid innovations is an unfocused strategy, i.e. the lack of clarity in strategic direction (Drew 1995, p. 19).

Several other enablers of successful NSD have been found, but they are not introduced in this literature review. The research on NSD environment in general was not discussed in a great detail since this study is concerned more about the actual development of services, not the enablers of the development. However, it is useful to get a clue about the elements affecting NSD before discussing the different models for NSD.

2.2.4. Models for New Service Development

Process-oriented NSD practices concentrate on planning and defining the actual sequence of stages the company follows when creating new service offerings (Froehle & Roth 2007). As it was mentioned earlier, formal NSD processes can have a positive effect on companies' success. Various models for new product development in the literature have formed a basis for several NSD models (Scheuing & Johnson 1989, p. 26). A few of these NSD models derived from NPD models are introduced next followed by the models taking a different perspective on NSD.

The NSD model for financial service development proposed by Donnelly et al. (1985) starts with formulating strategic guidelines, and the five stages after that include idea exploration, idea screening, comprehensive analysis of potential service ideas, development and testing of the ideas qualified in earlier stages, and finally introduction

to market. Johnson et al. (1986), who have significantly contributed to service marketing research, introduced a fairly similar six step model consisting of following stages: strategy formulation, idea generation, analysis, service design and process development, testing, and market introduction. Bowers (1986), in turn, created a more detailed NSD model consisting of 8 different steps. He highlighted the need to develop business strategy and service strategy (2 first stages). Strategy development was followed by idea generation and concept development/evaluation. Similarly to Johnson's et al. model the last stages were business analysis, service development and evaluation, market testing, and commercialization. (Scheuing & Johnson 1989, pp. 28-29.) All of these three models resemble the NPD model created by Booz, Allen & Hamilton (1982) to a high degree.

Scheuing and Johnson (1989) proposed a new NSD model, which combined aspects of previous models and added also new elements based on the conversations with service managers. In order to test and refine their model Scheuing and Johnson carried out a survey for selected members of Financial Institutions Marketing Association. Their model was highly detailed and it consisted of four broad areas of NSD: direction (steps 1-3), design (steps 4-11), testing (steps 12-13) and introduction (steps 14-15). In the figure 2.4. Scheuing's and Johnson's (1989) model is depicted. In summary, despite the big number of steps, the model is quite similar to other NPD-based NSD models.

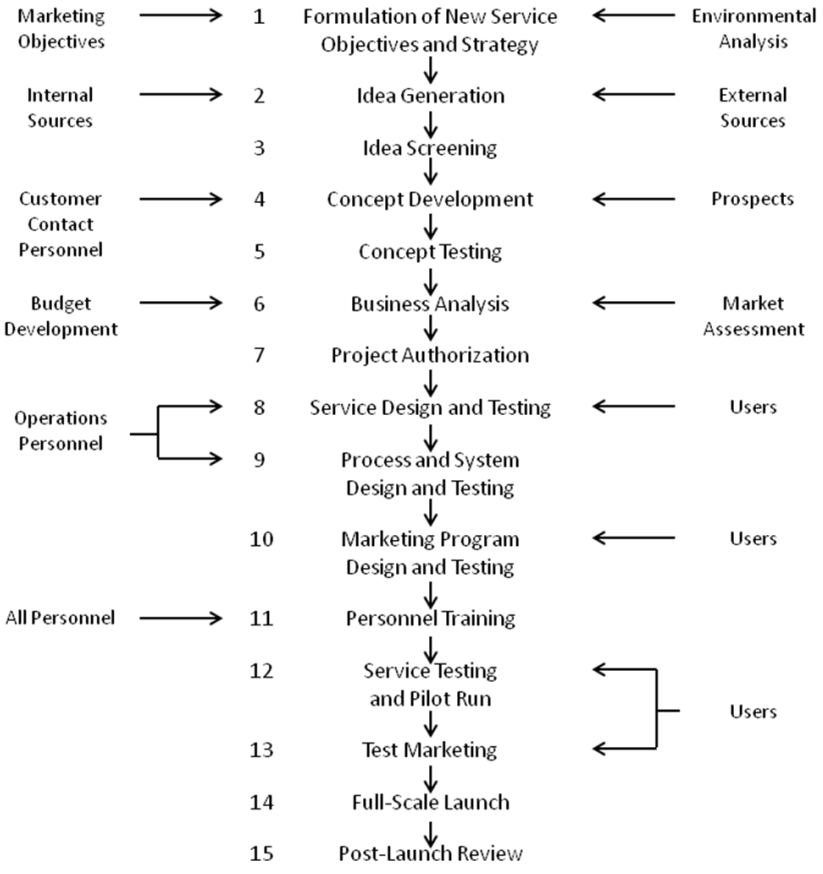


Figure 2.4. *Normative Model of New Service Development (Scheuing & Johnson 1989, p. 30).*

Contrary to Scheuing's and Johnson's (1989) exhaustive model, De Jong et al. (2003) created an NSD model, which shares the same ideas but is simplified and hence more easily approachable. They stressed that the model did not take into account the possible differences between various service sectors whereas Scheuing's and Johnson's model was financial service oriented. De Jong et al. (2003) divided the process of NSD into just two areas: search stage and implementation stage. Search stage consists of the following activities: idea generation, screening, and commercial evaluation while the implementation stage consists of development, testing, and launch. The model also stresses the idea of continuous NSD, which is shown in figure 2.5.

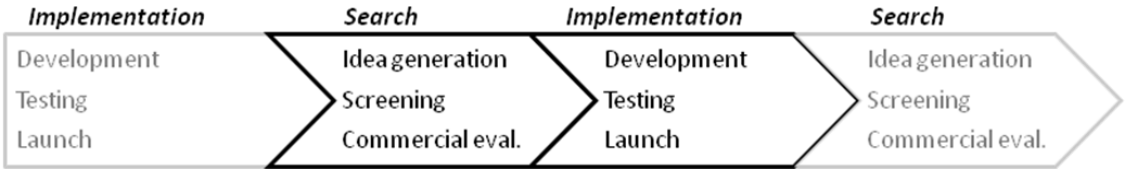


Figure 2.5. *A model for NSD (adapted from De Jong et al. 2003, p. 33).*

At least two models have been developed to capture both the ideas of NSD environment and the NSD process. These models are very valuable since in reality company managers have to be aware of both the ideas. On one hand, without proper and formal NSD process the continuous innovation of a company is at risk. On the other hand, without the so-called enablers the NSD process cannot exist in the first place.

The first of the two models, the NSD process cycle, was developed by Johnson et al. (2000). In their outstanding model the NSD process itself consists of the stages 'Design', 'Analysis', 'Development', and 'Full Launch'. Altogether, the stages consist of activities, which are exactly the same as in Scheuing's and Johnson's (1989) model in figure 2.4. Only the content of individual stages varies between the two models. Descriptively, in the design stage, new ideas are screened and the best concepts are further developed and tested for feasibility. In the analysis stage, the commercial potential of the chosen concepts is evaluated. The aim of the development stage is to create a new service and its process and field-test them with appropriate staff. Lastly, in the full launch stage the service is introduced into market. (Fitzsimmons & Fitzsimmons 2008, pp. 66-67.)

Moreover, in Johnson's et al. (2000) model, 'inside' the NSD cycle are the enablers of the whole NSD process. The cyclic model recognizes that the whole process of NSD revolves around the design and configuration of the service concept elements and different people, technology, and systems-based resources enable the process (Menor et al. 2002, p. 140). The NSD process cycle is presented in figure 2.6.

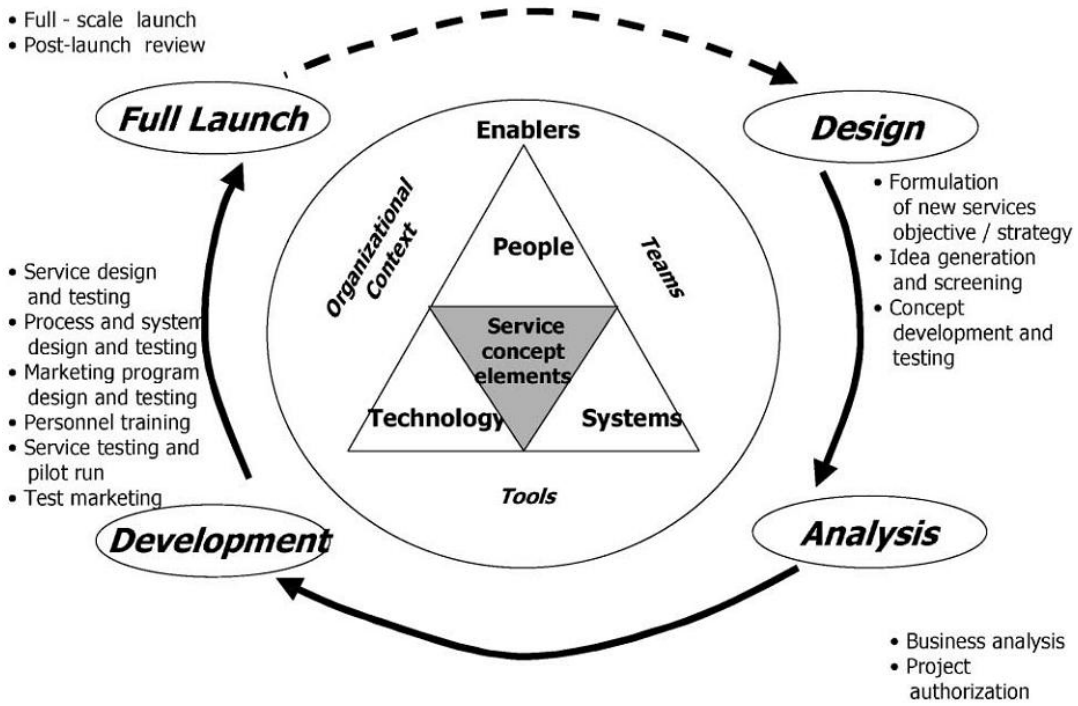


Figure 2.6. *The NSD process cycle adapted from Johnson et al. (2000) (Menor et al. 2002, p. 141).*

The other model combining the ideas of organizing NSD and the NSD process was introduced by Froehle and Roth (2007). They developed the model through literature review and several interviews with senior managers with experience in service development from a variety of industries. Similarly to De Jong's et al. (2003) approach, the goal was to develop a generic framework which does not accommodate industry specific practices.

Froehle's and Roth's (2007) model is called the Resource-Process Framework of NSD in which the process oriented practices are the same as in Johnson's et al. (2000) model. However, the resource-oriented practices are divided into intellectual resources, organizational resources, and physical resources. Intellectual resources include e.g. cultural and experiential knowledge contained within the company's employees. Organizational resources, in their part, are e.g. management systems and personal relationships adopted by the firm. Lastly, physical resources consist of e.g. tangible technologies, raw materials, and facilities. The Resource-Process Framework of NSD is presented in figure 2.7.

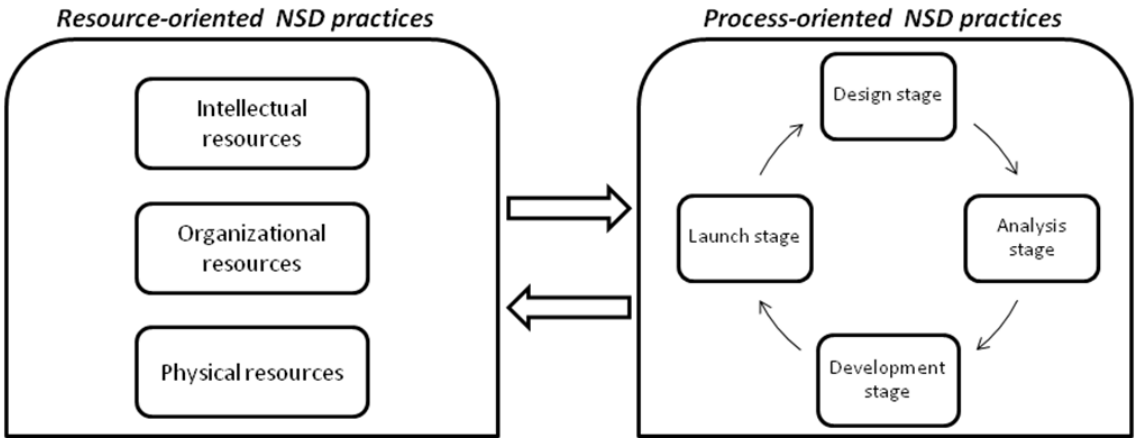


Figure 2.7. *The Resource-Process Framework of NSD (adapted from Froehle & Roth 2007, p. 170).*

2.2.5. Implications for the study

Several different models for NSD exist and many of them include the idea of a service concept at some level. Of all the models, the NSD process cycle in figure 2.6. gives the service concept probably the most significant role in NSD. As it was mentioned, the whole process of NSD circles around the design of the service concept elements. Also, Edvardsson et al. (1995) concluded in their study that service concept, service resource structure, and service process cover the most essential aspects in new service development (Edvardsson 1997, p. 40).

Cowell (1984) wrote about similar elements during the time when no significant NSD literature existed. He stated that service products need to be analyzed in four different levels:

a) the consumer benefit concept
b) the service concept
c) the service offer
d) the service delivery system

The consumer benefit concept is all about understanding what benefits customers want and value. However, Cowell's definition of the service concept is somewhat narrower than what later researchers have used. More modern definition of a service concept is more or less a combination of Cowell's service concept and service offer. The service concept will be introduced and defined in the following chapter 2.3. Lastly, the service delivery system has a lot in common with the service resource structure, which is described in chapter 2.3.4.

Similarly to Johnson et al. (2000), Menor et al. (2002), Edvardsson et al. (1995), and Cowell (1984), in this study, the creation of a service concept is seen as the most

essential aspect of developing new services. Hence, this study assumes that by creating a service concept and its respective resource structure, the development of the service is, for the most part, complete. However, before continuing to actually developing the service concept, one needs to scan and assess the environment of an organization in order to reveal opportunities for creating new services (Johnston & Clark 2005, p. 425), which is done via survey and interviews in this study.

2.3. Service Concept

The literatures on NSD, service design, and service innovation have at least one feature in common: they all deal with service concept at some level (Goldstein et al. 2002, p. 122). As was mentioned in the previous subchapter, to many researchers, service concept plays a central role in developing new services. Also, depending on the definition, service concept has certain elements in common with service blueprint and business model as well. Similarly to service characteristics, service concept is more abstract and intangible than, say, a product prototype. Hence, defining the essence of a service concept might not be straightforward.

Johnston and Clark (2005, p. 38) describe service concept to be of great importance to service organizations. They add that organizations often underutilize or even misunderstand it. Goldstein et al. (2002) state that the service concept is actually a missing link in service research in many fields, including research on professional services. When compared to different business strategy related terms, service concept is described as "more emotional than a business model, deeper than a brand, more complex than a good idea and more solid than a vision". It is something that can unite employees and customers and create business advantage at the same time. (Johnston & Clark 2005, pp. 38-39.)

The service concept needs to be defined clearly before developing a service, since it can serve as a driver of many decisions during the development process (Goldstein et al. 2002). By defining the service concept companies can align their marketing and operations to work seamlessly (Johnston & Clark 2005, p. 41). Johnston and Clark (2005) also point out that surprisingly few organizations have clearly defined their service concepts and hence customers' expectations are sometimes not me and staff feels frustrated.

However, before one can define their organization's own service concepts and ensure this way that the staff works toward the same goal and the customer expectations are met, one needs to define what is meant by a service concept. In the next subchapter, the service concept is defined followed by the description of the use of service concept. After that, since meeting customer expectations is one of the service concept's most

important goals, the issue of understanding customer value is addressed. Lastly, the service resource structure, which is tightly linked to the service concept, is discussed.

2.3.1. Defining the service concept

A service concept should be detailed according to the purpose for which it is used (Tekes 2010). In other words, the purpose of the service concept has an effect on what elements are included into the service concept. Consequently, the purpose of this study has implications on what elements are taken into account in designing the service concept, which will be discussed at the end of this subchapter.

Goldstein et al. (Goldstein et al. 2002, p. 122) point out that customers have an image of the service concept, which they form on the basis of real service experience, word-of-mouth or from other sources of information. Hence, it does not matter whether the service organization has explicitly defined their service concept; the customers will have an image of the service concept anyway. However, this image might not be the one wanted by the service organization. By having a clear understanding of the service concept inside the organization one can better affect the image perceived by the customers. Edvardsson (1997, p. 33) too, stresses the need to approach the service concept from the customer's point of view since ultimately "it is the customer's perception and opinion of the process and the total result that 'constitutes the service'". By developing the service concept one can ensure the service package fits the needs of the customer and the service organization itself (Goldstein et al. 2002, p. 122).

Following the notion of the image of a service concept the customers have, Johnston and Clark (2005) continue that the service concept is not only the elements of the service product but a mental picture that is held by customers, employees, and shareholders about the service in question. Because service concept is in the minds of shareholders, employees, and customers the service concept can be defined as abstractly as "service in the mind" (Clark et al. 2000). However, since one of the goals of the service concept is to concretize the nature of the service (Goldstein et al. 2002, p. 124), one cannot be satisfied with as vague a definition as "service in the mind". Hence, even though it is valuable to understand the abstract side of the service concept, it should be defined more explicitly.

By defining the service concept as the elements of the service package, researchers usually mean the elements that provide value to the customer (Goldstein et al. 2002, p. 123). Clark et al. (2000, p. 73) state that the service concept should encapsulate not only the value to the customers but also the form and function, experience, and outcomes of the service. The form and function should include the overall characteristic of the service as how it is created and how it works; the experience highlights the need to understand the service experience perceived by customers; the outcomes mean the

benefits that the service provides to customers and to service organization (Clark et al. 2000).

Johnston and Clark (2005, p. 40) further elaborate the elements of the service concept as follows:

a) Organizing idea: service in the mind
b) Service experience: customer's direct experience of the service process and service workers
c) Service outcome: the results for the customer of the service
d) Service operation: the actual way in which the service is delivered
e) Value of the service: the benefits of the service perceived by the customers weighed against the costs of the service

Basically these elements of the service concept answer the questions of what is offered to the customers and how it is done. The service concept also ensures integration not only between what is offered and how it is offered, but also between what the company intends to provide and what the customers actually need (Goldstein et al. 2002, p. 124). In figure 2.8. the context in which the service concept operates is depicted alongside the elements of the service concept. The smaller arrows represent the integrating nature of the service concept and the biggest arrow represents the ultimate goal of providing services in a company: meeting customer expectations.

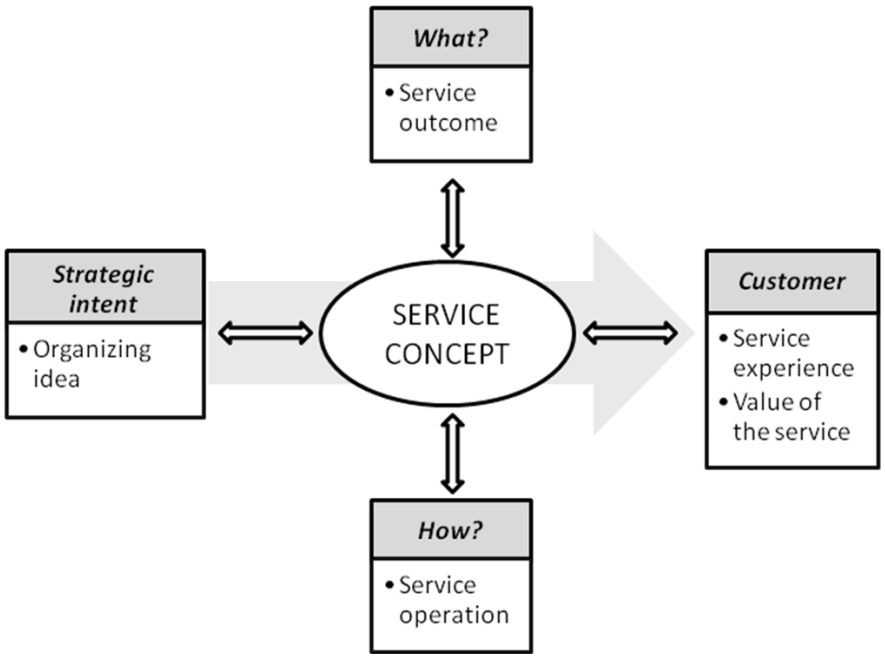


Figure 2.8. *The elements and context of the service concept (modified from Goldstein et al. 2002, p. 124 and Johnston & Clark 2005).*

The match between what is intended to provide and what the customers need is of great importance in this study. Also, Edvardsson and Olsson (1996) have seen this fit to be an essential part of the service concept. Their model of the service concept actually focuses solely on the dialogue between customer needs and service offer. The operational and structural aspects of the service concept, in their research, have been separated into individual parts of service resource structure and service process, which complement the service concept. Edvardsson's and Olsson's model of the service concept is presented in figure 2.9.

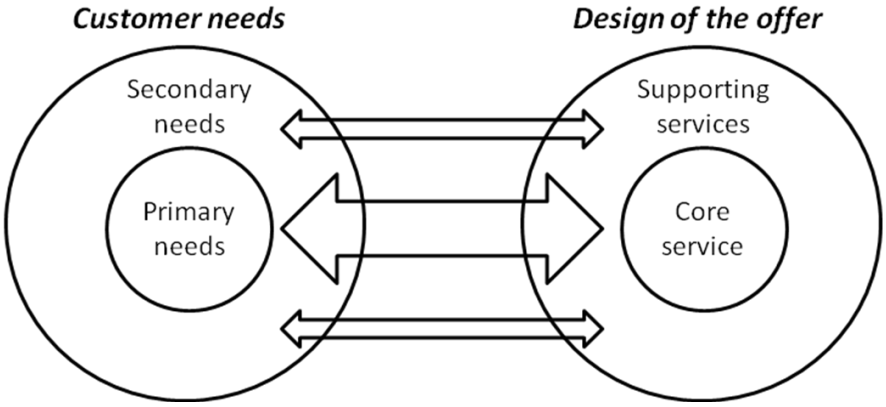


Figure 2.9. *Model of the service concept (adapted from Edvardsson & Olsson 1996, p. 150).*

Similarly to Grönroos's (1998) and Lovelock's (1992a) description of service packages (see chapter 2.1.1.), Edvardsson and Olsson (1996), too, view the offer as the combination of core service and supporting services. As depicted in figure 2.9., the service concept ascertains that the core service responds to the primary needs of the customers and additional services respond to secondary needs. In essence, the service concept is a detailed description of what needs are to be satisfied (the left side of the figure 2.9.) and how this is to be achieved (the right side of the figure 2.9.). Viewed this way, the service concept is the prototype for the service. (Edvardsson 1997.)

It should also be noted that individual services often form a part of a system with other services (Edvardsson 1997, pp. 35-36). The service concept actually makes possible that various derivatives of the same core service can be developed to different target segments (Goldstein et al. 2002, p. 131). This is to say that the service concept can and often is a source for multiple services slightly different from each other.

The point of departure for this study is the service concept model presented by Edvardsson and Olsson (1996) which focuses on the needs of the customers and defines how to address those needs via service offering. Furthermore, the service in mind approach is also prevalent in this study as it is important for people involved in the project to thoroughly understand what the service developed is about. The broader definition of the service concept by Goldstein et al. (2002) and Johnston & Clark (2005)

(summarized in figure 2.8.) is not utilized in its entirety since it is more applicable for an established company and service. For example, it is not possible to take into account customers' direct experience as no service nor company exists yet. In addition, for the same reasons, the element of service operation, i.e. the detailed service process is not analyzed. However, the service resource structure, which is included into the broader definition of the service concept, is analyzed in this study but separately from the service concept itself. This is done to emphasis the fact that the service concept defines the demand for the service resource structure (Edvardsson 1997, p. 36).

2.3.2. The use of a service concept

Goldstein et al. (2002) focused solely on the NSD aspect of the service concept by stating that "the service concept can be the key driver of service design decisions at all levels of planning". In addition, they underlined that without a clear and shared understanding of the nature of the service brought by the service concept, the managers cannot expect to design successful services. Apart from using the service concept as a tool to develop new services, researchers have seen it to be useful in many other ways too.

Many researchers have underlined the communication aspect of the service concept. In internal communication, if the service concept is not clear or it has not been articulated at all, the result will be an increased heterogeneity in services provided (Brax 2007, p. 33). The service concept can be used as a "communication construct" internally among managers and employees of different functions and also externally as a communication tool to attract customers (Clark et al. 2000). Also, Johnston and Clark (2005, p. 43) point out that the service concept is "a key tool that can communicate the set of benefits to the customer in order to demonstrate the potential value of the service".

Closely in relation to the communication, the service concept has also been presented as an alignment tool inside a company. Clark et al. (2000) and Johnston & Clark (2005), for example, have argued that the service concept can link different organizational functions with a common purpose. Goldstein et al. (Goldstein et al. 2002, p. 123), too, noted that the service concept is in the interface between service operations and service marketing. One can view the service concept to be the "mutual language" of different functions in an organization.

Service concept has also been viewed important, among other things, in developing service productivity. Brax (2007, p. 33) views service concept as an integrator between production and quality of a service. Furthermore, the service concept can act as an internal monitoring tool: By reviewing the service concept regularly, a company can prevent the service operation from having too optimistic beliefs about how good the service is in customers' perspective. It helps the company to focus on the value that can be provided to customers. (Johnston & Clark 2005.) As mentioned earlier, the

understanding of customer value of the service is crucial for service concept and for NSD in general. Hence, it is now discussed in detail.

2.3.3. Understanding customer value

One of the reasons for poorly perceived service is the mismatch between companies' intentions to provide to customers and customers' actual needs and expectations (Goldstein et al. 2002, p. 124). The mismatch between customers' expectations of a service and their perception of its delivery may be a result of a gap between customer expectations and service delivery (gap 1), or between service delivery and perception of service (gap 2). Possible provider related reasons for the gap 1 include lack of understanding of customer expectations, inappropriate specification, poor service design, and insufficient resources. Provider related reason for gap 2 is basically incorrect delivery in all of its forms. Customer related reasons for gaps 1 and 2 are inappropriate expectations and inappropriate perceptions respectively. (Johnston & Clark 2005, pp. 109-110.) If the value to the customer is understood correctly and the service concept is articulated clearly to the organization's different functions and to customers, these gaps could be prevented.

As correspondence between customer needs and service offer is of great importance (Edvardsson 1997, p. 36), it is necessary to pay attention to how the customer needs can be detected and analyzed in order to truly understand what customers need. Only after then can the development of the service concept begin, and the correspondence between the service offer and customer needs be ensured. Furthermore, it has been observed that in services customer needs vary according to customers' specific operations more than in products, thus reflecting the need to design a dynamic portfolio of offerings, which can change in concert with customer needs (Kindström 2010, p. 484).

Despite the importance of meeting customer expectations and ensuring customer value in services, no significant service literature exists about the issue. The idea of customer value and how to explore it has been more prevalent in quality management literature, e.g. quality function deployment (see e.g. Griffin & Hauser 1993). Even though certain tools and models have been developed to make the analysis of customer value possible, they have not been specifically designed to be used in the context of services that have their distinguishing characteristics.

Defining customer value can be simple but recognizing value is a different thing. Woodruff (1997, p. 142) defined customer value in the following way: "Customer value is a customer's perceived preference for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate (or block) achieving the customer's goals and purposes in use situations." Fitzsimmons and Fitzimmons (2008, p. 69) have presented customer value in the following equation:

$$Customer\ value = \frac{Results\ produced\ for\ the\ customer + Process\ quality}{Price\ to\ the\ customer + Costs\ of\ acquiring\ the\ service}$$

Basically, the value of a service for the customer is the sum of results for the customer and quality of the process divided by the sum of price to the customer and costs of acquiring the service. It should be noted that in services the value is not only the results divided by the price, but the quality of the process itself can add value and other costs than price, e.g. time and other customer effort can hinder the value brought by the service. (Fitzsimmons & Fitzsimmons 2008, p. 69.)

As always, an equation can hardly capture the full complexity of a phenomenon. Customers may or may not recognize value when they for example receive something they cannot do for themselves; or receive a service they do not have time to perform themselves; or when a service reduces their perceived risk or just makes them feel good. Another challenge for service providers comes from the fact that not only the value of the service is perceived differently from customer to customer but also something that is valued today by a certain customer might not be valued in the future by the same customer. (Johnston & Clark 2005, pp. 25-26.) Hence, it is not difficult to see that understanding what the customers want at the right time and place is not easy. However, methods and models have been developed to ease the task of understanding what customers value.

Woodruff (1997) introduced the Customer Value Hierarchy Model (see figure 2.10.) to help to understand the thinking process of a customer in terms of value of a product. The model suggests that customers visualize the desired value in a means-end way. Customer's ultimate goals and purposes are reflected in the desired consequences of the use of products and services. The desired consequences in turn are reflected in the desired product or service attributes and their performance. (Woodruff 1997.) Hence, customers' desired goals, consequences and product attributes form a continuum in which customer value operates. The customer's desired goals, the ultimate customer value, can be derived all the way from desired product or service attributes if one understands the customers' needs correctly. The same goal, consequence, and attribute structure describes received value by the customer in a similar way.

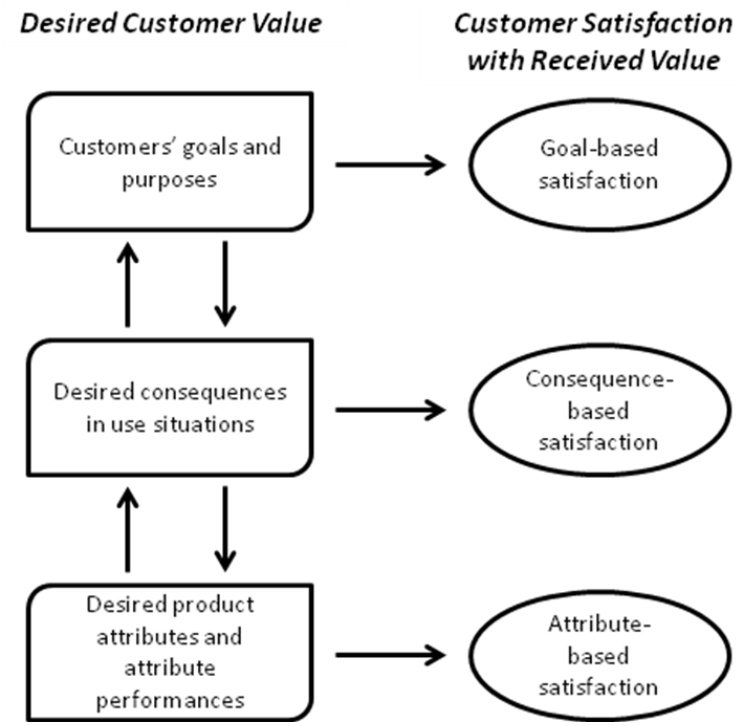


Figure 2.10. *Customer Value Hierarchy Model (adapted from Woodruff 1997, p. 142).*

Herrmann et al. (2000) further elaborated the left side of Customer Value Hierarchy Model in figure 2.10. Their means-end concept uses the term 'utility components' in place of 'desired consequences' and 'set of values' in place of 'customer's goals and purposes'. Hence, they stress that the goals and purposes are actually the values the customers are looking for. Furthermore, attributes, utility components, and set of values are all broken down into two categories based on their characteristics. Herrmann's et al. means-end concept is illustrated in figure 2.11.

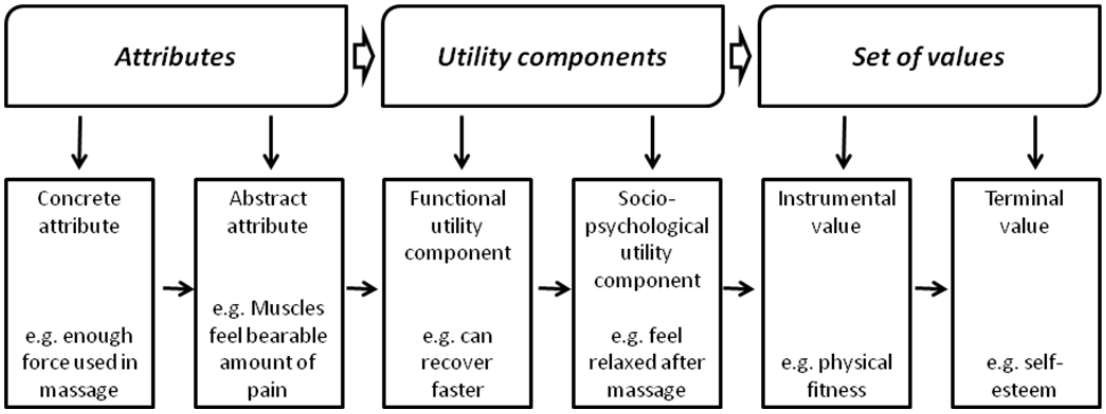


Figure 2.11. *The means-end concept (adapted from Herrmann et al. 2000, p. 81).*

The examples used in the figure 2.11. are related to sports massage. A concrete attribute can usually be observed directly and reflects one facet of a phenomenon whereas an abstract attribute is not measurable but permits more comprehensive description of a product or service. The functional utility specifies the usefulness of the product and the

consequences related to its usage. The socio-psychological utility, in turn, includes everything that is not vital to the actual function of the product. According to the means-end concept, the values held by customer ultimately control the choice of particular products and services. Values can be broken down into instrumental values and terminal values. The former values represent a desirable form of behavior and the latter embody desirable goals in customers' perspective. (Herrmann et al. 2000.)

Another customer value related tool worth mentioning is the Buyer Utility Map introduced by Kim and Mauborgne (2005). They point out that a customer can perceive utility or value in six different stages of the buyer experience cycle. Not only the value can be perceived in the use of a product or service but also in stages of purchase, delivery, supplements, maintenance, and disposal. Hence, the company managers might want to consider all these stages when trying to understand what customers value. Kim & Mauborgne (2005) divided also the utility components into six levers, namely, customer productivity, simplicity, convenience, risk, fun and image, and environmental friendliness. The Buyer Utility Map is depicted in figure 2.12.

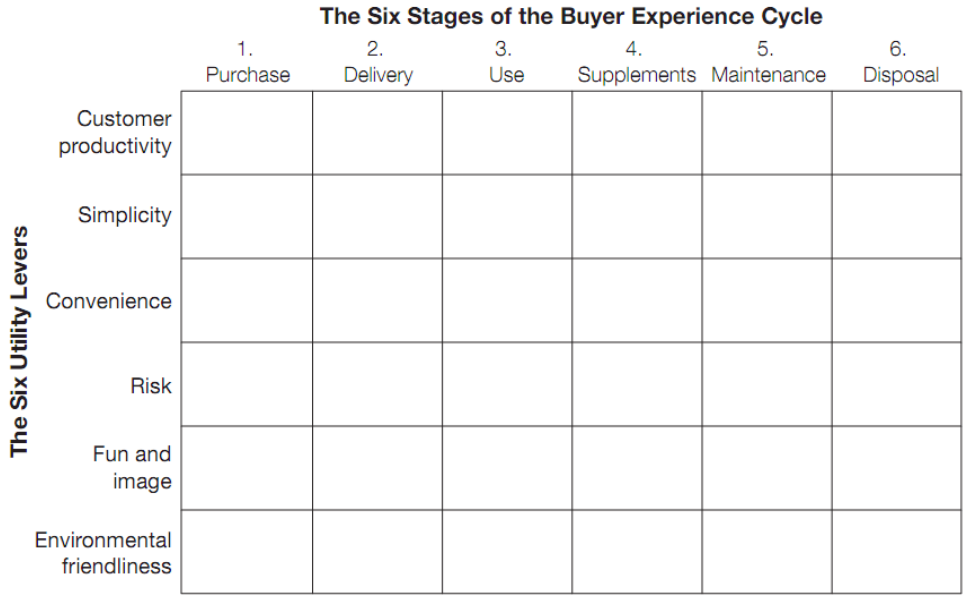


Figure 2.12. *The Buyer Utility Map (Kim & Mauborgne 2005, p. 121).*

All in all, understanding customer value and customer benefits is very important in business. Especially, in designing new services and creating a service concept it is of utmost importance. Consequently, in this study, the value for the customer is a dominant theme in service concept development. For example, the models described in this subchapter, even though not specifically developed for services, are utilized in designing the interviews and interpreting the results as you will see later. After understanding the customer value, the service concept can be developed. The service concept, in turn, places demands on the service resource structure, which should be developed so that the service concept can be realized (Edvardsson 1997; Cowell 1984).

2.3.4. Service resource structure

Barney (1991) was one of the major contributors to the resource-based view in strategic management literature. He argued that resources could be a source of sustained competitive advantage for a firm if they are valuable, rare, inimitable, and non-substitutable. By company resources Barney (1991, p. 101) meant all assets, capabilities, organizational processes, firm attributes, information, knowledge etc. that a company may possess.

Nowadays, resources are still viewed as important in all kinds of companies, including service firms. Especially, resource base is considered to be an important contextual component for professional service firms. Resources are considered to be at the core of the value creation of professional service firms. This is because professional service companies have clear limits to what they can do, what their members want to do, and what the customers accept that the firm can deliver. (Løwendahl et al. 2001.) Consequently, the resource base plays an important role also in this study.

A company needs certain resources in order to operate, and the same resources are needed by the services that the company provides. So-called service system or service resource structure includes the resources allocated to the service process for realizing the service concept. Different resources have to work together in order to form a system in which the service is created with high quality. (Edvardsson 1997, p. 36.) The creation of the service resource structure is a key capability in NSD, and the structure itself can take various forms from resources fully integrated in the company, to separate service organizations, and possible external service delivery partners, i.e. value networks (Kindström 2010).

The development of the resource structure focuses on e.g. developing the staff, interaction with the customers, and physical/technical resources (Edvardsson 1997, p. 42). However, in this study, since no actual company exists, the character of the service resource structure developed is ideal. It will be based on the current expertise of the potential future service provider and the service concept, which in turn is created through understanding customer needs and value. In a real company, the service system would be affected also by the business concept, strategy and the goals of the company (Edvardsson 1997, p. 36) but in this study, under the circumstances, they are not taken into account.

Resource structure typologies

The elements of the service resource structure can be categorized in many ways. The categorization used by Edvardsson (1997) is the following: Different subsystems of the service resource structure include customers, organization (e.g. processes, bureaucracy),

staff, and physical or technical resources. A company might have to adapt to the processes and current technical knowledge that the customers have, thus customers affect the resource structure of the company. Staff as a resource includes e.g. the knowledge, experience, and motivation of employees and management. Organizational resources consist of e.g. the structure of the organization, i.e. division of different functions, processes, and administrative support systems of the company. Lastly, physical and technical resources include e.g. premises, computers and software in the company. In figure 2.13. Edvardsson's (1997) view of the service resource structure elements is illustrated.

Figure 2.13. *Service resource structure elements according to Edvardsson (1997) (adapted from (Edvardsson 1997, p. 37).*

However, Edvardsson's (1997) view of resource categorization is not common in resource literature. In fact, the categorization used by Froehle and Roth (2007) in the Resource-Process Framework of NSD (see figure 2.7.) is much more prevalent in firm resource literature. They used three distinct resource categories, namely, intellectual resources, organizational resources, and physical resources. A more detailed description of these categories can be found in chapter 2.2.4.

The biggest difference between the two categorizations is that the latter does not include customers in the service resource structure. This actually makes sense, since customers are usually included in the environment of a firm. Even though customers have an effect on firm's resources, they still are not part of the resource structure of the company. It is the firm's inner resources that need to address the effects brought by customers' distinct operations. Hence, customer's resources should not be included in the service resource structure. The resource categorization used in this study can be seen in figure 2.14.

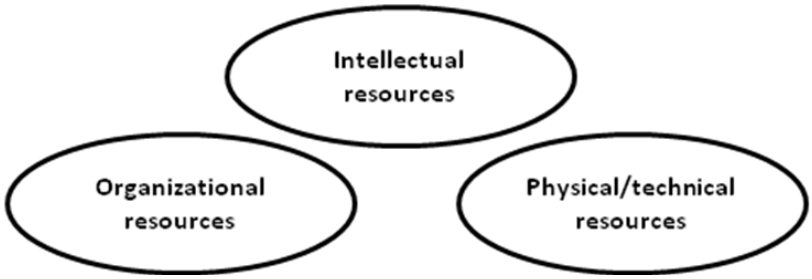


Figure 2.14. *The service resource structure utilized in this study.*

In this study, an ideal service resource structure is developed in order to make the service concept realization possible. The resources will be categorized as shown in figure 2.14. which is based on the resource categorization used by Froehle and Roth (2007) among others.

2.4. Synthesis

For a long time services have been under-researched compared to products. Hence, it is no wonder that services are generally under-designed and many new professional services fail (Froehle et al. 2000; de Brentani & Ragot 1996). Indeed, since industrialization the needs of the manufacturing industry have been more urgent. However, within the last two decades the importance of service sector to the economies of industrialized countries has grown fast and even surpassed the manufacturing sector as the biggest employer in many countries (Wölfl 2005). This has partly boosted the evolution and intensity of service related research. Still, the longer roots of manufacturing related research affect the service research in many instances.

Earlier service research concentrated intensively on defining what the distinctive characteristics of services compared to products are. Later on, many of these characteristics have been questioned by researchers. Nevertheless, it is useful to take into consideration certain unique characteristics of services while developing, marketing, and providing them. Another deeply researched area is the classification and typologies of services. Quite established a typology, which was originally influenced by manufacturing related research, divides services into professional services, service shops, and mass services (Silvestro et al. 1992). Also, newer service classes have emerged such as traditional professional services and new technology-based knowledge intensive business services (Miles et al. 1995). However, the research on service characteristics or typologies as such only paves the way for more applied research, which has practical implications for company managers.

Edvardsson (1997) took a step toward more practical service research by pointing out that a service consists of three elements, namely, customer outcome, customer process, and prerequisites for the service. The three elements have to work in concert in order to satisfy the customers. The prerequisites for the service could further be divided into

service concept, service resource structure, and service process that together enable the right customer outcome and process. In fact, service concept is considered to be at the core of a highly valuable and practical area for research: new service development (e.g. Johnson et al. 2000; Menor et al. 2002).

Characteristically to all service research, the first NSD models were developed decades after the first new product development models, and they were based on the NPD models to a large extent. Another characteristic of newer and more practical service research has been the perspective of financial services that is often prevalent also in NSD research. In addition to financial services, the greatest bulk of service literature has focused on business and transport service firms (De Jong et al. 2003, p. 11). Considerable amount of research has also focused on developing new services for already existing firms, particularly product-based companies (Kindström 2010) whereas NSD research for start-up companies has been basically ignored.

Many different models for NSD exist that include the idea of a service concept and its creation. In fact, Edvardsson et al. (1995) have shown in their studies related to e.g. smart card and cleaning services that service concept, service resource structure, and service process cover the most essential aspects of NSD (Edvardsson 1997). Despite the importance of service concept, it is stated to be a missing link in service research in many fields consequently leading into staff's frustration and not meeting customers' expectations (Goldstein et al. 2002; Johnston & Clark 2005). The service concept has been defined in many ways reaching from how to meet customers' needs to "service in the mind". In all the definitions, the understanding of customer value is of great importance. Various tools exist to ease the task of understanding what customers value even though they have not been developed specifically for services.

Depending on the definition of the service concept, the service resource structure is included in the service concept or addressed separately. The service resource structure is analyzed separately in this study to emphasis the sequential nature of the service concept and service resource structure in the case when no company exists. The designed service concept defines what the service resource structure should contain in order to provide the service intended. In addition to service concept, the service resource structure developed is based on the current expertise of the CSB research group. The resource structure developed is by nature ideal since no actual company exists. Resources are considered to be at the core of the value creation of professional service firms (Løwendahl 2001); hence, the resource base plays an important role also in this study. The resource structure is divided into organizational, intellectual, and physical/technical resources.

Essentially, this study breaks away from the tradition of developing new services for existing firms or product-based companies and aims for practically relevant solution. In

aiming to provide recommendations for the CSB research group as to how their image analysis expertise could be harnessed into a service, this study takes the perspective of pre-commercial professional B2B services relying heavily on image analysis expertise. Consequently, this study deals with the type of professional services that have not been studied as extensively as financial services, for instance. Hence, the study provides new empirical insight into NSD of new type of professional services.

In concert with many researchers (e.g. Edvardsson et al. 1995; Cowell 1984) this study relies heavily on service concept and service resource structure creation in new service development. In fact, all the other NSD elements are excluded from the study. In terms of service concept, the main emphasis is put on defining the needs of the customers and defining how to address those needs via service offering. Moreover, the service in mind approach is also prevalent in this study as it is important for people involved in the Imacom project to understand what the service developed is about. The needs of the customers are explored via survey and interviews, which take advantage of the customer value models created originally for product marketing. Hence, this study elaborates the service concept creation and customer value exploration in practice, which has not been done before in service research literature.

3. CASE DESCRIPTION

This chapter starts with an introduction to the field of image analysis by shortly going through its evolution, principle, application areas, and current practices in analyzing microscopic information. It is important to have certain understanding of the field before developing a service concept. After the introduction, the Imacom project, in which this study takes place, is discussed by going through its goals and results of the earlier studies. This will help to discern the context of the study and the current competencies and resources related to the Imacom project.

3.1. Image analysis

The word image can mean many different things. An example of an image can be the image on the human retina or an image, which is captured with a camera or a microscope (Sonka et al. 1999, p. 10). The digital capturing of images is becoming more and more widespread in modern science and technologies, i.e. the importance of digital images and their interpretation is growing constantly. Image analysis itself is very cross-disciplinary by nature: It utilizes techniques and ideas from optics, electronics, software design, statistics, and graph theory among others. (Dougherty 2009.)

Terms closely related to image analysis include but are not limited to image morphology, classification, image processing, image data compression, and image recognition, all of which have been a target of significant level of interest within the past few years (Gonzalez & Woods 2008). In general, image processing is used for two purposes: "improbing the visual appearance of images to a human viewer, and preparing images for measurement of the features and structures present" (Russ 2011). Both the purposes can be viewed as parts of the broad definition of image analysis but the step following the latter purpose, extracting meaningful information from images by means of digital processing techniques (Wikipedia 2011a), is at the heart of image analysis.

Already from 1960s, the field of image processing has developed fast. Various techniques developed are used to solve a myriad of problems in several different fields. (Gonzalez & Woods 2008.) A field probably ahead of others in terms of utilizing image analysis is the area of manufacturing and quality control, in which increasing quality demands and documentation requirements have led image analysis become one of the key technologies (Demant et al. 1999). These advances in image analysis and machine vision have led into many applications from remote sensing to technical diagnostics,

and the number of software and hardware products in the market is increasing steadily (Sonka et al. 1999).

It is valuable to discuss certain challenges faced by manufacturers of image processing systems for quality control since this area is somewhat more developed compared to other application areas. A machine does not "see" in the same way as humans do; its vision has not been developed through millions of years of evolution (Demant et al. 1999, p. 17). Hence, in many cases, a human eye can outperform a machine in an individual task requiring visual analysis, or at least the conditions and surroundings of the task have to be tailored for machine to make the analysis possible. This fact can be somewhat troubling for e.g. marketers of image analysis. However, Demant et al. (1999, p. 18) stressed that "automated visual inspection systems are able to deliver excellent recognition results continuously and reliably, equal to the average performance of humans over time, even better in some areas, provided that":

- The analysis task has been described precisely and in detail in a language understandable for a machine.
- All allowable variants of analysis samples and all types of errors have been taken into account.
- The environmental conditions, e.g. illumination and image capturing, are designed to be appropriate and kept stable.

3.1.1. Principle

At first, it should be noted that the most important tool of image analysis is the computer (Demant et al. 1999, p. 16). Of course, images have to be captured first with imaging systems, e.g. specific cameras, but the image analysis itself is mostly computer and algorithm related. Due to the focus of this study, the principle of image analysis is not discussed in deep detail. Instead, a rather superficial, but sufficient, description of image analysis is presented.

Usually two levels of image analysis are distinguished. Those levels are low-level image processing and high-level image understanding (Sonka et al. 1999, p. 3). The first level usually serves as a prerequisite for the second level. However, Gonzalez and Woods (2008), who have been major contributors to image analysis research, introduced three distinct levels of image analysis, namely, low-level processing, intermediate level processing, and high-level processing. These levels are illustrated in figure 3.1.

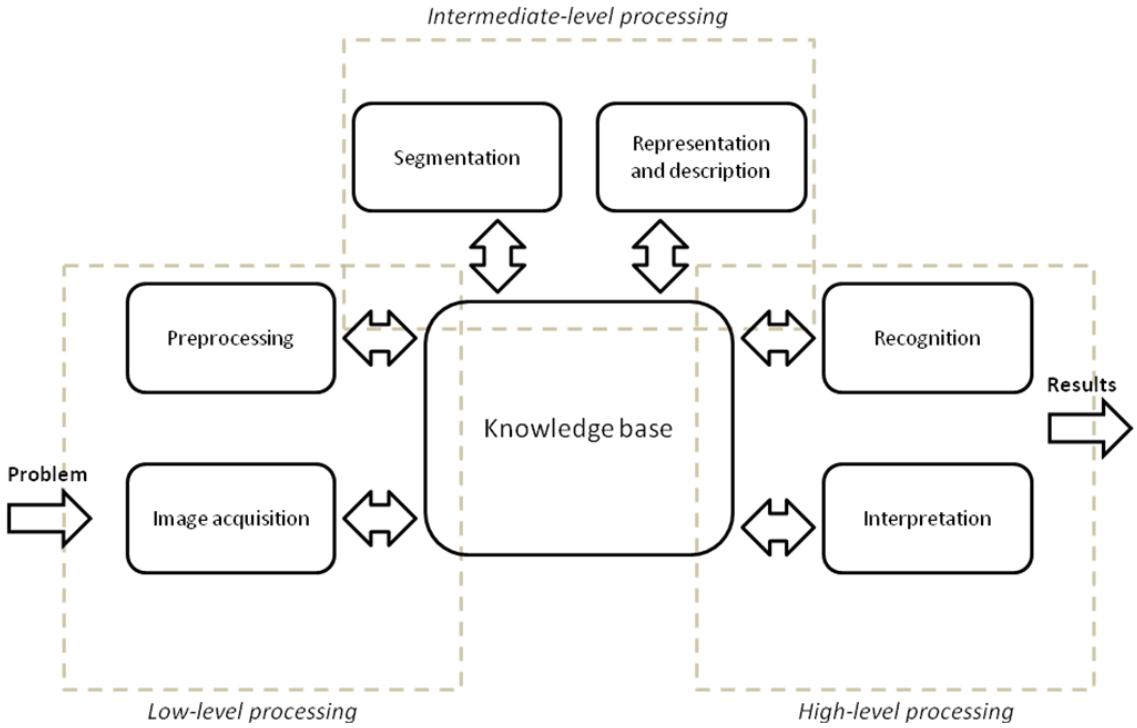


Figure 3.1. *Elements of image analysis (adapted from Gonzalez & Woods 2008).*

In figure 3.1. the overlapping dashed boundaries indicate that the three different levels of image analysis are not definitive. The steps in low-level processing make the next levels possible. Image acquisition deals with the issue of how the images should be taken, and preprocessing, such as image noise reduction, prepares the image for intermediate-level processing. In the next level, relevant components, e.g. certain regions, are segmented, i.e. extracted from the background of an image. Next, in representation and description step, certain features are selected for further analysis. In high-level processing, the computer "understands" the image by recognizing and labeling objects as e.g. cells or nuclei and finally interpreting the image by extracting quantitative information from it. All the steps interact with the knowledge base, which basically means the thorough understanding of the context and images analyzed, e.g. what the shape of a cell is or what kind of defects can there be in an image. (Gonzalez & Woods 2008.)

3.1.2. Application areas

Image analysis is applicable to be used in various fields and throughout the light spectrum from gamma ray imaging through visible light imaging all the way into imaging in the radio band (Gonzalez & Woods 2008). Regardless the application area, not only the knowledge of image analysis techniques is required but also knowledge and experience of the application area is needed (Dougherty 2009, p. 15). Image analysis can be used, for instance, in medicine to help in analyzing x-ray images. In geography, it can be utilized to study pollution patterns from satellite imagery. Image analysis can also be used in fields such as physics (e.g. electron microscopy) and surveillance (e.g.

automatic processing of fingerprints). (Gonzalez & Woods 2008.) Dougherty (2009) has made an extensive list of different application areas for image analysis. A few selected application examples are listed in table 3.1.

Table 3.1. *Examples of image analysis applications (adapted from Dougherty 2009).*

Biological imaging	Automatic counting and classification of cell types and morphology
	Motility assay for motion analysis of motor proteins
Medical diagnostic imaging	Analysis of images acquired from magnetic resonance imaging (MRI)
	Registration of multi-modal images
Law enforcement	Automated reading of license plates
	DNA matching
Automation and robotics	Vision systems for quality inspection
	Process monitoring
Materials research	Quantification of impurities in material
	3D image surface rendering
Astronomy	Telescope image enhancement and restoration
	Automatic detection of cosmic phenomena
Military	Tracking targets for missile-guidance systems
	Bomb damage assessment

Particularly, biomedical imaging, visualization, and analysis including e.g. molecular and cellular imaging are predicted to be of great importance in the future in increasing our knowledge about life and disease processes. The rapid pace of development is estimated to continue and advances in image analysis techniques will be required. (Dougherty 2009.) In the area of cell image analysis, for example, many analysis tasks are still done manually even though automated analysis is strongly preferable to analysis by eye since image analysis techniques are required to extract the full spectrum of information from biological images (Carpenter et al. 2006, p. 1). These facts create commercial potential for image analysis based services.

3.1.3. Analyzing biological information in microscopy

The current practices in analyzing biological information in microscopy are relevant to this study in order to understand the possible substitutes for image analysis based services. Hence, they are now discussed shortly. Different practices can be classified into visual inspection, open-source image analysis software, commercial general-purpose software, and hardware & software bundles.

Visual inspection

Automated analysis of microscope image data (including biological information) is done routinely only in a limited set of applications (Niemistö et al. 2010). Visual inspection is still used extensively. For instance, the screens of samples in most non-mammalian organisms have been limited to visual inspection (Carpenter et al. 2006, p. 2).

As it was mentioned above, automated analysis is preferable to analysis by eye. This is not to say that visual inspection is always inferior to automated analysis. Certain analysis tasks, at the current level of knowledge, are simply not comprehensible to a machine due to the different nature of human eye and machine vision. However, even though the vision of a human eye is more robust than machine vision, it has been observed that many benefits, such as speed, objectivity, and endurance can be received through automated image analysis in quality inspection for example (Demant et al. 1999).

Open-source image analysis software

Open-source image analysis packages, such as CellProfiler and ImageJ have been developed for analyzing biological information (Eggert & Mitchison 2006, p. 234). Even though they enable a user to use many different image analysis techniques, they generally require, in order to be used effectively, certain educational background in image analysis that the user, e.g. a biologist, might not possess (Niemistö et al. 2010). However, attempts have been made to develop software that is as easy to use as possible, such as CellC (Selinummi et al. 2005).

Moreover, in contrast to homegrown software, commercial software tends to be generally more reliable and user friendly (Eggert & Mitchison 2006, p. 234). On the other hand, one considerable benefit from open-source software compared to commercial software is that it is free. Open-source software also attracts interactive user communities (Eggert & Mitchison 2006, p. 234) in which users can develop the software further and give guidance to each other.

Commercial general purpose image analysis software

The mainstream of image analysis in microscopy applications has been commercial general-purpose image analysis software, such as Image-Pro Plus (Niemistö et al. 2010). The problem with this software is that it can be quite expensive and may not be designed to be flexible enough to answer the specific, and oftentimes unique, needs that different companies or research groups have in the area of image analysis (Eggert & Mitchison 2006, p. 234).

In addition, these software packages too, usually require image analysis expertise in order to be used effectively. Moreover, even though a user would be familiar with image analysis, these software packages do not usually provide the possibility to be developed further by the user. (Niemistö et al. 2010.) This is a major weakness, as new image analysis tasks often require some level of algorithm fine-tuning and customization.

Hardware and software bundles

Lastly, one approach has been to bundle image analysis software with imaging or screening systems (Niemistö et al. 2010). In other words, the hardware needed to acquire images are integrated with image analysis software and sold as a bundle. These systems enable a wide range of applications but are still not suitable for all customers with a variety of needs (Niemistö et al. 2010). Moreover, these systems are usually so expensive, that a smaller company or a research group would basically have no chance to finance these investments. Also, these systems, too, require certain image analysis expertise from the users.

In summary, image analysis solutions exist but they all have certain limitations and hence are not suitable for all the possible customers. Often, the limitations arise from the fact that image analysis needs are usually very unique and specific. Consequently, there might be room for image analysis services in the marketplace.

3.2. Image analysis in CSB research group

The Computational Systems Biology Research Group in the department of Signal Processing at Tampere University of Technology has expertise in the challenging field of image analysis, especially microscope image analysis. The department itself has over two decades of experience in digital image processing. (Niemistö et al. 2010.) It is the expertise of the researchers that the CSB group is trying to utilize in the purpose of creating a service oriented business model. This is called the Imacom project. In principle, if successful, the Imacom project could pave the way for a new spin-off company.

So far, in the Imacom project, two external consultancy studies have been conducted which concentrated mainly on analyzing the expertise, competencies and previous work of the researchers in the CSB group. They also evaluated potential needs for the image analysis expertise by arranging meetings with various university groups and companies. The previous work of the CSB group researchers was presented to the audiences in those meetings (Pasanen 2010).

3.2.1. Tentative image analysis needs

Before describing image analysis competencies of the CSB research group it is useful to discuss the tentative image analysis needs shortly. The main conclusions of the earlier consultancy studies have been that there are image analysis related needs among research groups and companies, but the question remains as to how to address those varying needs. In the first consultancy study, it was stated that some of the potential customers are in the broad industry of pharmaceuticals including not only 'the Big Pharma' but also smaller, often biotechnology related firms involved in drug discovery and development (Pasanen 2010).

In addition to pharmaceutical industry, health care industry (e.g. hospitals), food industry, and process industries (e.g. minerals, pulp and paper) were identified as potential customer segments. Tentatively, certain university groups were interested about image analysis services, especially training related services. (Pasanen 2010.) The pharmaceutical industry was chosen to be the focus of this study for the reasons discussed below.

3.2.2. Competencies in CSB research group

The expertise in the field of microscope image analysis of the CSB research group includes an ability to understand the typical problems in the application domain better than many other image analysis experts (Niemistö et al. 2010). Moreover, it was observed in the first two consultancy studies that one of the competencies of the CSB group researchers is in utilizing image analysis to analyze biological information, especially (Pasanen 2010). More precisely, the CSB research group has developed solutions in the application areas of microbiology, cell and molecular biology, systems biology, cancer research, drug discovery, and fluorescence microscopy among others (Imacom project 2011). Consequently, the pharmaceutical industry is a natural focus of this study.

Concrete examples of the solutions developed include but are not limited to methods for in-vitro assays assessing drug efficacy, shape analysis for multi-cellular organisms and yeast colonies, methods for segmentation of unlabeled cells from bright field microscopy images, and methods for imaging-based retina verification (Imacom project 2011). So far, the solutions have been done in academic collaboration (Niemistö et al. 2010).

The outstanding level of expertise in image analysis of the CSB research group can be seen from the list of reference organizations that have benefited from the solutions developed. These organizations include: Institute for Systems Biology, Regea (Institute for Regenerative Medicine), University of Texas M.D. Anderson Cancer Center, Swiss Federal Institute of Technology (ETH) Zürich, Harvard University, Massachusetts

Institute of Technology (MIT), Sandvik Oy, and Nokia Oyj among others (Imacom project 2011; Selinummi 2011). It can be concluded that currently, the competencies of the CSB research group in terms of image analysis include not only the world-class knowledge and expertise in the broad field of biology but also a global network of collaborators, especially in the academic world.

Since the aim of this study is service concept development for pharmaceutical industry, the study is concerned with B2B services. Moreover, in line with Løwendahl (2005), the facts that the image analysis knowledge and expertise are at the core of the services developed; image analysis usually requires a high degree of customization; and substantial interaction is required with the client, all indicate that services developed will be of professional nature. However, as mentioned in chapter 2.1.3., alongside professional services, the services developed could also be classified, at least according to certain definitions (e.g. Den Hertog 2000), as KIBS due to the technical nature of image analysis.

4. METHODOLOGY

This study is a multi-method qualitative single case study, which combines two qualitative methods, namely, Internet-based survey and semi-structured interviews. In addition, the designed service concept was tested by interviewing potential customers. Qualitative approach is usually preferred over quantitative, when one wants to collect versatile information from the research subject, and when the research question can be answered better through qualitative methodology (Strauss & Corbin 1990). As the research question is "How should the CSB research group utilize its image analysis expertise in order to meet the needs of the potential customers via service?", one can expect better results from a qualitative approach. Moreover, for service research, Johne and Storey (1998, p. 206) have stated that more emphasis is needed on in-depth qualitative research due to the intangible characteristic of services.

The results of the methods used form the main data set for further analysis. Hence, the study is of empirical nature. Moreover, since the objective of the study is to provide recommendations on how image analysis expertise could be harnessed into a service, the study is of normative nature in contrast to descriptive. Being both empirical and normative, the approach of this study, according to Kasanen et al. (1993), can be characterized as constructive. Kasanen et al. (1993, p. 261) describe a successful constructive study to:

a) Produce an innovative solution to a real-world problem,
b) Demonstrate specific usability and theoretical connections of the solution,
c) Examine the potential for generalizability of the solution.

The information from the survey and the interviews were used to analyze the actual needs of the potential customers and ultimately construct appropriate service concept and service resource structure, which together answer the research question. Lastly, the designed service concept was evaluated through testing. Next, the details of the methods used are described.

4.1. Survey

The survey had two goals: First, it provided insight into the development of relevant interview themes; second, it gathered information of the business and actual needs of the potential customers internationally. The Internet-based survey was conducted using Kwik Surveys (http://www.kwiksurveys.com/), and it was sent to pharmaceutical

industry companies analyzing biological information in their operations in Finland, Sweden, Norway, and Denmark.

The questionnaire was designed to be short to increase the response rate, but the questions were designed to induce diverse responses in order to collect versatile information from the field. The questionnaire consisted of 19 questions, eight of which were open questions. At the beginning of the questionnaire, a few examples of image analysis were presented alongside a description of what is meant by image analysis in the questionnaire. The original questionnaire can be seen in appendix 1 (the pictures are reprinted with permission).

The list of email addresses which the questionnaire was sent to, was created by exploring the following comprehensive company lists in Nordic countries: Biofinland catalogue 2011-2012 (http://www.finbio.net/en/biofinland), List of DANSK BIOTEK Members (http://www.danskbiotek.dk/uk/list-dansk-biotek-members), Medicon Valley Online Organizations (http://www.mediconvalleyonline.com/Organisations/), Norsk Biotekforum drug development members (http://www.biotekforum.no/Members/), and Sweden BIO members (http://www.swedenbio.com/en/Member-Companies/).

Organizations were excluded from the list of email addresses if, based on the websites, their operations did not seem to deal with image analysis at all. In addition, the questionnaire was sent only to companies that had biology related research and development in the countries of Finland, Sweden, Norway, and Denmark. For example, a global pharmaceutical company with only marketing operations in Sweden would have been excluded from the list. The email addresses were selected from the websites with the following priority: Scientific/research director, CEO/managing director, any person related to research, any person in the company, general mailbox. Only one survey invitation was sent per company.

Before sending the questionnaire to the companies it was piloted by sending it to 8 affiliates at Tampere University of Technology and the questionnaire was revised based on their feedback. The questionnaire was sent to 229 companies via email, which contained the cover letter alongside a link to the questionnaire. Two reminder letters were also sent to increase the response rate. The cover letter and the reminder letters are shown in appendix 2. Due to reasons of confidentiality, the organizations and the email addresses, which the questionnaire was sent to, are not revealed in this report.

Altogether 24 responses were received to the questionnaire, thus the response rate was approximately 10,5 percent. Twelve (12) responses were received from Finland, 7 from Sweden, 4 from Denmark, and 1 from Norway. The answers were received mainly from smaller companies as 54 % of the respondents answered that nine or less people are involved in research activities in their organization in the country they are working in.

4.2. Interviews

The second qualitative method in the study, semi-structured interviews, is now discussed in two parts: developing the structure for the interviews and conducting the interviews.

4.2.1. Interview structure development

After receiving the results of the survey, the themes for semi-structured interviews were designed. The interview was designed to consist of six different phases. First, in the introductory phase, the study and its objectives were introduced shortly alongside the aspects of confidentiality and the definition of image analysis. In addition, the interviewees were asked to describe their role in the organization.

In the second phase, the current operations of the company were explored. This included discussion of the following aspects: business, customers, procurement, operations, research and development, and the use of visual inspection. Visual inspection was deliberately discussed separately from image analysis since companies might have visual analysis tasks even though they would not use image analysis software. This kind of companies, actually, might prove to be most in need for image analysis services. In general, the second phase focused especially on the concept of value in different forms, e.g. business value for the customers and value of visual inspection for R&D and operations. The six stages of the buyer experience cycle in the Buyer Utility Map (Kim & Mauborgne 2005) (see figure 2.12.) were also taken into account in the second phase of the interview.

The third phase of the interview consisted of discussion related to business in general in the future. For instance, opportunities and threats in the business environment were discussed alongside future trends of the industry. The fourth phase concentrated solely on the image analysis needs of the company and of the industry, currently and in the future. In the fifth phase, extra attention was given on what factors the interviewees valued in terms of business, research and development, and suppliers. Lastly, in the sixth phase, closing questions were presented. The interview structure was revised before conducting the interviews based on the feedback received from two experts affiliated with the study. The original interview structure can be seen in appendix 3 accompanied with English translation.

The information collected through the survey was used in many ways in designing the interview structure. First, the themes, to which to concentrate in the interview were identified. In addition, answers to certain questionnaire questions were used as an ‘example list’ of possible discussion topics. For example, when discussing the important factors of visual inspection in the interview, example factors were taken from the answers to the questionnaire question no. 13: “What are the three most important

qualities in image analysis in your organization?" These 'example lists' developed from the questionnaire answers helped to direct the conversation during the interview when needed.

4.2.2. Conducting interviews

The interviews were conducted with the staff of different Finnish companies of the pharmaceutical industry. The interviewees were selected to be responsible or familiar with the research of the respective organization. Furthermore, based on the information received from the interviews, staffs of certain Finnish health care laboratories were interviewed as well. Due to reasons of confidentiality, the organizations and the people interviewed are not revealed in this report. Instead, in the report, individual interviews are referred to with a code I-X in which the 'X' represents the number of the interview. The interviews conducted, including service concept testing interviews (see below), and their respective codes are presented in appendix 4.

The first contact to the organizations interviewed was done by phone. In a few instances, additional information about the study was sent via email. Apart from phone interviews, all the interviews were arranged in the premises of the organizations in question. Altogether 11 interviews were conducted; 8 of them were live interviews and 3 phone interviews. Seven pharmaceutical companies and four health care laboratories were interviewed. All the interviews had one interviewee except for one group interview in which five people attended. The interviews lasted from 10 minutes to 2 hours and 6 minutes, average length being 78 minutes. The interviews were recorded when permitted by the interviewees. The phone interviews could not be recorded.

The information from the survey and the interviews were used to analyze the actual needs of the potential customers. This was a prerequisite to define how the needs should be met, i.e. what the service offer should contain. The information acquired through the methods combined with the information from the previous consultancy studies made the service concept and resource structure development possible.

4.3. Service concept testing

The designed service concept was also tested by conducting two interviews, one with a representative of a pharmaceutical company and one with a representative of a health care laboratory. The testing was done in order to receive feedback on the service concept from potential customers. In addition, testing the service concept increases the validity of the designed service concept. Testing can also be viewed as what Kasanen et al. (1993) describe as the weak market test which gives first-hand knowledge on whether the construction, i.e. the service concept, is appealing to potential customers.

Concept testing interviews were held at the premises of the organizations interviewed. First, the designed service concept was explained with PowerPoint presentation as a visual aid. After that, the interviewees were asked a list of questions eliciting feedback on the service concept. The interviews were also recorded. The average length of the service concept testing interviews was approximately 33 minutes. In appendix 5, the original interview structure of service concept testing is presented accompanied with English translation.

5. RESULTS

The results of the survey and the interviews are presented in this chapter. First, the nature of business of the companies interviewed is presented followed by the introduction to their research operations. Next, the procurement practices and the future of the organizations are discussed shortly. Lastly, companies' practices related to visual inspection and image analysis are addressed followed by the discussion of the organizations' image analysis needs. In figure 5.1. all the aspects analyzed in this chapter are illustrated. The arrows in the figure represent the sequential nature of the aspects analyzed. For instance, in order to fully understand research operations one needs to first understand the nature of businesses which, in turn, requires understanding of industry characteristics, customers, and business environment in general (these three aspects are included in the discussion of the nature of businesses).

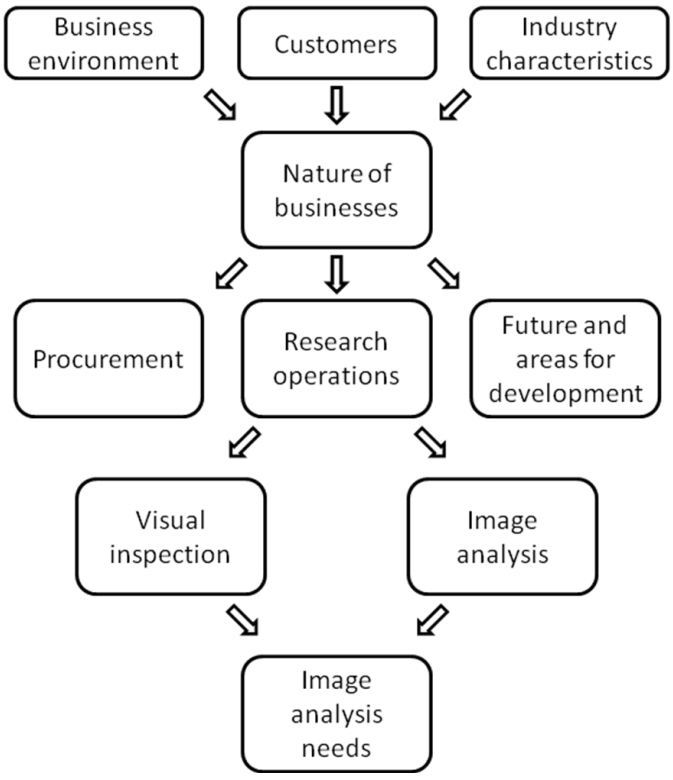


Figure 5.1. *Framework for analysis of survey and interview data.*

By analyzing the aspects represented in figure 5.1. one acquires a comprehensive view on the potential customers and their environment, which is a necessity in order to design a successful service concept.

5.1. The nature of businesses

In order to understand the needs of potential customers one has to understand their business first. Because of the different nature of business in pharmaceutical companies and health care laboratories, these two areas are discussed separately. However, these two areas are tightly interconnected as will be seen later.

5.1.1. Pharmaceutical companies

The pharmaceutical industry itself is very broad and there are numerous actors in the field. One way to classify the different types of companies involved in drug discovery and development is to make a difference between traditional pharmaceutical companies, biotech pharmaceutical companies, and contract research organizations (CROs). Certain characteristics of the businesses of these different types of companies are discussed separately but first the industry in general is addressed.

Pharmaceutical industry

Several interviewees stressed that drug discovery and development is extremely expensive. In general, the whole research process from the start to a ready drug product costs from €500 million to €1 billion (I-3). Consequently, it is not a surprise that the companies are constantly trying to find new ways to make drug research more cost-effective. In fact, many of the global big pharmaceutical companies are downsizing their research operations and letting their collaborators (e.g. universities and other companies) conduct the actual research (I-3).

Not only is the research expensive but it also consumes considerable amount of time. The whole research process of one drug can take from 10 years to 15 years. This is very problematic for the pharmaceutical companies as the drug patents expire after 20 years. Basically, in the worst case scenario, a pharmaceutical company would have less than 5 years to get profit from the drug in which approximately €1 billion has been invested (I-3). After the expiration of the patent, the sales will decrease because of the interchangeable drugs entering the market. Consequently, it is in pharmaceutical companies' best interest to speed up the drug research process as the faster the process is the more time the company has to get profit from the drug developed. Both the aims toward cost-effectiveness and faster development process provide a fertile ground for image analysis solutions.

The trend in the industry, in general, is to focus on core competencies (I-5, I-8). As there are many different therapeutic areas (e.g. neurology, oncology, and infectious diseases) to which drugs are developed and several different phases in the drug development process (see chapter 5.2.) it is often not the best solution for a company to do everything themselves. A myriad of companies have specialized in either different

therapeutic areas or different phases of drug development or even specific research technology. Nowadays, in drug development, many tasks or processes are outsourced globally. Also, insourcing and different collaborative models are used extensively in the industry (I-5).

The phenomenon closely related to outsourcing is that drug research in general is highly networked. Multiple organizations take part in the development of a certain pharmaceutical. These include not only all the pharmaceutical companies already mentioned, namely, traditional, biotech, and CROs, but also universities and laboratories (I-3, I-5). One interviewee described that the industry pretty much revolves around the needs of the bigger pharmaceutical companies that employ many smaller organizations (I-8). One example of different collaborative models that the industry utilizes is the following: A smaller pharmaceutical company starts to develop a drug from the start and if the drug shows potential in the earlier research phases then the company aims to form a partner relationship with a bigger pharmaceutical company, which will fund the further development of the drug (I-11). In summary, drug research is exceptionally networked and several highly specialized companies exist from which services are bought. However, no company in Finland, at least, has specialized in image analysis services, particularly.

An aspect that has implications on image analysis needs, especially, is the general aim for high quality and high reliability in drug research and in final products (I-3, I-5, I-7, I-8, I-11). A study wrongly conducted can promote "bad medicines" to enter the market, which can have serious consequences for patients starting from dangerous side effects to even death. In addition to human suffering of the patients and their loved ones, the withdrawal of a drug costs millions for the pharmaceutical company and hurts its reputation as well. (I-8.) Consequently, the reliability of the methods used in drug research is of utmost importance for pharmaceutical companies. In addition to high quality of research and products mentioned in the interviews, according to the survey, the respondents describe their organizations' business with the qualities presented in table 5.1. (70 % of the qualities mentioned belong to the groups in the table).

Table 5.1. *The qualities best describing organizations' business in the survey.*

	quantity
Customer-centric	14
Flexible	12
Research-driven	11
Creative/innovative	4
Professional/experienced/strong expertise	3
Dynamic/fast/responsive	3

All in all, the general characteristics of the pharmaceutical industry suggest that there might be need for services and solutions that are fast, reliable, and cost-effective, among other things. Next, the unique characteristics of different types of pharmaceutical companies are discussed.

Traditional pharmaceutical companies

In general, traditional pharmaceutical companies include the biggest and most famous companies in the industry, e.g. 'the Big Pharma' companies. Of course, many smaller firms are also included in traditional pharmaceutical companies, but there are not many big companies in the other types of pharmaceutical companies.

The competition especially among traditional companies is fierce. It is quite difficult to differentiate from other companies with uniquely effective drugs since many of the drugs developed by different companies to certain diseases differ from each other to a low degree (I-3). The companies try to differentiate from each other by more scientifically orientated research or by preservativeless products, for example (I-5, I-3).

Traditional pharmaceutical companies have customers in many different levels. The end-customers, naturally, are the patients that use the drugs but there are other customers as well (I-7, I-3). Especially, in case of prescription drugs, the customers are also the medical doctors that write the prescriptions. In addition, hospitals and pharmacies can be seen as customers since through them the patients can get access to pharmaceuticals. (I-3.) It can be concluded that the relationship between a pharmaceutical company and a patient taking the drug is of transactional nature since no real dialog exists. On the other hand, the relationship between a pharmaceutical company and hospitals, pharmacies, and doctors is more or less a partnership since company representatives regularly visit them to give information about new drugs and collect feedback from the field (I-3). In these partner relationships, customers value especially the service quality and smooth dialog with a pharmaceutical company (I-3, I-5).

Biotech pharmaceutical companies

An increasing amount of new drugs is developed with methods broadly described as biotechnology. The majority of the biotech pharmaceutical companies use biotechnology to create novel molecules and compounds that are further developed into drugs. Oftentimes, these companies make licensing or other collaborative deals with bigger (often traditional) pharmaceutical companies to get more resources for drug development (I-11).

Because of the different business model of biotech companies compared to traditional pharmaceutical firms, the customers of the biotech firms are actually other pharmaceutical companies that are e.g. bigger players or do not conduct their own drug development, at least not in the same therapeutic area. Of course, the end-user again is the patient but a large part of the revenue for biotech firms comes from developing the drug further according to the agreements made with other pharmaceutical companies that fund the development. (I-11.)

The relationships with the customers are essentially partnerships. The collaboration projects last several years since drug development takes considerable amount of time. The customers of the biotech pharmaceutical companies value primarily the product. They pay attention among other things to how convincing the product is, how big a risk there is to develop it further, how original is the idea of the product, and how the product differentiates from other existing therapies. Also, the customers are interested about the track record and reputation of the biotech pharmaceutical firm. (I-11.)

Contract research organizations

CROs usually differ from traditional and biotech pharmaceutical firms in that they do not develop their own drugs. Instead, they develop their customers' drugs. CROs are often specialized in a certain therapeutic area or certain phases of drug development, hence being experts in their specialized area of drug discovery and development. Also, certain consortiums exist in which multiple CROs together offer all the phases of drug development for their customers. (I-8.)

In many cases, the customers of CROs include not only pharmaceutical companies but also firms in other industries that can benefit from the CROs expertise in a certain field, e.g. safety studies (I-2, I-8). The quality of the research services is valued highly by the customers. The quality in research is based on the scientific knowledge and expertise of the CRO. In addition, the smaller the studies ordered are in scale the more valuable is the speed by which the studies are conducted. However, the speed cannot be gained at the expense of quality. (I-8.)

5.1.2. Health care laboratories

The interviewees from health care laboratories were all from different fields of specialization. However, their organizations had all the major fields of specialization represented, and the interviewees more or less knew about the other fields of specialization as well. The laboratories interviewed were closely related to municipal health care, thus they were not companies in the purest form. In fact, one of the interviewees stressed that making profit is not essential but advancing the care is (I-6).

The differences in operations of different specializations are discussed in chapter 5.2. Now, the general nature of health care laboratories and their business is addressed.

In short, the core business of health care laboratories is to conduct laboratory studies for their customers. Often, the laboratory takes the samples from customers (e.g. blood), and after processing and analyzing deliver the results according to what was ordered (I-4). Similarly to pharmaceutical companies, health care laboratories, too, can be thought to have customers in different levels. The direct customers are medical doctors (both public and private) that request the studies for their patients (I-4, I-6, I-9, I-10). Another customer group, naturally, is the patients from whom the samples are taken and whose health is analyzed. In certain laboratories there is a possibility for people to order and pay for their studies themselves. Hence, in some cases, patients are direct customers, as well (I-4). The last group of customers, which in most cases pay the studies, includes municipalities and private laboratories whose citizens' and customers' samples are analyzed respectively (I-6).

The nature of the relationship between laboratories and direct customers, the medical doctors, depends on the area of specialization. In some areas, e.g. in microbiology, the collaboration between the two is often so deep that in some instances a doctor in customer's side and a doctor in a laboratory could exchange their jobs, and the operations would not be disturbed (I-6). On the other hand, in some other areas, e.g. clinical chemistry, not much collaboration exists and the relationship is thus more transactional (I-10).

In general, the customers of laboratories value quality. They need to be able to trust the results that the laboratories provide them. The quality is usually assured through accreditation and quality standards (I-4, I-6, I-10). Moreover, professional expertise of laboratory employees is valued and oftentimes the speed of the studies is of great importance (I-4, I-6, I-9). When the interviewees were asked what differs their organizations from the competitors, many of them underlined that not much competition exists. The health care laboratories closely related to municipalities do not compete with each other; in fact, they collaborate e.g. in case of capacity problems (I-6). Genuine competition exists basically among purely private laboratories which are not numerous in Finland (I-10).

Basically, in all health care laboratories, regardless the area of specialization, the laboratory studies conducted all have implications on how the patients, whose samples were analyzed, are treated and cured. In other words, the analyses of the samples affect diagnosis and treatment decisions made by doctors for their patients. Consequently, in health care laboratories, the reliability of the results provided for the customers is of utmost importance. (I-6, I-10.) Hence, in terms of image analysis in health care

laboratories the reliability and validity of methods utilized are crucial since they will have direct implications on how the patients' illnesses are treated.

Characteristically to all the laboratories interviewed, the volume of samples analyzed routinely is enormous. In fact, the volume in which image analysis could be utilized is considered significantly bigger in laboratories than in pharmaceutical companies (I-3). In all the laboratories interviewed, the volume of samples analyzed per year is several millions, although the majority of the samples are analyzed with basic chemical analysis methods that do not require images at all (I-4, I-6). The volume of samples calls for automated procedures and therefore the development of methods utilized has been toward automation (I-4); something that gives a good starting point for image analysis services.

Laboratory analysis of the samples takes time not only in the form of actual analysis but also in preparing the samples to be analyzed. Laboratory studies can be considered as the bottleneck for treating the patient since valuable information for diagnosis can be received through them and treatment decisions are not made before receiving the results. Hence, one of the goals of the laboratories is to speed up the analysis so that the customers could receive the results faster and more samples could be analyzed altogether (I-10). This goal, too, advances the need for image analysis.

Another characteristic to laboratory operations is that several employees conduct the analyses. Certain analyses are done by bioanalytics while the others are conducted by doctors (I-4, I-9). In general, all the analyses should be done in the same way so that the results are consistent. Currently, the objectivity and quality of manual analysis is maintained through periodical peer reviews (I-9). However, even though considered sufficient, these peer reviews do not remove subjectivity from the analysis entirely nor do they take into account the possible implications of human fatigue on analysis.

5.1.3. Customer segments

Based on the survey, the interviews, and earlier consultancy studies it can be concluded that the different potential customer segments in the context of pharmaceutical industry can be divided into pharmaceutical industry itself, which consists of traditional pharmaceutical companies, biotech pharmaceutical companies, and CROs; and universities and health care laboratories that are closely connected to the industry. These segments and their linkages are illustrated in figure 5.2.

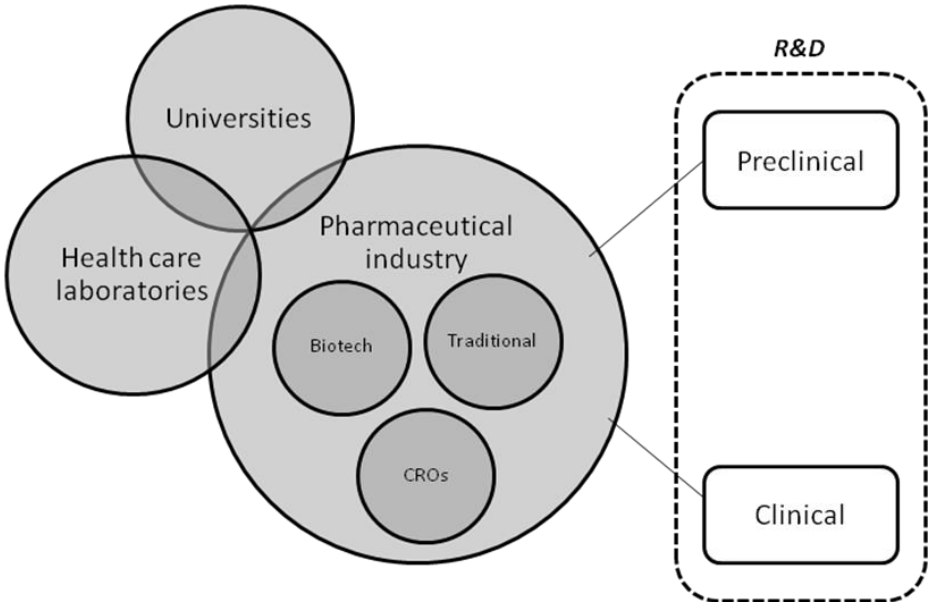


Figure 5.2. *Potential customer segments in the context of pharmaceutical industry.*

In figure 5.2. research and development in pharmaceutical industry is divided into preclinical studies and clinical studies whose potential as the application area for image analysis differ. The differences between the two are discussed in the next subchapter.

5.2. Research operations

Research on pharmaceuticals is generally divided into preclinical and clinical studies. These two areas are discussed separately. In general, it should be noted, that research projects in pharmaceutical companies change, and it is not unusual that needs between different projects vary considerably. Hence, in pharmaceutical companies the needs related to e.g. image analysis can change from time to time (I-11) whereas in health care laboratories the research is tightly linked to the actual operations (I-6) making the needs in laboratories more constant. After preclinical and clinical studies, laboratory operations are discussed.

Research operations are discussed in detail because they are a natural application area for image analysis in pharmaceutical companies. In table 5.2. the most frequent answers to the questionnaire question “Name three qualities best describing your organization’s R&D” are shown.

Table 5.2. *The qualities best describing organizations' R&D in the survey.*

	quantity
Reliable/trustworthy	9
High quality/focus on quality	6
Innovative	6
Fast	5
Cost-effective	4

The qualities in table 5.2. account for 48 percent of all qualities mentioned in the replies. It can be seen from the table that the themes of reliability and high quality recur also in these answers.

5.2.1. Preclinical studies

One of the interviewees (I-11) described the process of preclinical studies as follows. Nowadays, when a company starts to develop a molecule or a compound, which affects a specific target, e.g. certain enzyme, the company has to have a clear idea of where to utilize it in a human body, i.e. which condition is to be affected. The general paradigm in drug discovery and development is to start with in vitro research. If possible, recombinant proteins are used to identify potential molecules for further development. In the next phase, cell models are used in order to repeat the results with recombinant proteins so that it can be verified whether certain molecule is better than the others in affecting the target. At this point, specificity tests are also conducted to find out whether the molecule affects other targets, e.g. enzymes, as well.

After the cell models the development proceeds into animal models in which pharmacological effects are studied in animals, e.g. mice. It is investigated whether the metabolism of an animal changes due to the molecule in question. Next, in the disease model it is studied whether the molecule cures a disease in an animal. If the molecule passes all the tests above, tests with humans, i.e. clinical trials, follow. In general, it is important to find an effective molecule, to prove that it is working, and aim for global markets. For example, in the case of a specific cancer, sufficient demand may exist internationally even though the local needs would not be adequate commercially. (I-11.)

Global traditional pharmaceutical companies practically do not conduct preclinical research in Finland. Instead, preclinical research is done in specific research centers abroad (I-1). Hence, the possible needs related to image analysis in preclinical studies of the big traditional pharmaceutical companies are inevitably abroad. Consequently, image analysis related needs in preclinical studies in Finland are, for the most part, limited to the needs of biotech pharmaceutical companies and CROs. In addition, needs exist in a related context of laboratory services as described later.

In preclinical studies, analyses are conducted in molecular, cellular, and tissue level. Among other methods and tools, microscopy and high content screening are used extensively. (I-2, I-7.) However, in terms of image analysis, it seems that the methods utilized are not quite established if they are used in the first place (I-8, I-11). It should be added, though, that in certain companies considerable effort is put into establishing routine image analysis systems (I-7). According to the interviews, different sub-studies of preclinical studies, e.g. toxicology, pharmacology, and cell and animal models in general seem to be very potential application areas for the image analysis expertise of the CSB research group.

5.2.2. Clinical studies

Clinical studies are commonly classified into four distinct phases, namely, phase I, II, III, and IV. In those studies, e.g. safety and efficacy of a drug are analyzed. One of the most crucial parts of clinical trials is the clinical proof of concept (POC) which is conducted in phase IIA. In POC, significant drug feasibility and functionality tests are carried out with real patients. If the drug passes POC, the actual product development begins. POC is one of the most potential areas for development in drug research since the sooner POC can be conducted the faster the development of poor drugs can be stopped, thus saving time and money. (I-3.)

Pharmaceutical companies and CROs conduct clinical studies in deep collaboration with health care staff of hospitals and clinics (I-5). It is actually the medical doctors in the hospitals and clinics that interact with the patients and collect the information needed for the study by using case report forms (I-1). The role of the pharmaceutical companies is to make the studies possible by making arrangements with hospitals and clinics, finding suitable medical doctors, coordinating the studies, and finally analyzing and refining the data collected in the studies. In general, standard operation procedures are abided but variations in the studies occur due to distinct characteristics of different drugs and studies. (I-5.)

Contrary to preclinical studies, global pharmaceutical companies conduct clinical studies also in Finland. In fact, clinical studies are often international. Usually, the information is gathered and pre-processed in Finland and sent to specific data analysis units abroad for further refinement. (I-1, I-5.) If images are analyzed in clinical studies, it is usually done already in hospitals or clinics; the data that is forwarded to further analysis is often in written or numerical form (I-1). The images analyzed in hospitals or clinics include e.g. MRI, ultrasound, and x-ray images, which belong into area of medical diagnostic imaging. In general, the analysis of these kinds of images is already more established compared to image analysis in preclinical studies (I-1). Hence, apart from certain therapeutic areas, e.g. eye or skin related diseases, the potential of clinical studies as an area to utilize image analysis expertise of the CSB research group is far inferior to preclinical studies.

5.2.3. Laboratory operations

As mentioned above, the scientific research conducted in health care laboratories is tightly linked to the actual laboratory operations (I-6). Hence, by addressing laboratory operations one can go through all the relevant aspects of research operations in terms of image analysis.

Laboratories have several different areas of specialization. They all have their distinct characteristics but the actual operations process in all of them is more or less generic. The process starts with a request for certain analyses made by a doctor in a customer organization. Next, samples are taken from a patient according to the requested needs. The samples are transported to the unit conducting the analysis. Before the actual analysis, the samples are preprocessed if needed. After analysis, the results are delivered to the requesting doctor. In certain areas of specialization the results are accompanied with a statement of a laboratory doctor specialized in the area in question. The generic process is illustrated in figure 5.3.

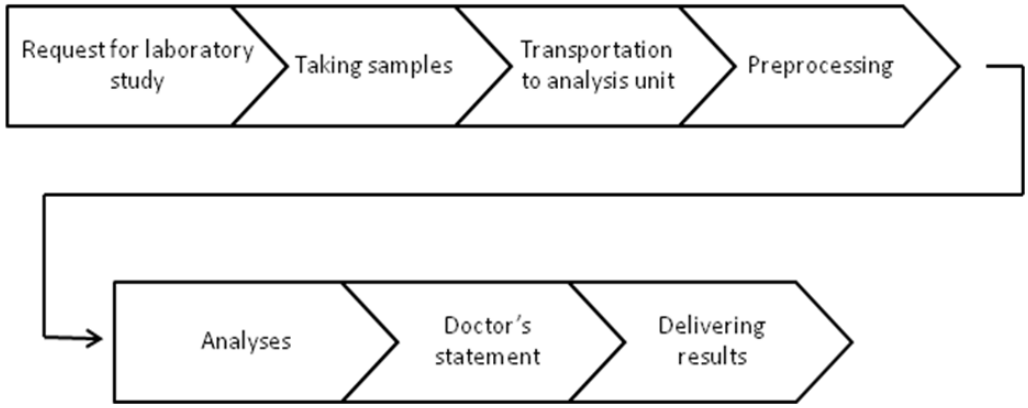


Figure 5.3. *Generic process of laboratory operations.*

In certain areas of specialization, certain tasks in the process are more laborious or time-consuming compared to others but the generic process is the one depicted in figure 5.3. Next, distinct characteristics of different areas of specialization are introduced in terms of their potential to image analysis services.

In clinical chemistry, the volume of samples is considerably larger than in the other areas of specialization. Many of the analyses tasks in clinical chemistry have actually been automated. (I-4.) However, none of the analyses is based on analyzing images, thus making clinical chemistry an unattractive area for image analysis services. In hematology, samples of bone marrow and blood, for instance, are analyzed. In practice, the formation of blood cells and its complications are examined. Hematology results are usually accompanied with doctor's statement, which is based on extensive microscope analysis done by the doctor. (I-9.) Consequently, image analysis is tentatively useful in hematology even though there was controversy on its usefulness among the interviewees (I-4, I-10, I-9). In immunology, too, microscopes are used widely. Also in

this area of specialization, similarly to hematology, many methods are not yet automatic, thus laborious and subjective manual work is done both in preprocessing and microscope analysis (I-4).

In clinical microbiology, samples are grown in cell culture dishes and analysis normally requires more time compared to other areas of specialization because the bacteria examined have to be allowed time to form colonies. In clinical microbiology, too, microscopes are used routinely in analyses thus making microbiology a tentatively potential application area for image analysis. (I-6.) Lastly, in pathology, microscopes are used probably most extensively of all the areas of specialization. Similarly to hematology, in pathology doctor's statement is provided alongside the analysis results. In addition, in pathology, a new technology of web microscopy is becoming more common. In short, in web microscopy the samples are scanned and analyzed afterwards using a computer screen, thus enabling pathologists to make diagnoses without the use of a microscope. (I-10.)

5.3. Procurement

If certain image analysis services are to be commercialized in the future, it is important to understand how the potential customers make purchases. Hence, it is useful to go through certain issues and procedures related to the procurement process of pharmaceutical companies and health care laboratories. Oftentimes, the principles in procurement strategy also reflect the aspects that are valued by the organizations in question.

5.3.1. Pharmaceutical companies

In general, separate research units themselves decide on what products or services to purchase and especially in the case of CROs certain initiatives stem from customer requests for certain type of services (I-3, I-8). However, especially bigger investments need to be first approved by higher levels in organization hierarchy (I-3, I-7). Often, different research projects have their own budgets and certain expenses are allocated to those budgets. Larger investments that can be used in many research projects, however, are allocated to a different budget. (I-8.)

As described above, many different collaboration models exist in pharmaceutical industry. Consequently, service outsourcing and insourcing are common among pharmaceutical companies, and for example, certain laboratory services are put out to tender regularly (I-5). The reasons for outsourcing and insourcing include but are not limited to focus on core competencies, capacity problems, and aim for increased flexibility (I-3, I-5, I-8).

When discussed which factors are important in buying new products or services, many of the interviewees stressed the importance of product validation and service audits. One of the interviewees elaborated that the documentation and validation related to purchasing a completely new machine may turn out to be far more laborious task than the actual deployment of the machine (I-3). In the case of services, the companies value continuity and reliability of service (I-7, I-8). According to the interviews in general, suppliers and service providers need to provide high quality, be flexible, and abide the standards of e.g. documentation.

5.3.2. Health care laboratories

The procurement practices in health care laboratories resemble pharmaceutical companies in how the investment decisions are made and what the reasons for outsourcing are. However, according to interviews, outsourcing is not used as extensively as in pharmaceutical companies.

In health care laboratories, extra attention is paid on the continuity and reliability of services and products. For example, when buying new analysis machines, the laboratory has to consider the possibility that the machine breaks down and urgent analyses could not be made. Consequently, every time new machines are bought, the minimum of two pieces are acquired so that patient samples can be analyzed on time even in the case of machine failure. (I-6.)

Because of the strong link between laboratory operations and patients' health, the price of machines or services purchased can never be the only factor affecting buying decisions (I-10). In fact, laboratories never trust solely on vendors' quality assurance but validate all new machines and methods, which further increases the final cost for laboratories (I-4). Suppliers and service providers of health care laboratories, in general, have to provide high quality according to quality certificates and fast maintenance so that laboratory operations would not be disturbed (I-6, I-10).

5.4. Future and areas for development

Assuming that a new company offering image analysis services would be founded in the future, it is necessary not only to understand the current state of affairs of customers' businesses but also to anticipate relevant changes in the future. As in previous subchapters, the future of pharmaceutical companies and health care laboratories are discussed separately.

5.4.1. Pharmaceutical companies

Many of the interviewees pointed out that regulatory provisions are getting stricter all the time, which may have consequences on how e.g. marketing or research are

conducted in the future. Partly because of new regulatory provisions, new drugs are introduced to the market less frequently (I-3). Another reason for this phenomenon is that it is increasingly difficult to discover new drugs with current practices. Consequently, a new field of personalized medicine is appearing. In other words, the trend in drug development is to focus on smaller and smaller patient groups and tailor drugs to those groups. Through customization, genuinely novel drugs can be discovered, although, at the same time, R&D costs are increasing. (I-5, I-7.)

At the same time with increasing R&D costs and regulatory provisions getting stricter, the price competition brought by interchangeable drugs is intensifying in pharmaceutical industry (I-3, I-5). These changes put pharmaceutical companies in a tight spot in the future, as they have to find out new ways to keep the business profitable. In relation to this, the internationalization continues and new market areas are entered. The focus shifts to Asia and South America in the future. (I-5, I-8.) Also, outsourcing will be used more extensively in the future (I-3).

In drug research, more and more sophisticated molecule and cellular level techniques and methods, e.g. proteomics and computer modeling, are utilized in the future since they enable personalized medicine and also contribute to higher predictability in drug research (I-7, I-8). The better the predictability in research the sooner the development of poor drugs can be stopped. It was also anticipated that imaging would take a bigger role in certain studies in the future (I-8).

In terms of image analysis services, specific future challenges of pharmaceutical companies can be seen as opportunities to enter the market. For instance, solutions decreasing the cost of drug research or helping companies to meet stricter regulatory provisions are most probably welcomed to the market. However, the validation of new technologies is laborious which hinders the adoption of new technologies in the industry (I-5).

5.4.2. Health care laboratories

An educated guess is that private sector of laboratories will get stronger in Finland in the future. This will eventually bring more competition to the market and force current actors to improve their operations and competitiveness. (I-6.) Moreover, similarly to pharmaceutical industry, the internationalization is increasing. One of the trends improving the competitiveness of laboratories is the growing automatization of operations. (I-4.) Currently, in certain areas of specialization, automation technologies are treated with reserve due to the high cost of investment and lack of dominant design (I-6). Automatization is increasing in the future not only to enable higher throughput but also to take into account the increasing resource deficit of professionals and experts (I-6, I-10).

In addition to automatization, the research and operations of laboratories are developing toward more sophisticated techniques of e.g. molecular genetics (I-6, I-9, I-10). This trend is the result of a growing demand for more accurate diagnosis in laboratory studies. Also, in pathology, virtual microscopy will become more widespread. (I-10.) In general, the field of diagnostics will develop fast, although, new technologies do not frequently replace existing ones because the so-called gold standards of technologies are not lightly abandoned (I-6).

Generally speaking, the changes and threats of health care laboratories are not as severe as in pharmaceutical industry. However, health care laboratories' attempts to improve their competitiveness through, e.g. automatization in the future, provide a fertile ground for image analysis services.

5.5. Visual inspection and image analysis

The magnitude and characteristics of visual inspection in pharmaceutical companies and health care laboratories are discussed in this subchapter. Visual inspection can be seen as a prerequisite for the needs related to image analysis since if no operations utilize visual inspection, e.g. by human eye, microscopes, or scanners, there is most probably no need for image analysis either. Being strongly related to visual inspection, image analysis practices of the companies interviewed are also discussed in this subchapter. Furthermore, general attitudes toward image analysis and barriers in the adoption of image analysis are addressed, too.

5.5.1. Pharmaceutical companies

In drug discovery and development, visual inspection is used in many different applications. Visual inspection by mere human eye is done for example in chemical research laboratories to check whether a solution precipitates (I-3). In certain companies, scanners are used among other tools to help in visual inspection, e.g. Western blot scanners (I-7). However, the most widely used tools in visual inspection are microscopes. Visible light microscopes and fluorescence microscopes are most frequently used in pharmaceutical research according to the survey. Moreover, in clinical studies, e.g. MRI and CT imaging are used regularly (I-5).

More rarely used equipment in visual inspection among the interviewed organizations that can actually be classified as image analysis tool is high content screening (HCS) scanner, which, in terms of imaging, is essentially a combination of automated fluorescence microscope and comprehensive image analysis software. HCS scanners are used in molecule discovery and are so expensive that smaller companies generally cannot afford them. (I-7.) Certain image analysis software have also been used in the companies interviewed, e.g. ImageJ and Image-Pro Plus (I-3, I-11). In addition, a few companies have microscope cameras connected to microscopes but they are often used

only when something unusual is found from the samples (I-2, I-3, I-8, I-11). In other words, routine image documentation is generally missing.

Visual inspection is traditionally used e.g. in histology, histopathology, and in cancer studies in which MRI images are used (I-7, I-11). For example, in OECD regulations it is said that histopathological sections need to be visually inspected which has been done manually so far. The volume of the samples to be analyzed was said to be thousands per study. (I-8.) However, the degree of use of visual inspection and image analysis depends very much on what kind of drugs are developed (I-6).

According to the interviews, many of the visual inspection tasks are related to classification of samples. For instance, one might want to determine, or score, how much a sample differs from a reference sample on a scale from 0 to 3+ (I-7, I-8). In addition, in cancer studies, RECIST criteria are used to determine whether the cancer has evolved (I-5). In addition, parameters such as diameter, size, surface area, and cell count are often determined in drug related research even though exact quantification is not always needed (I-11). However, according to the survey results, the quantification of image data is viewed as the most important benefit from image analysis. In table 5.3. the answers to the question "What are the most important things that you could use image analysis for in your organization's research?" are presented as groups (approximately 77 % of the responses belong to the groups below).

Table 5.3. *The benefits from image analysis to drug discovery and development.*

	quantity
Measurements/quantification in cell level	6
Measurements/quantification in tissue level (tumors, histology, histopathology)	6
Measurements/quantification in organ level (eye, wound size)	5
Measurements/quantification in molecular level (pharmacology, toxicology)	4
Depends on the customers' needs	3

Furthermore, in table 5.4., the qualities, which are valued in image analysis by the questionnaire respondents, are presented (approximately 85 % of the responses belong to the groups below).

Table 5.4. *The qualities of image analysis valued in drug discovery and development.*

	quantity
Speed	9
Flexibility	9
Objectivity	8
Repeatability/throughput/automation/good routine/efficiency	8
Reliability/validity/professionalism	7
Easy-to-use/user-friendly/simple	5

As mentioned above, apart from a few companies, images are not routinely taken in the research. Hence, a clear process around imaging cannot be determined. In companies where images are taken routinely, there are problems related to transferring and storing images. However, a few interviewees stressed that the preprocessing of the samples to be analyzed is often more time consuming than the actual analysis of the samples (e.g. I-3, I-8). On the other hand, the time to conduct the analysis depends on whether exact measurements are needed or not.

In general, visual inspection is viewed important in research since it gives first hand information, which often guides the research into certain direction (I-8). In addition, the information gained through visual inspection is often used alongside other methods to increase research predictability and form the big picture (I-7, I-8). However, certain pharmaceutical companies forward the actual analysis of samples to commercial laboratories (I-5).

5.5.2. Health care laboratories

Apart from clinical chemistry, visual inspection is conducted extensively in health care laboratories. Moreover, since laboratory operations do not consist of individual projects, as is the case with research in pharmaceutical companies, the need for visual inspection and image analysis is both greater and more continuous. Some visual inspection is conducted by mere eyes especially in clinical microbiology in which cell culture dishes are analyzed (I-6). However, similarly to pharmaceutical companies, the main equipment in visual inspection is the microscope. In pathology and hematology, especially, the microscope is a central tool of analysis (I-4). Other equipment such as scanners for histological sections and some image analysis software are used in smaller scale (I-3, I-10). The benefits of using microscopes are that the simplest ones are fairly inexpensive and employees are accustomed to them (I-10).

New technologies for visual inspection are developed for example to automated analysis of bacteria samples. The performance of this technology is currently at 90 percent, which, however, is inadequate for laboratory operations (I-6). Also, web microscope is used by pathologists in certain Swedish hospitals, although the development has not been as fast in Finland (I-10). Depending on the area of specialization, microscope cameras are used either not at all or fairly often. However, similarly to pharmaceutical companies, images are not taken routinely. (I-3.) Instead, they are taken e.g. from abnormal samples, for publications, or as additional information for the doctors who requested the analysis (I-6, I-9, I-10).

For laboratory operations, the exact quantification of images is not as important as for certain pharmaceutical companies. One of the interviewees noted that it might be useful to get quantified data of light intensity in samples, but in general the majority of the visual inspection tasks aim for classifying different samples based on the amount of

colonies or the amount of dividing tumor cells, for example (I-3, I-6, I-10). Depending on the analysis the classes can be from 0 to 3+ or in every 5 percents of an investigated parameter, for instance (I-6, I-10). Also, in certain analyses plain ‘yes or no’ answer as whether the sample contains fluorescence or not is adequate (I-3). Generally, all of these classifications are done manually nowadays. Specific applications for visual inspection include anti-nuclear antibody tests, plaque counting, blood cell morphology analysis, and tumor cell analysis among others (I-4, I-6, I-9, I-10).

In many analyses conducted in health care laboratories visual inspection is an essential, and sometimes even the only source of information from samples. In pathology, for instance, additional information to support visual inspection can be gained through immunohistochemical tests but the main source of information is still in visual form (I-10). As was the case with pharmaceutical companies, visual inspection can also orientate and give direction for further analysis (I-6). All in all, it can be concluded that visual inspection is even more important in laboratory operations than in drug research. Interestingly, in spite of this observation, it seems that image analysis tools and methods are not utilized in laboratory operations as widely as in pharmaceutical companies.

5.5.3. General attitudes toward image analysis

The attitude of the interviewees toward image analysis was generally positive. Only one of the interviewees saw no use at all for image analysis in their organization. However, a few others saw only minor application areas for image analysis in their organization’s operations. In the survey, 29 percent of the respondents viewed image analysis to be ‘unnecessary’ or ‘very unnecessary’ in their organizations’ research; the rest viewed it as ‘necessary or ‘very necessary’. The respondents saw image analysis necessary in getting quantified and reliable results among other reasons. Two respondent organizations also offered image analysis services in some form.

One interviewee described manual visual inspection as the “last frontier” of old technology, which will be digitalized and automated in the future. Hence, the potential for image analysis development in the context of pharmaceuticals and laboratories is promising. (I-6.) The field of biotechnology in general was also mentioned to be a potential application area for image analysis (I-8). On the other hand, another interviewee saw that image analysis would have more future in production (e.g. machine vision solutions) than in the research of pharmaceuticals (I-3).

In the survey, 80 percent of the respondents were ‘satisfied’ or ‘very satisfied’ with the current quality of image analysis utilized in their organizations’ research. When asked, what value image analysis brought to the overall research activities, approximately 83 percent of the responses can be classified in the groups presented in table 5.5.

Table 5.5. *The value of image analysis to the research activities of pharmaceutical companies.*

	quantity
Complements other research tools or techniques	3
Quantification of various changes	3
Brings clarity into decision making / Provides confirming or convincing information	3
More objectivity in measurements	2
Certain research method is dependent on image analysis	2
Part of the service provided / Customers prefer over visual judgment	2

In terms of pharmaceutical research, as described above, preclinical studies were generally viewed to be much more potential an application area for image analysis compared to clinical studies (e.g. I-1, I-3, I-11); only one interviewee offered an opposite opinion. Potential, more specific applications that were mentioned by the interviewees include analysis of laboratory wells, immunohistochemical studies of histological sections, animal behavior studies, microarray analysis, tumor cell analysis, and nerve cell counting among others (I-11, I-6, I-10). For some of these applications solutions are being developed already. One interviewee concluded that image analysis would prove to be useful in morphological studies in general as visual inspection is the most important source of information in those studies. (I-11.)

5.5.4. Barriers to the adoption of image analysis

Certain concerns were raised about whether the volume of samples to be analyzed with image analysis would be big enough economically so that the investments on image analysis could be justified, especially in pharmaceutical companies where research projects can differ from each other considerably (I-3). This has also implications on a company providing image analysis services, as it might not be clear whether there is enough consistent demand in the market.

Another possible barrier to the adoption of image analysis is change resistance. Especially in laboratory operations, many analyses have always been conducted manually with the use of a microscope. Hence, in certain companies, the barrier to let a machine or software do the analysis instead of a human is of psychological kind (I-4). In addition, monetary issues can also form barriers. A few interviewees were afraid that image analysis solutions might be too expensive to be purchased. This is an issue especially in laboratories since when a system is replaced, for certain time there has to be two systems, the old and the new one, in place at the same time so that there is always a backup if the new system proves to be inappropriate. The temporary co-existence of two different systems raises costs and the question is whether a laboratory can afford it. (I-6, I-10.)

However, clearly the most frequently expressed concern related to image analysis is its capability to reliable and consistent analysis. These concerns stem from the fact that many biological samples differ from each other and certain elements in the samples are difficult to be recognized from each other. Generally, if there is a large variation from sample to sample, automated analysis might be difficult to create. In microbiology, for instance, certain cell culture dishes are sometimes blurry, hence making an automated analysis very challenging (I-6). Also, in hematology, one has to recognize highly similar structures from each other, e.g. lymphocytes from monocytes, which can be extremely difficult with image analysis (I-9). Moreover, e.g. in histological samples and cancer samples the quality and character of the samples can vary, thus setting a challenge for automated image analysis (I-11).

The profound problem seems to be that the input for image analysis may vary due to the fact that samples vary from each other and also the imaging environment might not be standardized (I-3, I-10). The inconsistency of the input can lead to inconsistency of the output, which, in the context of pharmaceutical industry and health care laboratories, is unacceptable. If the output is inconsistent then image analysis solutions could not be validated and they would not be implemented (I-8). Indeed, it seems that fully automated image analysis might not always be possible which needs to be taken into account in service concept development.

5.6. Image analysis needs

As described above, in many of the companies interviewed, visual inspection is viewed as an indispensable part of research (e.g. I-7, I-8). Consequently, image analysis, which essentially improves visual inspection, can be considered a promising area of expertise to be utilized in the organizations' research and operations. For example, 57 percent of the questionnaire respondents were ready to invest or recommend investing in external services that would improve the quality and/or efficiency of image analysis utilized by their organizations.

By far, in this report, pharmaceutical companies and health care laboratories have been discussed separately. However, in terms of image analysis, enough mutual needs exist so that generic discussion of image analysis needs is justified. In the following subchapters, first, the classification of image analysis related needs is presented. Lastly, the types of services needed by the organizations are discussed.

5.6.1. Classification of image analysis related needs

In this study, it was revealed that a considerable amount of needs in the organizations are closely related to image analysis even though they are not image analysis needs in their purest form. In general, it was observed in the study that many 'pure' image

analysis needs exist, although doubts were raised whether there is sufficient demand for a company offering image analysis services in the market.

However, it was noticed that the more the organizations already utilize image analysis in their operations the more their needs are related to further refining the information collected from the images, i.e. data analysis. Furthermore, the less the organizations utilize image analysis the more their needs are related to documenting their research and operations by images. In fact, it was observed that oftentimes it was difficult for interviewees to even consider image analysis needs if research operations were not documented in images.

Consequently, image analysis related needs can be classified into three highly inter-related groups, namely, documentation needs, image analysis needs, and data analysis needs. This classification is illustrated in figure 5.4. The different groups of needs are next discussed separately.

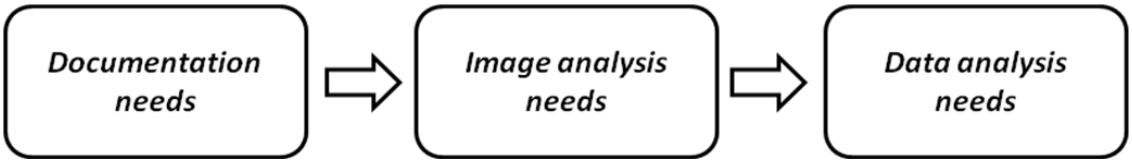


Figure 5.4. *Classification of image analysis needs in pharmaceutical companies and health care laboratories.*

Documentation needs

Several interviewees, especially among health care laboratories, identified a need for image documentation in their organizations' operations. If images would be taken routinely from samples, it would provide many benefits to companies' research. Perhaps the most important benefit from image documentation would be increased traceability. Image documentation would not only enhance quality control but also one would have the opportunity to reanalyze images in the cases of e.g. acquiring supplementary information or checking whether previous analysis was done correctly (I-4, I-6, I-8, I-11). Other benefits from image documentation include the possibility to send an image to a customer, a service provider, or a colleague instead of the actual sample (I-4, I-6, I-8). Moreover, image documentation was considered useful e.g. in orientation for new employees, in teaching purposes, and in creating demo material (I-4, I-6, I-9).

However, a few contradictory opinions on image documentation were also presented. While some saw archiving images as a useful tool for quality control, the others viewed it more as a burden (I-4, I-8). Also, not all viewed systematic routine documentation useful in research (I-9). In addition, one interviewee underlined that in order to start systematic image documentation one would have to be ascertained that reliable and

valid methods to analyze the images exist; otherwise archiving the images would be useless (I-11).

In summary, image documentation was viewed valuable to research activities by many interviewees. It should also be noted that, in general, the interviewees who underlined the value of image documentation were not the ones who had the most clearly articulated image analysis needs. Hence, established image documentation procedures can be seen as more or less a prerequisite for image analysis needs.

Image analysis needs

In general, image analysis is needed in companies for measurement and quantification of various parameters from images as was shown in table 5.3. In addition, based on the interviews and the survey, many needs for image analysis arise from the fact that current solutions, e.g. manual visual inspection, are subjective, laborious, and very time-consuming (I-8). In the survey, for example, the respondents described their organization's equipment and processes for image analysis to be e.g. outdated, clumsy, slow, unreliable, and prone to human error. Moreover, one interviewee pointed out that a clear benefit from image analysis is faster support for decision-making compared to visual inspection (I-10). Different screenings conducted in drug research and health care are a perfect example of activities in which humans have to invest considerable amounts of time to monotonous manual analyses (I-3, I-6).

Controversy exists as to whether image analysis solutions should provide exact measurements, e.g. how many cells there are in an image, or whether a division of samples into certain classes is adequate, e.g. small, medium, and big number of cells in an image. As was described in chapter 5.5. many of the current visual inspection tasks are based on dividing samples into certain classes. Indeed, some interviewees felt that it is perfectly enough if an image analysis solution can do the same classifications as are done currently in visual inspection, only e.g. faster, more automated, and objectively (I-3, I-6, I-8). However, other interviewees viewed that exact quantification of parameters in an image would bring more value to research compared to traditional division to classes (I-3). In fact, certain interviewees viewed exact quantification to be a necessity in research (I-7).

It was also revealed in the interviewees that in some cases where there are a myriad of samples to be analyzed, an automated pre-analysis would already provide considerable value. For instance, if one could analyze negative samples of anti-nuclear antibody tests automatically, it would account already for two-thirds of all the samples, which would save substantial amount of time and spare human resources to be allocated elsewhere. (I-3, I-8). However, this pre-analysis, too, would have to be extremely reliable in order

to be implemented which is the case with all image analysis in the context of drug research and health care laboratory operations.

Separate image analysis system related needs that were mentioned in the interviews include e.g. 3-D analysis of samples and machine learning software, which would learn from users' behavior to recognize certain domains in an image (I-6). A more general system related need is that the system has to be easy-to-use (e.g. I-2, I-11). It was indicated not to be enough if e.g. software has all the capabilities to analyze a sample if the actual analysis requires multiple inputs from a user in the form of fine-tuning settings and defining thresholds et cetera. In general, a user-friendly interface is needed in which one could ideally press only one button and all the relevant figures for further research would appear on the screen (I-11).

As a conclusion, as long as images are involved in research, image analysis can bring more value to research operations in several different ways. In terms of needs and benefits from image analysis, some view e.g. greater speed important while others value the fact that image analysis can enable certain analyses that are practically impossible to be conducted manually routinely.

Data analysis needs

Based on the interviews, it seemed that the companies whose operations utilized image analysis to a high extent were not as interested about enhancing their image analysis procedures as they were about refining great amounts of data collected from images through image analysis. In other words, when a myriad of images were analyzed already, the question became as to how to analyze the data collected in order to extract meaningful information from large data sets. These needs were also prevalent in clinical studies even though in those studies the data sets were not usually collected from images (I-5).

The articulated data analysis challenges related to decreasing data deviation; increasing objectivity, reliability, and speed of the analysis; and combining large data sets to form meaningful information, among others (I-5, I-7). One considerable need was to collect all the information from many different parameters measured with image analysis and to compile it into a package, which is not only easily transferable to the next research phases but also meaningful and useful for the next users. This would enable the companies to get more information to support decisions and make faster revision of certain research procedures possible. (I-7.)

In summary, the most relevant needs of the organizations in the three different classes of needs are presented in appendix 6 in the form of the means-end concept created by Herrmann et al. (2000). Appendix 6 draws input also from the earlier parts of the results

chapter, especially related to what the organizations value. It is shown in the appendix that the concrete attributes preferred by the company representatives are ultimately reflections of what is valued by the companies. For example, the concrete parameters such as images can be taken, analysis is faster, and meaningful data can be extracted actually reflect the ultimate values of high quality, fast product development, and company reliability. Moreover, the need for applications that are simple to use ultimately reflects the need for greater employee satisfaction.

5.6.2. Types of services needed by the organizations

Both in the questionnaire and the interviews the respondents were asked what kind of image analysis related services their organizations would be ready to invest in. Outsourcing was clearly the most preferred practice, especially among the pharmaceutical companies. For example, 33 percent of the answers in the questionnaire to an open question of "What are the biggest challenges that your organization faces in the area of image analysis?" can be grouped into finding a suitable subcontractor, service provider, or a collaborator. In addition, in the questionnaire, the most frequently chosen option to what kind of services the respondents would be interested in was outsourcing.

In the interviews, the preference for outsourcing was explained with the focus on organization's core competencies (I-8, I-11). There is a drastic difference in attitude toward outsourcing of image analysis between the organizations explored in this study and another potential customer segment, university research groups, to whom a questionnaire was sent earlier in the Imacom project. In that questionnaire the option for outsourcing was the least preferred option of different services.

Other image analysis services such as consulting and training were also preferred in the survey and a few interviews (e.g. I-4, I-5, I-7). In one of the laboratory interviews, it was stated that the preference is on buying a machine or software instead of any services (I-6). Considering laboratories it should be kept in mind that visual inspection and image analysis are tightly linked to the operations, hence outsourcing it might not be the most preferred solution in reality.

In this chapter, the organizations' business and operations were discussed thoroughly. At the end of the chapter, image analysis related needs were summarized and the companies' preferences toward different types of services were defined. Next, one can continue to developing a service concept and its respective resource structure to tackle the image analysis needs in pharmaceutical industry and health care laboratory operations.

6. CONCEPT DESIGN

In this chapter, service concept and its respective service resource structure are designed based on the results discussed above. Moreover, feedback from testing the service concept is addressed. In addition, commercial considerations of the service concept are shortly discussed.

6.1. Service concept design

This subchapter deals with the design of the service concept. First, different customer segments to which the service concept is designed are addressed. Second, service in the mind is designed to form the big picture of the intended service. This more or less an abstract discussion is followed by a more specific coverage of how customers' needs should be met and how value is created. However, the discussion of the service concept in this study does not include a detailed analysis of service operations, i.e. the responsibilities of employees and the sequence of tasks et cetera.

6.1.1. Customers

The starting point in offering services is to meet customer needs and expectations. However, it should be noted that meeting customers' preferences as precisely as possible might put the company at risk. A company should not aim for satisfying customers' demands too precisely if this cannot be achieved economically. (Johne & Storey 1998, p. 224.) Consequently, a service concept, too, should not be designed for too narrow a customer base, which could result in losing economies of scale. This is especially important for companies operating in small economies, such as Finland.

By designing a mutual service concept for more than one customer segment, one is not doomed to meet customer expectations poorly; instead, as was described in chapter 2.3.1., service concept makes possible that various derivatives of the same core service can be developed to different target segments (Goldstein et al. 2002, p. 131). Hence, when needed and economical, one can tailor the service concept-based service offering to meet specific needs of certain customer segments or customers.

Based on the results of this study, pharmaceutical industry and health care laboratories demonstrate fairly similar image analysis related needs. For both of the customer segments high quality and reliability is of utmost importance. Moreover, their operations have several application areas to which image analysis and fields closely

related to it can provide remarkable value. The customer segments, which the service concept is designed for are illustrated in figure 6.1.

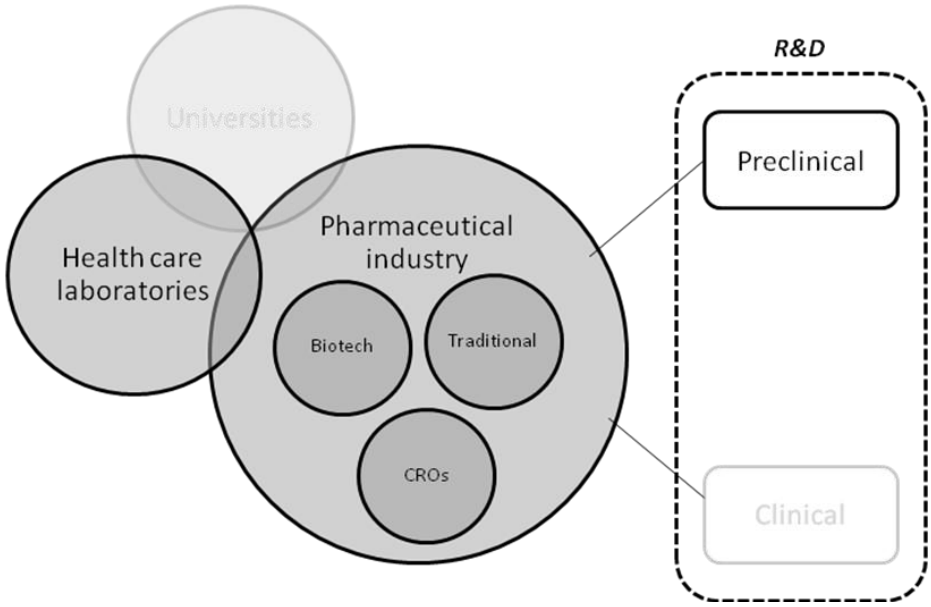


Figure 6.1. *Customer segments of the designed service concept.*

As can be seen from figure 6.1. the initially potential customer segment of universities is excluded since their image analysis needs vary too much from the needs of the other two segments. For example, due to differences between basic and applied research the volumes in universities are considerably lower. Moreover, as was described in the previous chapter, university research groups are generally interested in different type of services than the other two customer segments. In addition to leaving out universities as a customer segment, in terms of general application area, the focus is limited to preclinical studies of pharmaceutical companies. Clinical studies were observed to be significantly less promising an application area for new image analysis based services.

6.1.2. Service in the mind

As was discussed in the literature review, the service concept is, among other things, the mental picture that is held by customers, employees, and shareholders about the service in question (Clark et al. 2000). In order to form the big picture of the service to be provided, the service in the mind approach is appropriate. In this study, the aim of this approach is to provide a unified vision of the service to all stakeholders. The service itself is further elaborated in the next subchapter.

As was described in chapter 5.6. the needs of pharmaceutical companies and health care laboratories related to image analysis can be classified into documentation needs, image analysis needs, and data analysis needs. These three classes of needs form a continuum: if an organization does not utilize image documentation then there are not many image

analysis or data analysis related needs. Also, if an organization takes advantage of image documentation but does not utilize image analysis there are not many data analysis related needs. In fact, this observation appears to be a special type of innovation adoption pattern.

Rogers (1995), who is a renowned creator of diffusion of innovations theory, claimed that attributes affecting the diffusion of innovations include compatibility, complexity, and trialability among others. Compatibility refers to the degree to which the innovation is consistent with e.g. experiences of the potential adopters; complexity is related to how difficult it is for potential adopters to understand and utilize the innovation; and trialability refers to the possibility to try or experiment with the innovation. In the case of image analysis, all the three attributes disfavor the diffusion of image analysis in the organizations in which image documentation is not utilized: Potential adopters do not have too many experiences of image analysis; due to the lack of experience it is difficult to understand image analysis in the first place; and without image documentation it is quite difficult to experiment with image analysis to gain more experience and understanding.

It seems to be woefully inadequate to rely solely on pure image analysis services since these kinds of needs do not seem to exist in large scale, especially in Finland. However, pure image analysis needs combined with image analysis related needs, i.e. documentation needs and data analysis needs, together form a considerably bigger demand already. In fact, in harmony with the idea of a special type of innovation adoption pattern, fulfilling documentation needs of organizations itself could create more pure image analysis needs in the future. A similar scheme might be observed between image analysis and data analysis needs: fulfilling image analysis needs creates more data analysis needs in the future.

Tyre and von Hippel (1997), who have contributed to the research on innovation, for example, observed in the context of problem solving around new manufacturing equipment, that specific physical settings, including e.g. events, procedures, and technical systems, partly determine what actors can do, what their experiences are, and what they can learn. Analogously, in the case of image analysis, the presence of image documentation equipment can advance users' learning of image analysis and consequently promote the diffusion of image and data analysis technologies while simultaneously creating more demand for them.

Based on these observations, a promising service concept would take into account the whole continuum, or chain, of different image analysis related needs from documentation needs through image analysis needs to data analysis needs. By covering the whole chain of needs, the service concept could meet the expectations of pharmaceutical companies and health care laboratories more comprehensively.

Basically, this approach would not result in too narrow demand. In figure 6.2., Edvardsson's and Olsson's (1996) model of the service concept is exploited to illustrate the big picture of the service concept designed in this study.

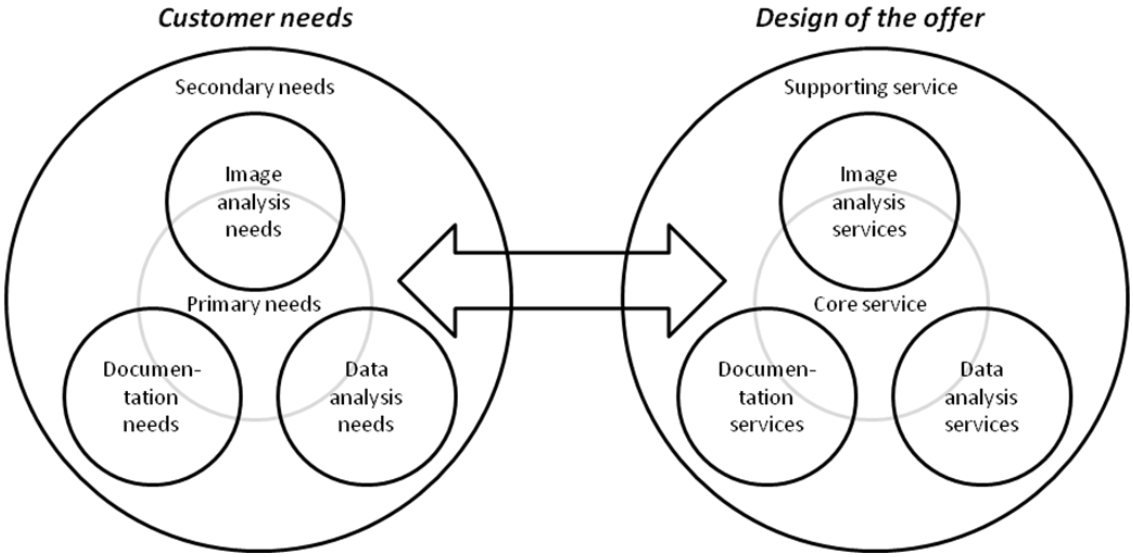


Figure 6.2. *General level scheme of the designed service concept.*

In figure 6.2. no distinction between primary needs and secondary needs, or core service and supporting service, is made. Instead, different classes of needs (services) are situated in both primary (core) and secondary needs (supporting services). This is to signify the fact that for some organizations e.g. documentation needs are primary while other needs are secondary. This calls for documentation services to be the core service. On the other hand, for other organizations image analysis needs could be primary, others being secondary, in which case the core service should consist of image analysis services instead of documentation services. Consequently, a distinction between primary and secondary needs, in this context, would be artificial and unnecessary.

In summary, the idea of the service concept is to provide services in the whole chain of activities from image documentation to image analysis and data analysis. Ideally, a customer organization would have needs related to all three classes of needs so that the service package would answer them all simultaneously. However, as was observed in the interviews, it may be that an organization, at specific time, would have only e.g. data analysis needs. In that case, the service concept would answer only those types of needs. In other words, the idea is to offer services for all the different classes of needs either as a package consisting of all the three service types or just one or two, depending entirely on the needs of the customers.

6.1.3. Concept value chain

Considering more specific content of the whole service concept at least two alternative approaches can be distinguished. In theory, both the alternatives could be used at the

same time but to maintain economy of scale it would be wiser to choose just one. Both the alternatives have the potential to meet customer expectations, and ultimately, the choice between the two should be based on e.g. what resources are available to provide the service and how big the commercial potential of the two alternatives is.

Alternative 1: Customized systems

In this alternative, the service characteristic of intangibility is not quite evident. The idea is to create customized solutions to tackle the needs for documentation, image analysis, and data analysis. Particular attention has to be paid to customized systems' flexibility to be modified later since, especially in pharmaceutical companies, research projects vary and thus the needs of the organizations change from time to time.

Essentially, in this alternative, customers do all the imaging and analyses themselves. The main function of the organization providing the service is to design and deliver a customized system, which makes it possible for the customers to conduct imaging and analyses effectively and reliably in their operations with their level of knowledge on image and data analysis. Naturally, the role of the service provider is not limited to only designing and delivering a system but also the service package has to include customers' constant access to support and maintenance so that reliable and fast research operations valued by the customers would be achieved.

In chapter 5.5.4. it was concluded that fully automated image analysis might not always be possible due to variations from sample to sample. This combined with reliability being very important for potential customers, one might be better off by offering customized solutions that do not move accountability from users to a system entirely. This could be done e.g. by requiring a user to approve the analyses conducted by the system by showing the user how the images had been analyzed (e.g. images showing which spots were counted as cells).

Based on the table of image analysis related needs in appendix 6, in addition to providing reliable results, the customized systems would have to make high quality analysis possible. The system developed would have to enable the customer organization to extract all the relevant information from images and large data sets in order to support decision-making. Moreover, in terms of both hardware and software of the system, they would have to be designed to allow straightforward use so that analyses could be conducted fast and employees would not get frustrated. Ideally, this would mean that one could receive the results needed with only one click. The first alternative of the more specific content of the service concept is illustrated in figure 6.3.

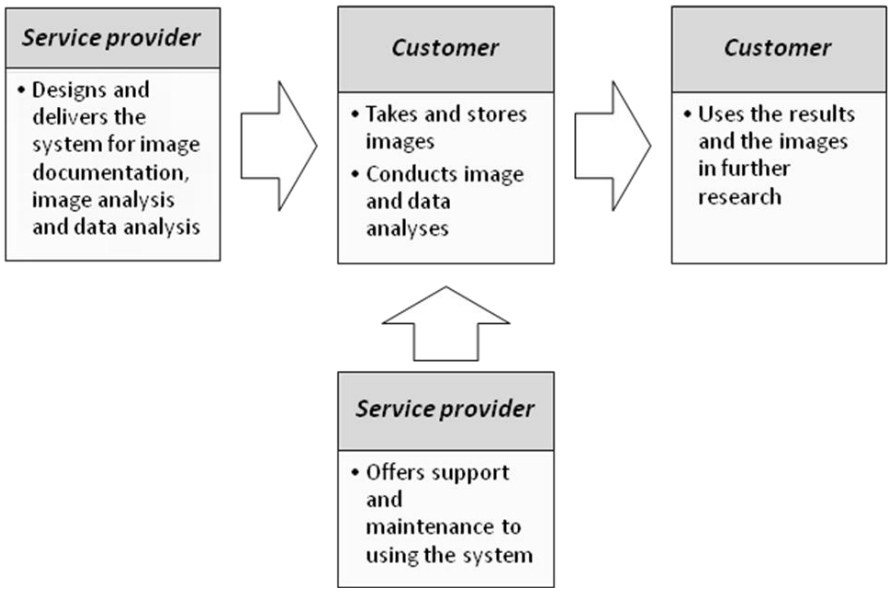


Figure 6.3. *Illustration of the specific content of the service concept, alternative 1.*

Next, the other alternative, which shares some commonalities with the first one, is addressed. A few aspects, related to both the first and the second alternative, are discussed at the end of the discussion of the second alternative.

Alternative 2: Analysis services

The second alternative is similar to the first alternative in terms of tackling documentation needs. The organization providing the service would design and deliver appropriate image documentation system that would allow the customer organizations to take and store images for further analysis routinely. The service provider would have to make sure that the system and imaging procedures are designed to minimize the variation of input for image and data analyses. This could be done by training customer employees to take the images in the right way and by standardizing the environmental conditions, e.g. illumination.

In theory, one could make possible for customer organizations to outsource the actual imaging. However, this would not necessarily be the optimal solution since many of the potential customer organizations already have proper microscope equipment, which is used to conduct manual analyses. What they actually need is microscope cameras connected to those microscopes to allow taking the images. In addition, the customers might need image database too. Hence, if imaging would be outsourced, customers' microscopes would become redundant. Moreover, the service provider would have to invest on both microscopes and cameras. In other words, this would not be the most cost-effective solution for neither of the parties.

The actual image and data analysis in this alternative would be conducted by the experts of the organization providing the service. Compared to the first alternative this practice would resemble more a traditional service, at least in its intangibility. In practice, the images taken by the customer organization would be allowed to be accessed by the employees of the service provider. After utilizing image and data analysis expertise in analyzing the images the service provider would deliver the results to the customer in the desirable form. It should be noted, however, that since fully automated analysis is most probably not possible for all the images, the service provider would have to possess substance expertise (e.g. in pathology), too, if the analyses are conducted entirely by service provider's employees. This will be addressed in designing appropriate service resource structure.

In this alternative, too, one would have to ensure that the aspects of high quality, reliability, and fast analysis would be realized and the final results would be meaningful to customers' employees so that they could make decisions based on them. However, this alternative does not require user approval nor "one-click analysis" in a similar way as the first alternative since the actual analysis is not done by customer employees. Nevertheless, the interface in taking the images and giving access to those images would have to be easily approachable since these actions would be done by customer employees. An illustration of the second alternative of the more specific content of the service concept is shown in figure 6.4.

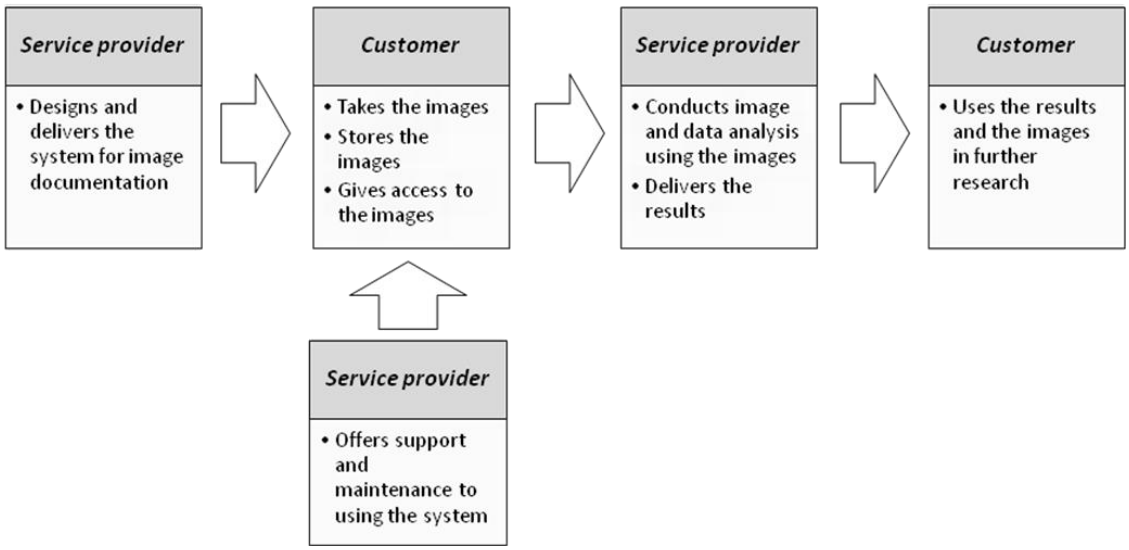


Figure 6.4. *Illustration of the specific content of the service concept, alternative 2.*

In harmony with the service in mind approach, both the alternatives could be broken down into smaller services if needed. For example, in the first alternative, only customized data analysis software could be provided if the customer would already have the equipment and skills for image documentation and image analysis. On the other

hand, in the second alternative, if a customer would already have microscope cameras in place then the service would consist of outsourced image and data analysis.

6.2. Testing the service concept

The service concept was tested to ensure that it meets the expectations of pharmaceutical companies and health care laboratories. In addition, the testing allowed the evaluation of the potential of the service concept to be utilized by commercial services in the future. This can be considered as a part of the external analysis of the idea for a new service (Edvardsson 1997, p. 40). Moreover, the testing gave a possibility for potential customers to compare two different alternatives of the service concept.

In concept testing, the general level scheme of the designed service concept (see figure 6.2.) was considered to be logical, solid, and feasible (I-13). Moreover, the division into three different classes of needs was seen to be appropriate and to capture the needs of the organizations interviewed (I-12). A few potential application areas for the service concept were also identified in the interviews (I-12, I-13). For potential customers the value of the service concept would come in the form of better analyses and a possibility to reanalyze images (I-12). Also, the services would ideally save time and money (I-13). The factors of reliability, validity, and privacy issues, on the other hand, were considered to be prerequisites for an appealing service (I-12, I-13). Both the interviewees viewed that demand for these kinds of services exists both nationally and internationally. However, it was said that the biggest needs are probably in more routine analyses in health care laboratories than in pharmaceutical companies (I-13).

In terms of the two alternatives, the first alternative, customized systems, was preferred over the other. The reason for this was that certain analyses and diagnosis require feedback from a substance expert (e.g. pathologist) who has to be able to control the analyses. However, when asked whether the second alternative, analyses services, would also be appealing, if the service provider would possess this substance expertise as well, both the interviewees agreed. Moreover, the second alternative was viewed to be better in more routine analysis tasks (I-12). Related to the first alternative, a trade-off was observed between the adequate customization level to meet the needs of different customers and the goal to provide a profitable service (I-13).

The biggest concerns in terms of the service concept, regardless the alternative, were the following: diversity of customer needs and technical executability of analysis. Customer needs were stated to be so diverse that it might prove very difficult to meet the different expectations of different customers. Not only the objects analyzed vary but also the accuracy in which the samples are wanted to be analyzed changes from customer to customer (I-12). Moreover, certain analyses, especially in drug discovery and

development, were said to require such a high level of interpretation and quantification that the applicability of automated image analysis was doubted (I-13).

Specific areas for development of the service concept were also revealed. First, the issues of operational reliability, continuity, and customer support should be addressed in more detail (I-12). In addition, the content of the three different types of services should be specified (I-12, I-13). Standardization and modularization of the content of the three service types were suggested in order to develop a commercially potential service (I-13).

6.3. Commercial considerations

This study was deliberately limited to the design of the service concept and service resource structure based on the needs of potential customers, not including an intense discussion of the commercial potential of the developed concept. However, since one of the goals of the Imacom project is ultimately to commercialize image analysis expertise of the CSB research group, a few aspects related to the commercial potential of the service concept are now discussed.

In implementing the service concept one would have to focus on the most common customer needs related to image analysis. In other words, when specifying the content of the three different types of services, one would have to pay attention to which customer expectations can be met profitably. The more the needs resemble each other (e.g. division of histological samples to different classes) the easier and more cost-effective it is for the service provider to develop proper solutions for them. Consequently, it is important to focus on the needs to which earlier solutions and practices could be reproduced. Among other things, this would allow the service concept to be commercially potential, too.

Another important aspect in terms of the commercial potential of the service concept is the level of internationalization of the service provider-to-be. Even though it might prove difficult to attract customers abroad without an established customer base in the home country, in a country as small as Finland, one would have to consider the possibility of a so-called born global company. As it was discovered through the interviews, major traditional pharmaceutical companies do not conduct pre-clinical research in Finland, which is, as observed, the most potential application area for image analysis in drug development. Thus, for the future service provider, global approach in obtaining customers is tentatively recommended.

In general, there is a natural tendency for organizational growth to follow the pattern of first expanding the market and then increasing the range of services, or first by service proliferation followed by market expansion (Johnston & Clark 2005, p. 59). In the case

of the Imacom project, based on the designed service concept, the range of services would first have to be increased to take into account image analysis related needs of documentation and data analysis. After that follows the market expansion with an international focus.

6.4. Final content of the service concept

As described above, the big picture of the service concept was proven appropriate. However, before continuing to the design of the service resource structure, one would have to make a decision on which alternative, customized systems or analysis services, to select since choosing both would be counterproductive and not economical.

The interviewees in service concept testing saw no difference between the two alternatives of the service concept as long as the service provider would possess substance expertise of the samples analyzed. However, as it was discussed also in service concept testing interviews, the high-level customization of analysis systems as a whole might take considerable amount of time and be very expensive, consequently leading to a service that is not economical for neither the customer nor the service provider. Moreover, the customized systems would have to be validated which further increases the costs.

On the other hand, at least for a start-up company, a more lean approach such as the second alternative, analysis services, would be more appropriate. Even though the second alternative, too, requires customization of analyses, it does not require severe modifications to actual systems, instead, fine-tuning of analysis algorithms would be sufficient in most cases. In addition, analysis services correspond better to the observed customer preference of outsourcing. Consequently, the recommended service concept for the CSB research group is offering customers a customized image documentation system combined with external image and data analysis services. Next, the service resource structure of this service concept is presented.

6.5. Service resource structure design

Based on the designed service concept, an ideal service resource structure can be developed. As described in chapter 2.3.4. service resource structure includes the resources allocated to the service process for realizing the service concept. Naturally, since the details of the service operations are not addressed in this study, the discussion of the ideal service concept is not comprehensive; instead, it is based on the level of discussion in designing the service concept.

At this point, it is worthwhile to underline the context in which the service concept and service resource structure are developed in this study. If the designed service concept is

utilized in the future, it is most probably done by a start-up company. Menor et al. (2002) pointed out that for new start-ups outsourcing is particularly beneficial in the context of new service development because they are not likely to possess competence in all of the various service features, not to mention the in-house resources to provide those features. Consequently, outsourcing is a potential practice to acquire specific resources needed for the service resource structure. The discussion of the resources is divided into intellectual, physical/technical, and organizational resources.

6.5.1. Intellectual resources

The designed service concept requires intellectual resources specific to different classes of needs. First, for meeting the needs related to documentation, the service provider would have to have knowledge on different microscope cameras and systems that can be used to store and transfer the images with ease. These skills are needed in order to enable the design and delivery of image documentation systems. Moreover, the service provider would have to possess expertise in how to take images from samples consistently and appropriately to make further image analysis possible. In addition to be used in the design phase of image documentation system, this expertise is relevant in training customer employees to take the images and offering support to using the system.

The image analysis experts in the CSB research group have considerable experience in using microscope cameras and in setting up conditions in which meaningful images for further analysis can be taken. However, if one would implement the designed service concept, this knowledge would have to be deepened in order to make high quality system design and professional support possible.

As described in chapter 3.2., image analysis expertise in the CSB research group is one of its key capabilities, and it is also crucial for the service concept that this expertise can be taken advantage of. However, this expertise might not be ready per se to be utilized in the service concept. Instead, one would have to develop image analysis expertise to meet the needs of commercial organizations since so far, as described in chapter 3.2., the majority of the reference organizations has consisted of universities and publicly owned research organizations. The collaboration projects with the reference organizations have probably not been as strict in terms of reliability and validity concerns as would pharmaceutical companies and health care organizations be.

Moreover, in terms of image analysis, if the analyses were conducted entirely by service provider's employees, the service provider would have to possess substance expertise related to the images analyzed in order to support image analysis expertise since fully automated analyses are not always possible to be conducted. This was viewed important also in the service concept testing. Depending on the images analyzed, this would mean

for example the help of a pathologist. However, once needed, this expertise could be outsourced.

CSB research group is familiar with data analysis as well. This expertise is required in the service concept to meet the needs related to data analysis. However, data analysis expertise would have to be strengthened so that the service concept could meet the demanding data analysis needs of the potential customers. The future service provider could acquire this expertise by hiring data analysis experts or outsourcing data analysis, for example. The option of outsourcing is discussed in further detail when addressing organizational resources.

In addition to afore described intellectual resources, if the service concept would be utilized by a for-profit start-up company, then the staff would also have to possess marketing and sales expertise. Indeed, many good ideas have not become widespread due to insufficient marketing and sales efforts of different companies.

6.5.2. Physical and technical resources

The issue of physical and technical resources supporting the service concept is interesting since in principle the company harnessing the service concept could be virtual. Similarly to many professional companies the service provider would not need many physical or technical resources due to the fact that core resources of the firm are of intellectual nature.

However, if the service provider would offer modest image documentation systems, too, such as plain microscope cameras, one would have to consider investing in warehouse space. Moreover, related to image documentation, one would have to establish seamless communication channels for user support and maintenance. Decisions would have to be made on whether to use e-mail, phones, faxes, instant messaging, or other methods to provide support.

In terms of both image and data analysis the main tools are computers and software that are needed to carry out analyses or develop new analysis methods. Hence, in order for the service concept to be realized, computers and software licenses would have to be invested in. Furthermore, a system for transferring the images and delivering the results would have to be established. The system would have to be reliable enough to be used in the context of drug development and health care laboratory studies. For example, data privacy would have to be guaranteed. The system could require e.g. purchasing of servers. In addition, the service provider would need premises in which employees would work.

6.5.3. Organizational resources

In the case of organizational resources, in general, attention would have to be paid on the reliability of the processes and the supply chain. The potential customers require extremely reliable products and services, thus the processes of the service operations would have to be accurately determined and the solutions offered would have to be validated. Based on the interviews, without the validation of solutions, there is not too big a chance to attract customers from pharmaceutical industry or health care laboratories.

If the service concept would be used by a for-profit company, then it would be wise to conduct division of different functions so that selected employees would focus on the actual execution of analysis services and designing image documentation systems while the others would concentrate on sales and marketing. Furthermore, in terms of image documentation, one would have to establish relationships with imaging equipment manufacturers so that their products could be sold bundled with other services of the service provider. Also, clear procedures would have to be established to allow reliable and swift maintenance.

Lastly, in terms of data analysis, if the service provider would choose to outsource data analysis services instead of hiring experts then one would need to establish a reliable partner relationship with a data analysis company. The collaboration between the two would have to be seamless. Also, the processes of the data analysis company would have to be validated. In figure 6.4. the final service resource structure of the designed service concept is presented. The items in parenthesis are optional and depend on the preferences of the service provider management.

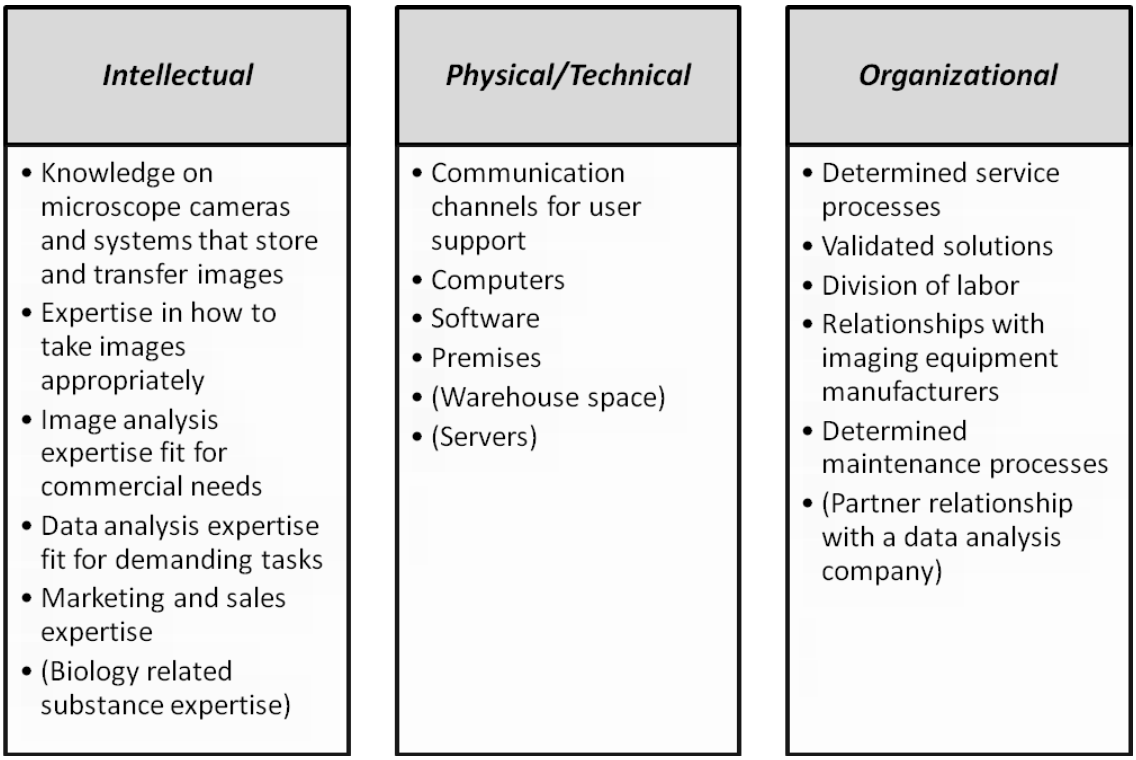


Figure 6.4. *The service resource structure of the designed service concept.*

At least the resources listed in figure 6.4. are needed in order to realize the designed service concept. Together the service concept and its respective service resource structure provide a fertile starting point for the commercialization of image analysis expertise of the CSB research group.

7. DISCUSSION

In this chapter, the research conducted is evaluated. After that, the limitations of the study are discussed. Lastly, suggestions for further theoretical research and practical implications for the CSB research group are presented.

7.1. Research evaluation

In this subchapter, the conducted study is evaluated. As described in the methodology chapter, this study is a constructive single case study, which, in order to be successful, should produce a solution to a real-world problem, demonstrate usability and theoretical connections of the solution, and examine the potential for generalizability of the solution (Kasanen et al. 1993, p. 261). These and other aspects are discussed in this subchapter. First, meeting the objectives of this study are addressed followed by a discussion about reliability and validity of the research. Lastly, contributions to service research in general are discussed.

7.1.1. Meeting the objectives

The need for this study arose from the Imacom project in which the CSB research group is aiming for utilizing its image analysis expertise in order to create a service oriented business model. Before this study took place, the expertise, competencies, and previous work of the researchers in the CSB group had already been analyzed alongside gathering tentative signals of potential image analysis needs by arranging meetings with selected university research groups and companies.

This study was to be built on the earlier work in the Imacom project and to answer the research question of "How should the CSB research group utilize its image analysis expertise in order to meet the needs of the potential customers via service". The main objective was to provide recommendations for the CSB research group as to how their image analysis expertise could be harnessed into a service. These recommendations were to be given through the analysis of what kind of concept for image analysis services should be created and what kind of service resource structure would support the designed service concept.

By conducting a survey and interviews with the original focus group of the study, pharmaceutical companies in Nordic countries, the needs of the potential customers were revealed alongside exploring how those needs should be tackled. In addition,

health care laboratories were also interviewed based on the recommendations received from the interviews with pharmaceutical companies. By thoroughly exploring the needs of potential customers, a service concept and its respective ideal resource structure were created which, at the same time, fulfilled the main objective of the study.

The designed service concept utilizes the image analysis expertise of the CSB research group to a high extent although it does not rely solely on pure image analysis needs which were observed to be scarce among the potential customers. Instead, the service concept aims to tackle the discovered continuum of needs from image documentation through image analysis to data analysis needs. These needs are to be met by offering the potential customers a customized image documentation system combined with external image and data analysis services.

The designed service concept, in order to be realized, requires specific elements from the service resource structure, such as relationships with imaging equipment manufacturers, data analysis expertise fit for demanding tasks, and image analysis expertise fit for commercial needs. The designed service concept and service resource structure also fulfill the ultimate needs of potential customers, which are high quality, reliability, and speed of research.

In summary, the practical objectives of the study were fulfilled precisely. Retrospectively, this study could have been more independent from the earlier work done in the Imacom project. For example, the study could have included interviews with the image analysis experts from the CSB research group to define more precisely their competencies related to image analysis and adjacent fields. This way the current capabilities of the CSB group could have been utilized better for example in designing the service resource structure. However, this study was specifically designed to continue from the earlier consultancy studies conducted in the Imacom project.

Furthermore, this study could have studied the commercial aspects of the future services more comprehensively since the ultimate goal of the Imacom project is to create a service oriented business model. Due to time and resource constraints of this study, however, deeper commercial analysis is assigned to further practical research addressed in chapter 7.4.

7.1.2. Study reliability and validity

Throughout the research process, the reliability and validity of the study were attempted to be ensured. First, all the aspects of the study were documented as precisely as possible to increase study reliability, e.g. the interviews were recorded and the structures of the survey and the interviews were documented (see the appendices). Furthermore, the survey was piloted in order to ensure its reliability. Also, the interview structure was evaluated by two experts affiliated with the study to ensure its

appropriateness to gather information from potential customers. The interviewees were selected to be familiar with the research of the respective organization but also to have knowledge on the organization and the field as a whole in order to receive as rich qualitative information as possible.

To increase the validity of the study the created service concept was tested by interviewing one representative of both the potential customer segments, pharmaceutical companies and health care laboratories. The feedback from service concept testing was taken into account in the final service concept and service resource structure to ensure greater validity of the solution. Also, through testing, the tentative usability of the solution was able to be demonstrated.

Specific reliability and validity related concerns were raised from the conducted survey. First, it is natural that the majority of the people who answered the survey were interested in image analysis. Still, it remained unclear whether the people not answering the survey did not have image analysis related needs at all or just simply were reluctant to answer the survey. In addition, in questions number 4, 5, and 13, examples of possible qualities were given alongside the questions to clarify the meaning of the word "quality". However, the majority of the answers to these questions consisted of the qualities given as examples. This raises a question whether the respondents truly pondered about different qualities or just replicated the given examples.

The reliability and validity of the study could have been increased, for example, by randomly selecting the organizations to be interviewed from the focus group instead of convenience-based selection. Moreover, service concept testing could have been more comprehensive and the people interviewed in concept testing should have been the ones responsible for the financial results of their business units as was suggested by Kasanen et al. (1993, p. 253).

In general, however, reliability and validity of the study are estimated to be at good level. Still, the solution provided is reliable and valid only in the specific context of the study. In fact, it may be claimed that in case studies the aim is not to generalize at all (Kasanen et al. 1993, p. 255). Nevertheless, the general contributions of the study are discussed next.

7.1.3. Contributions to service research

In the literature review of this study, earlier research on services was discussed. First, service literature in general was addressed including the research on service characteristics and various service typologies. Next, the aspects of new service development were discussed. Particular attention was paid on the development of various models for NSD. Lastly, the literature review went deep into discussion about various elements of service concept. The use and importance of the service concept

were discussed alongside its distinct models. Also, relevant issues for the service concept, understanding customer value and service resource structure, were addressed.

It was concluded that many researchers, including but not limited to Edvardsson et al. (1995), Menor et al. (2002), and Johnson et al. (2000), view the development of the service concept as the most essential element of new service development. Nevertheless, service concept has not been studied nearly as extensively as new service development in general. In fact, Goldstein et al. (2002) consider service concept to be "the missing link in service design research". Indeed, the research on service concept, in general, has remained mostly at a conceptual level. For example, as was described in the literature review, various models for NSD have been created and empirically tested (e.g. Scheuing & Johnson 1989; De Jong et al. 2003), whereas no significant research nor empirical studies related to service concept development exist, despite the fact that service concept is thought to be a crucial part of NSD.

This study, however, brought new insight to the actual development of a service concept including e.g. customer value exploration and developing service offering based on the needs of potential customers. By utilizing a single case method, this study empirically elaborated the creation of a service concept and its respective service resource structure. Also, in this study, a framework was developed to systematically analyze the data from the survey and interviews.

By analyzing business environment, customers, and industry characteristics one was able to explore the nature of potential customers' businesses. After gaining understanding on the businesses one could better analyze procurement practices, research operations, future, and areas for development of the companies in question. Increased knowledge on these aspects gave a possibility to analyze the actual application areas for image analysis, which ultimately led to increased understanding of the potential customers' image analysis needs. This framework might prove to be useful in other studies in the future too, regardless the context, in which thorough analysis of customer needs is required.

In addition, this study broke away from the tradition of examining NSD of e.g. existing firms, product based companies, and financial services. Differing from earlier research, this study took the perspective of pre-commercial professional B2B services relying heavily on technological expertise, i.e. image analysis. This study also brought forth new topics for further research, which are discussed in chapter 7.3.

7.2. Limitations

This study has certain limitations, which are now discussed. Probably the biggest limitation is that the study focuses on service concept development for a very specific

professional service. Hence, the routines utilized in designing the service concept in this study might not be applied, at least not without modifications, to service concept development for other types of professional services, not to mention e.g. mass services.

Another significant limitation of the study is related to the subjectivity of the researcher. Even though the study was attempted to be carried out as objectively as possible, one cannot avoid subjectivity completely for example in conducting interviews and analyzing the data collected from the survey and the interviews, especially when the analysis is done qualitatively. Still, objective approach was reinforced both in collecting data, e.g. by using the same wording of questions in different interviews, and in analyzing data, e.g. by consulting experts.

Also, the geographical and industry related decisions that were made in focusing the study may limit the generalizability of the designed service concept and of the process used in designing the service concept. Focusing solely on Nordic countries does not take into account their distinct characteristics in drug development. For instance, the level of public health care in Nordic countries, which affects drug research among other things, is more or less unique compared to many other countries in the world.

7.3. Further theoretical research

A few potential topics for further research were identified during the research process. As it was mentioned above, not much empirical research on developing a service concept exists. In particular, there is no discussion about "best practices" of service concept development in service literature. Meanwhile, several NSD models are being empirically tested and validated. This study provided one of the first attempts to empirically elaborate the process of developing a service concept but much more empirical studies are needed in order for service concept to be as useful a construct in practice as it is claimed in the NSD literature.

In addition to defining the best practices of service concept development, more insight should be brought into the question as to whether the creation of a service concept is adequate for NSD. At least in this study, it was observed that the mere development of the service concept does not enable the commercialization of the service. More effort is needed before commercialization. In the next subchapter, this issue is touched on.

Furthermore, in terms of exploring customer value, more development of service related tools for customer value exploration is needed to take into account the distinct characteristics of services. Oftentimes, for example, the value for the customer in services is created in a different way compared to products. Still, the majority of the models for understanding customer value have been developed with products in mind. It

should be studied whether these models per se are applicable to services or whether they should be revised.

7.4. Practical implications for CSB research group

This study provided the Imacom project and the CSB research group recommendations for a service concept and its respective service resource structure. They were designed based on earlier consultancy studies and extensive research on the needs and values of potential customers and their operations. Together the service concept and the resource structure provide a way for the CSB research group to harness their image analysis expertise into a service. However, more work has to be done before the service concept could be implemented. For the CSB research group it would be worthwhile to consider whether further development would be conducted in the form of a research project or through assembling a team which would change the perspective from a university research project to that of a start-up company.

Further areas for development include the details of service operations and extensive commercial analysis of the service concept. Both the areas could be developed more or less simultaneously. In case of service operations, they should be determined with more detailed specifications before the actual implementation of the service concept. This might include the use of specific service design techniques such as service blueprinting. Moreover, the content of the three different types of services should be specified and designed to be commercially potential. Standardization and modularization of the content are also highly recommended. The issues of operational reliability, continuity of the service, and data privacy should be taken into account, as well. It should be noted, however, that much of the final configuration of service operations depend on the resources that can be utilized in the service resource structure.

In terms of commercial analysis of the service concept, at least two distinct research subjects can be identified. First, the commercial potential of the service concept needs to be tested more thoroughly. In this study, the so-called weak market test was conducted but more analysis is needed. In general, prior to market introduction, test marketing is widely advocated (Johne & Storey 1998, p. 208). In practice, this would mean marketing the service, which is based on the designed service concept, to potential customers; not just asking whether they like the service concept or not but also persuading them to determine whether they would purchase the service and when they would purchase it. As was described above in chapter 6 it is tentatively recommended to obtain customers from abroad as well. Consequently, test marketing should have international focus, too.

Once implemented, the service concept would have to go through additional tests analyzing its commercial potential. Kasanen et al. (1993) talk about semi-strong market

test and strong market test which follow the weak market test. In semi-strong market test, it should be studied whether the service has become widely adopted by companies. In strong market test, in turn, it is studied whether the units applying the service systematically produce better results than those that are not using the service. Both the tests require statistical analysis and considerable amount of implementation data. Hence, these tests would have to be conducted while the service is already implemented. (Kasanen et al. 1993.)

The second and more urgent research subject, at least compared to semi-strong and strong market tests, is the revenue mechanism of the future service. In product-based companies, the revenue mechanism is often based on unit sales whereas the revenue mechanisms of service-based companies vary from e.g. hourly-billed activities to profit sharing regimes (Kindström 2010). The revenue mechanism of the service concept would have to be carefully designed to both enable a profitable service and be appealing to customers. Figure 7.1. summarizes a roadmap for CSB research group for the following 18 months.

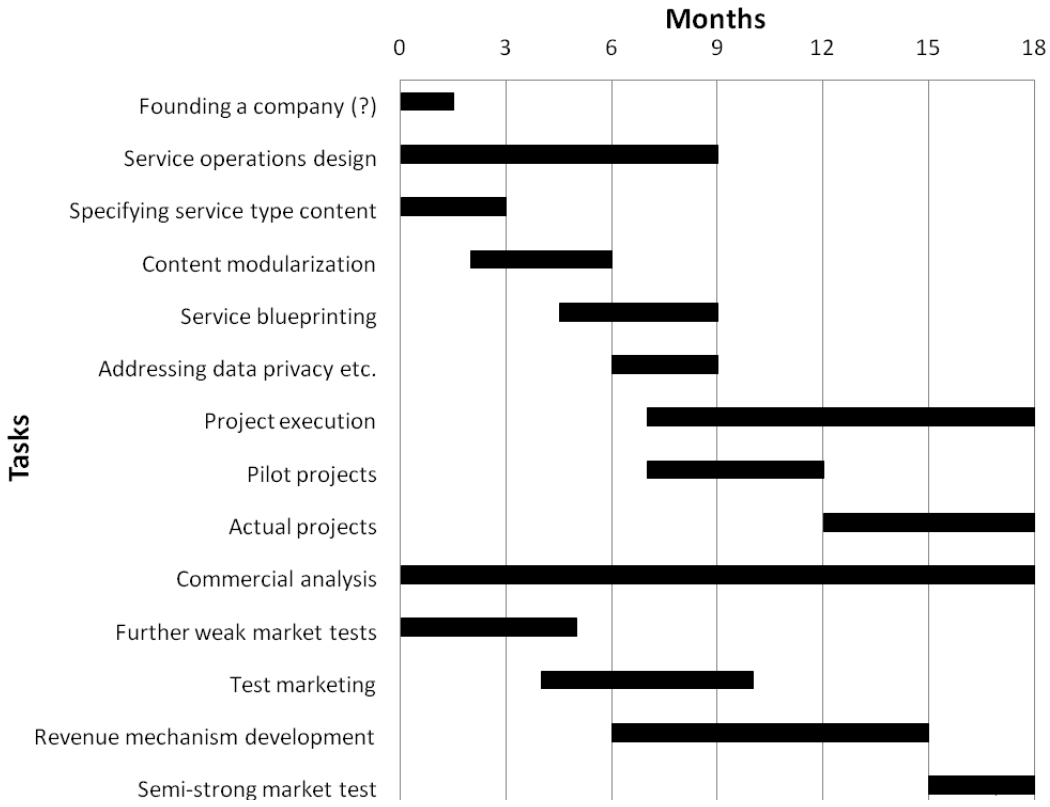


Figure 7.1. *18 month roadmap for CSB research group.*

In addition to broad tasks of designing service operations and conducting commercial analyses figure 7.1. brings forth the need for carrying out pilot projects as soon as the service operations are, for the most part, designed. Conducting projects increases the knowledge on customers' needs and of the actual services.

8. CONCLUSIONS

The Imacom project, for which this study was conducted, investigates the possibility of the CSB research group to utilize its image analysis expertise in order to create a service oriented business model. This study contributed to the Imacom project by designing a concept for image analysis services and its respective resource structure by which the CSB group could harness their image analysis expertise into a service. However, further work is needed to evaluate the commercial aspects of the designed service concept.

Through literature review, it was discovered that no prior research on service concept development exists, even though the importance of service concept for new service development is stressed in research literature. Consequently, the service concept created in this study was designed ad hoc. Needs and values of potential customers in and in contact with the pharmaceutical industry were examined.

The needs of potential customers were divided into three distinct but highly interrelated classes: documentation, image analysis, and data analysis needs. Moreover, the ultimate needs of potential customers were discovered to be high quality, reliability, and speed of research. To fulfill these needs a service concept was developed whose customer segments were defined to include preclinical side of pharmaceutical industry and health care laboratories. First, the big picture of the service concept was created. After that, two alternatives for the more specific content of the service concept were developed.

Through concept testing and further evaluation, only one alternative for a service concept was chosen to be recommended: offering customers a customized image documentation system combined with external image and data analysis services. The commercial potential of the chosen service concept was tentatively evaluated and the respective service resource structure was designed. The resource structure included elements such as relationships with imaging equipment manufacturers, data analysis expertise fit for demanding tasks, and image analysis expertise fit for commercial needs.

Alongside meeting its objective of providing recommendations for the CSB research group as to how their image analysis expertise could be harnessed into a service, this study empirically elaborated the creation of a service concept and its respective resource structure including e.g. customer value exploration and designing service offering based on the needs of potential customers. Still, more research is needed to develop best practices for service concept development.

REFERENCES

Barney, J. 1991. Firm resources and sustained competitive advantage. Journal of Management, vol. 17, no. 1, pp. 99-120.

Booz, Allen & Hamilton. 1968. Management of New Products. Booz, Allen & Hamilton, Inc., New York.

Booz, Allen & Hamilton. 1982. New Products Management for the 1980s. Booz, Allen & Hamilton, Inc., New York.

Bowers, M. 1986. New Product Development in Service Industries. Texas A & M University, College Station.

Brax, S.A. 2007. Palvelut ja tuottavuus. Tekes, Helsinki.

Bureau of Labor Statistics 2006. Industry Employment, United States Department of Labor.

Carpenter, A.E., Jones, T.R., Lamprecht, M.R., Clarke, C., Kang, I.H., Friman, O., Guertin, D.A., Chang, J.H., Lindquist, R.A., Moffat, J., Golland, P. & Sabatini, D.M. 2006. CellProfiler: image analysis software for identifying and quantifying cell phenotypes. Genome Biology, vol. 7, no. 10.

Clark, G., Johnston, R. & Shulver, M. 2000. Exploiting the Service Concept for Service Design and Development. In New Service Development: Creating Memorable Experiences, eds. J.A. Fitzsimmons & M.J. Fitzsimmons, Sage Publications, pp. 71-91.

Cowell, D.W. (ed) 1984. The Marketing of Services. William Heinemann Ltd, London.

de Brentani, U. 2001. Innovative versus incremental new business services: Different keys for achieving success. Journal of Product Innovation Management, vol. 18, no. 3, pp. 169-187.

de Brentani, U. & Ragot, E. 1996. Developing new business-to-business professional services: What factors impact performance?. Industrial Marketing Management, vol. 25, no. 6, pp. 517-530.

De Jong, J.P.J., Bruins, A., Dolfsma, W. & Meijaard, J. 2003. Innovation in service firms explored: what, how and why. EIM Business Policy Research, Strategic Study B. 73 p.

De Jong, J.P.J. & Vermeulen, P.A.M. 2003. Organizing successful new service development: a literature review. Management Decision, vol. 41, no. 9, pp. 844-858.

Demant, C., Streicher-Abel, B. & Waszkewitz, P. 1999. Industrial Image Processing - Visual Quality Control in Manufacturing. Springer-Verlag Berlin Heidelberg, Germany. 353 p.

Den Hertog, P. 2000. Knowledge-intensive business services as co-producers of innovation. International Journal of Innovation Management, vol. 4, no. 4, pp. 491-528.

Donnelly, J.H.J., Berry, L.L. & Thompson, T.W. 1985. Marketing Financial Services. Dow Jones-Irwin, Homewood. 268 p.

Doole, I., Lancaster, P. & Lowe, R. 2004. Understanding and managing customers. Financial Times Prentice Hall. 340 p.

Dougherty, G. 2009. Digital Image Processing for Medical Applications. Cambridge University Press. 447 p.
Drew, S.A.W. 1995. Accelerating innovation in financial services. Long Range Planning, vol. 28, no. 4, 1 p.
Edvardsson, B., Haglund, L. & Mattsson, J. 1995. Analysis, planning, improvisation and control in the development of new services. International Journal of Service Industry Management, vol. 6, no. 2, pp. 24-35.
Edvardsson, B. & Olsson, J. 1996. Key concepts for new service development. The Service Industries Journal, vol. 16, no. 2, pp. 140-164.
Edvardsson, B. 1997. Quality in new service development: Key concepts and a frame of reference. International Journal of Production Economics, vol.52, no.1-2, pp. 31-46.
Eggert, U.S. & Mitchison, T.J. 2006. Small molecule screening by imaging. Current Opinion in Chemical Biology, vol. 10, no. 3, pp. 232-237.
Fitzsimmons, J.A. & Fitzsimmons, M.J. 2008. Service Management: Operations, Strategy, Information Technology. 6th edn, McGrawHill, Boston. 537 p.
Froehle, C.M. & Roth, A.V. 2007. A Resource‐Process Framework of New Service Development. Production and Operations Management, vol. 16, no. 2, pp. 169-188.
Froehle, C.M., Roth, A.V., Chase, R.B. & Voss, C.A. 2000. Antecedents of new service development effectiveness. Journal of Service Research, vol. 3, no. 1, pp. 3-17.
Gebauer, H., Fleisch, E. & Friedli, T. 2005. Overcoming the Service Paradox in Manufacturing Companies. European Management Journal, vol.23, no.1, pp. 14-26.
Goldstein, S.M., Johnston, R., Duffy, J. & Rao, J. 2002. The service concept: the missing link in service design research?. Journal of Operations Management, vol. 20, no. 2, pp. 121-134.
Gonzalez, R.C. & Woods, R.E. 2008. Digital Image Processing. 3rd edn, Pearson/Prentice Hall. 954 p.
Griffin, A. & Hauser, J.R. 1993. The voice of the customer. Marketing Science, vol. 12, no. 1, pp. 1-27.
Grönroos, C. (ed) 1998. Nyt kilpaillaan palveluilla. WSOY, Porvoo. 360 p.
Herrmann, A., Huber, F. & Braunstein, C. 2000. Market-driven product and service design: Bridging the gap between customer needs, quality management, and customer satisfaction. International Journal of Production Economics, vol. 66, no. 1, pp. 77-96.
Imacom project 2011. Imacom Makes Solutions to Get Information from Images Faster and More Efficiently. Booklet.
Johne, A. & Davies, R. 2000. Innovation in medium-sized insurance companies: how marketing adds value. International Journal of Bank Marketing, vol. 18, no. 1, pp. 6-14.
Johne, A. & Storey, C. 1998. New Service Development: A review of the literature and annotated bibliography. European Journal of Marketing, vol. 32, no. 3, pp. 184-251.
Johnson, E.M., Scheuing, E.E. & Gaida, K.A. 1986. Profitable Service Marketing. Dow Jones-Irwin, Homewood. 303 p.
Johnson, S.P., Menor, L.J., Roth, A.V. & Chase, R.B. 2000. A Critical Evaluation of the New Service Development Process. In New Service Development: Creating Memorable Experiences, eds. J.A. Fitzsimmons & M.J. Fitzsimmons, Sage Publications, pp. 1-32.
Johnston, R. & Clark, G. 2005. Service operations management: improving service delivery. Financial Times Prentice Hall. 516 p.

Kasanen, E., Lukka, K. & Siitonen, A. 1993. The Constructive Approach in Management Accounting Research. Journal of Management Accounting Research, vol. 5, pp. 243-264.

Kelly, D. & Storey, C. 2000. New service development: initiation strategies. International Journal of Service Industry Management, vol. 11, no. 1, pp. 45-63.

Kim, W.C. & Mauborgne, R. 2005. Blue Ocean Strategy: How to Create Uncontested Market Space and Make Competition Irrelevant. Harvard Business School Press.

Kindström, D. 2010. Towards a service-based business model – Key aspects for future competitive advantage. European Management Journal, vol. 28, no. 6, pp. 479-490.

Lievens, A., Moenaert, R.K. & Jegers, R.S. 1999. Linking communication to innovation success in the financial services industry: a case study analysis. International Journal of Service Industry Management, vol. 10, no. 1, pp. 23-48.

Lovelock, C.H. 1992a. A Basic Toolkit for Service Managers. In Managing Services. Marketing, Operations, and Human Resources. Ed. C.H. Lovelock, 2nd edn, Prentice-Hall, Inc., New Jersey.

Lovelock, C.H. 1992b. Classifying Services to Gain Strategic Marketing Insights. In Managing Services. Marketing, Operations, and Human Resources. Ed. C.H. Lovelock, 2nd edn, Prentice-Hall, Inc., New Jersey.

Løwendahl, B. 2005. Strategic Management of Professional Service Firms. Copenhagen Business School Press.

Løwendahl, B.R., Revang, Ø. & Fosstenløkken, S.M. 2001. Knowledge and value creation in professional service firms: A framework for analysis. Human Relations, vol. 54, no. 7, pp. 911-931.

Martin Jr, C.R. & Horne, D.A. 1995. Level of success inputs for service innovations in the same firm. International Journal of Service Industry Management, vol. 6, no. 4, pp. 40-56.

Mathieu, V. 2001a. Product services: from a service supporting the product to a service supporting the client. Journal of Business & Industrial Marketing, vol. 16, no. 1, pp. 39-61.

Mathieu, V. 2001b. Service strategies within the manufacturing sector: benefits, costs and partnership. International Journal of Service Industry Management, vol. 12, no. 5, pp. 451-475.

Menor, L.J., Tatikonda, M.V. & Sampson, S.E. 2002. New service development: areas for exploitation and exploration. Journal of Operations Management, vol. 20, no. 2, pp. 135-157.

Miles, I., Kastrinos, N., Flanagan, K., Bilderbeek, R., Den Hertog, P., Huntink, W. & Bouman, M. 1995. Knowledge-intensive business services. EIMS publication.

Muller, E. & Doloreux, D. 2007. The key dimensions of knowledge-intensive business services (KIBS) analysis: a decade of evolution. Working Papers "Firms and Region", vol. U1.

Nachum, L. 1999. Measurement of productivity of professional services: An illustration on Swedish management consulting firms. International Journal of Operations & Production Management, vol. 19, no. 9, pp. 922-950.

Nählinder, J. 2005. Innovation and employment in services: the case of knowledge intensive business services in Sweden. Department of Technology and Social Change, Linköping University.

Nesta, L., Patel, P. & Arundel, A. 2003. 2002 European Innovation Scoreboard: Biotechnology Innovation Scoreboard. European Comission.

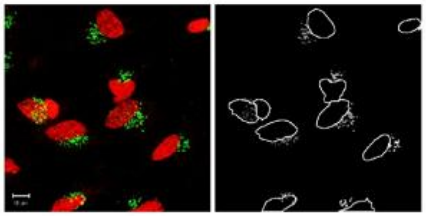
Niemistö, A., Ruusuvuori, P. & Yli-Harja, O. 2010. Commercialization of an image analysis algorithm bank through a service-oriented business model. Research plan.

Nijhof, A., Krabbendam, K. & Looise, J.C. 2002. Innovation through exemptions: building upon the existing creativity of employees. Technovation, vol. 22, no. 11, pp. 675-683.
Pasanen, O. 2010. Imacom-kaupallistamishankkeen loppuraportti (helmi-kesäkuu 2010). PLANUM Partners.
Robinson, A.G. & Stern, S. 1998. Corporate creativity: how innovation and improvement actually happen. Berrett-Koehler Publishers.
Rogers, E.M. 1995. Diffusion of Innovations. Free Press. 519 p.
Russ, J.C. 2011. The Image Processing Handbook. Taylor & Francis.
Scheuing, E.E. & Johnson, E.M. 1989. A proposed model for new service development. Journal of Services Marketing, vol. 3, no. 2, pp. 25-34.
Schmenner, R.W. 1992. How Can Service Businesses Survive and Prosper. In Managing Services. Marketing, Operations, and Human Resources. Ed. C.H. Lovelock, 2nd edn, Prentice-Hall, Inc., New Jersey.
Selinummi, J. 2011. Articles using CellC [online]. Available: http://sites.google.com/site/cellcsoftware/articles-using-cellc. Cited: 12.6.2011.
Selinummi, J., Seppälä, J., Yli-Harja, O. & Puhakka, J.A. 2005. Software for quantification of labeled bacteria from digital microscope images by automated image analysis. Biotechniques, vol. 39, no. 6, pp. 859-863.
Silvestro, R., Fitzgerald, L., Johnston, R. & Voss, C. 1992. Towards a classification of service processes. International Journal of Service Industry Management, vol. 3, no. 3, pp. 62-75.
Sonka, M., Hlavac, V. & Boyle, R. 1999. Image Processing, Analysis, and Machine Vision. 2nd edn, Brooks/Cole Publishing Company, USA.
Strauss, A. & Corbin, J. 1990. Basics of qualitative research grounded theory procedures and techniques. Sage, Newbury Park.
Sundbo, J. 1997. Management of innovation in services. The Service Industries Journal, vol. 17, no. 3, pp. 432-455.
Tekes 2011. SERVE - Palveluliiketoiminnan edelläkävijöille 2006-2013. Tekes.
Tekes 2010. Vocabulary of Service Business.
Tien, J.M. & Berg, D. 2006. On services research and education. Journal of Systems Science and Systems Engineering, vol. 15, no. 3, pp. 257-283.
Tyre, M.J. & von Hippel, E. 1997. The Situated Nature of Adaptive Learning in Organizations. Organization Science, vol. 8, no. 1, pp. 71-83.
Verma, R. 2000. An empirical analysis of management challenges in service factories, service shops, mass services and professional services. International Journal of Service Industry Management, vol. 11, no. 1, pp. 8-25.
Wemmerlöv, U. 1990. A taxonomy for service processes and its implications for system design. International Journal of Service Industry Management, vol.1, no. 3, pp. 20-40.
Wikipedia 2011a. Image Analysis [online]. Available: http://en.wikipedia.org/wiki/Image_analysis. Cited: 24.5.2011.
Wikipedia 2011b. Service economy. Available: http://en.wikipedia.org/wiki/Service_economy. Cited: 24.5.2011.
Wölfl, A. 2005. The Service Economy in OECD Countries. Organisation for Economic Co-operation and Development.
Woodruff, R. 1997. Customer value: The next source for competitive advantage. Journal of the Academy of Marketing Science, vol. 25, no. 2, pp. 139-153.
Zeithaml, V.A., Parasuraman, A. & Berry, L.L. 1990. Delivering quality service: balancing customer perceptions and expectations. Free Press.

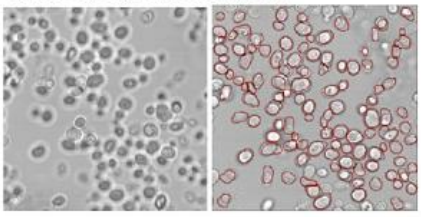
Image analysis questionnaire

The purpose of the questionnaire is to explore the use and needs of image analysis in drug discovery/development and CRO companies. The information you provide will be treated in the strictest confidence. Your answers will not and cannot be traced back to you. Your answers are important!

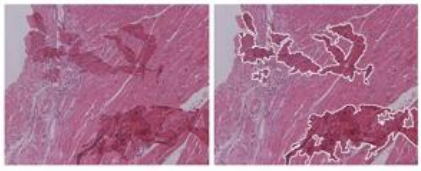
In the images below you can see examples of image analysis conducted by the researchers of Tampere University of Technology. In this survey 'image analysis' can refer to acquisition, processing, analysis and/or data quantification of images.



Detection and dispersion analysis of subcellular structures (Golgi apparatus, in green)



Yeast cell detection in bright field microscopy



Detection of folded tissue section regions

1. Which of the following fields best describes your organization?

- [ ] Clinical services
- [ ] Contract research
- [ ] Drug discovery and development
- [ ] Medical biotechnology
- [ ] Preclinical services

Other (please specify):

2. In which country is your work located?

- ○ Denmark
- ○ Finland
- ○ Norway
- ○ Sweden

Other (please specify):

3. How many employees are involved in research activities in your organization in the country you are working in?

- ○ 0-9
- ○ 10-19
- ○ 20-49
- ○ 50-99
- ○ 100 or more

4. Name three qualities best describing your organization's business (e.g. customer centric, flexible, research driven, etc.).

5. Name three qualities best describing your organization's R&D (e.g. fast, reliable, expensive, etc.).

6. What type of imaging hardware is your organization using in the country you are working in?

- [ ] Confocal microscope
- [ ] Electron microscope
- [ ] Fluorescence microscope
- [ ] MRI scanner
- [ ] PET scanner
- [ ] Visible light microscope
- [ ] None
- [ ] I don't know.

Other (please specify):

7. What type of image analysis software is your organization using in the country you are working in?

- ☐ Commercial analysis software bundled with imaging system
- ☐ Imaging system independent commercial analysis software
- ☐ Non-commercial analysis software
- ☐ No software used in image analysis
- ☐ I don't know.

Other (please specify):

8. Estimate the time used for image analysis in your organization in the country you are working in (man-hours per average week).

- ○ 0-10 hours
- ○ 10-20 hours
- ○ 30-40 hours
- ○ 40-50 hours
- ○ 50-60 hours
- ○ 60 hours or more

9. On a scale from 1 to 4, how necessary is image analysis in your organization's research?

○ 1 (Very Unnecessary) ○ 2 (Unnecessary) ○ 3 (Necessary) ○ 4 (Very Necessary)

10. Why is image analysis necessary/unnecessary in your organization's research?

11. On a scale from 1 to 4, how satisfied are you with the current quality of image analysis utilized in your organization's research?

○ 1 (Very Dissatisfied) ○ 2 (Dissatisfied) ○ 3 (Satisfied) ○ 4 (Very Satisfied)

12. If you answered anything else but "very satisfied" to the question number 11, what are the reasons for your answer?

13. What are the three most important qualities in image analysis in your organization (e.g. speed, objectivity, flexibility, etc.)?

14. What value, if any, does image analysis bring to the overall research activities/pipeline of your organization?

15. What are the most important things that you could use image analysis for in your organization's research?

16. What are the biggest challenges that your organization faces in the area of image analysis?

17. Would you be ready to invest or recommend investing in external services that would improve the quality and/or efficiency of image analysis utilized by your organization?

- ○ Yes
- ○ No

Other (please specify):

18. If you answered "Yes" to the question number 17, what kinds of services would you find most useful?

- ☐ Consulting
- ☐ Customized software development
- ☐ Customized hardware development
- ☐ Insourcing (fixed-term employee from the service company)
- ☐ Outsourcing
- ☐ Training

Other (please specify):

19. If you answered "No" to the question number 17, what are the main reasons for your answer?

- ☐ Doubts about the quality of the services
- ☐ Fear of data privacy
- ☐ Lack of financial resources
- ☐ No need

Other (please specify):

20. Feedback on the survey, comments on the subject etc.:

Thank you for your time!

Cover letter:

Topic: Image analysis survey;

Dear Recipient,

In Tampere University of Technology, in the Department of Signal Processing we are working on a project related to commercialization of image analysis technologies and services. A part of this project is a survey which consists of questionnaires that have been sent to over 200 drug development and CRO companies in Finland, Denmark, Norway and Sweden. The purpose of the questionnaire is to explore the use and needs of image analysis in the companies.

We would be extremely grateful if you could participate in the survey by completing the short questionnaire below. Your responses are very important. However, if you feel that you are not suitable to answer the questionnaire, we would appreciate if you could forward this message to the one person in your company who would be most suitable. An ideal person to answer the questionnaire could be e.g. CSO, R&D director or senior scientist. The questionnaire should take approximately 6 minutes to complete. The answers from your questionnaire and others will be used as essential data set for my research project for my degree in Tampere University of Technology. The information you provide will be treated in the strictest confidence. Your answers will not and cannot be traced back to you.

By taking part in the survey you might have an influence on the direction of the development of improved image analysis techniques and services. Moreover, it is possible to receive a result report of the questionnaire afterwards by sending me an email (possible company identifying information will be omitted from the answers).

You can access the questionnaire through the link below:

http://www.kwiksurveys.com/online-survey.php?surveyID=INOLKF_4893528b

If you have any questions or would like further information, please do not hesitate to contact me.

Thank you for your help.

Emil Ackerman
Master's thesis worker
Tampere University of Technology

1st reminder letter:

Dear Recipient,

If you have already participated in the image analysis survey, thank you and please, ignore this message.

This message has been sent as a reminder that you have not participated in the survey about image analysis. We would greatly appreciate if you could complete the short questionnaire. Also, you don't have to answer all the questions if you don't want to. However, if you feel that you are not suitable to answer the questionnaire, we would appreciate if you could forward this message to the one person in your company who would be most suitable.

You can access the questionnaire through the link below and it should take you approximately 6 minutes to complete. The survey will close on April, 21st.

http://www.kwiksurveys.com/online-survey.php?surveyID=INOLKF_4893528b

Thank you very much for your time!

Emil Ackerman
Master's thesis worker
Tampere University of Technology

2nd reminder letter:

Dear recipient,
Thank you all for participating in the image analysis survey. As a reminder, if you want to receive a result report of the questionnaire, please send me an email (possible company identifying information will be omitted from the answers).

However, if you haven't had time to answer the questionnaire, you can still do it through the link below until April, 21st. Please note that you don't have to answer all the questions if you don't want to.

http://www.kwiksurveys.com/online-survey.php?surveyID=INOLKF_4893528b

Thank you once again!

Emil Ackerman
Master's thesis worker
Tampere University of Technology

Esittelyvaihe / Introductory phase

- Tutkimuksen tavoitteet: Tavoitteena on kartoittaa kuva-analyysin käyttöä ja tarpeita, joiden pohjalta on tarkoitus suunnitella kuinka kuva-analyysiosaamista voitaisiin kaupallistaa. Tulette huomaamaan, että kysely pyrkii selvittämään organisaationne toimintaa myös laajemmin kuin pelkän kuva-analyysin osalta. */ Study objectives: The objective is to explore the use and need for image analysis. The information will be used to design how image analysis expertise could be commercialized. You will notice that the interview explores your organization from many perspectives, not only from image analysis.*
- Luottamuksellisuus: Kirjoitan tutkimuksesta diplomityöni, jossa hyödynnetään haastatteluista saatua informaatiota, mutta ei mainita minkä nimisiä organisaatioita ja henkilöitä on haastateltu. */ In my Master of Science thesis the information from interviews will be used but the identity of organizations and interviewees will not be revealed.*
- Palkinto: Lähetän diplomityöni sähköisessä muodossa syksyllä kunhan se valmistuu. */ As a reward from attending the interview, I will send my Master of Science thesis electronically for the interviewees.*
- Kuva-analyysin yleinen määrittely: Merkityksellisen informaation irrottaminen kuvista esimerkiksi digitaalisten kuvankäsittelytekniikoiden avulla (Wikipedia). */ Definition for image analysis: the extraction of meaningful information from images by means of, for instance, digital image processing techniques* (Wikipedia 2011a).
- Haastateltavan aseman ja tehtävien/kokemuksen lyhyt selvitys */ A short discussion of the role and experience of the interviewees in the organization.*

    - Kauanko olette olleet yrityksessä töissä? */ How long have you been working in the company?*

    - Mikä on teidän toimenkuvanne yrityksessä? */ What is your role in the company?*

    - Oletteko tehneet samoja asioita myös aikaisemmin työurallanne? */ Have you done similar work in your career before?*

Nykyinen toiminta */ Current operations*

- Mitä teidän yrityksenne/yksikkönne tekee ja ketkä ovat teidän asiakkaita? */ What does your company/department do and who are your customers?*

- Mitä asioita asiakkaanne arvostavat? */ What things do your customers value?*

    - Millaisia asiakassuhteet ovat? */ What is the type of your customer relations?*
        - transaktio */ transactional*
        - partneri */ partner*
        - muu? */ other?*

    - Miksi asiakkaanne ovat juuri teidän asiakkaita? */ Why are your customers exactly your customers?*
        - Mikä erottaa teidät kilpailijoista? */ What distinguishes your company from the competitors?*

- Voisitteko kuvata, mitä tutkimustoiminnassanne tehdään? */ Could you describe what is done in your organization's research and development?*
    - Mitä vaiheita tutkimusprosessiin kuuluu? */ What phases are included in your R&D process?*
        - Ovatko prosessit ja niiden vaiheet tapauskohtaisia vai yleisesti päteviä? */ Are the processes and their phases generally similar or more of an ad hoc type?*
    - Kuinka suuren mittakaavan tutkimustoiminnasta on kyse? */ What is the scale of your R&D?*
        - Esim. volyymi/toistot */ Volume/repeats, for instance.*
- Miten hankinnat tehdään tutkimustoimintaan? */ How is procurement conducted in R&D?*
    - Mistä aloitteet lähtevät? */ What is the source of initiatives?*
    - Mikä taho/tahot hankinnoista päättävät? */ Where are the decisions made concerning procurement?*
    - Käytetäänkö palveluostamista/ulkoistamista/alihankintaa? */ Does your organization purchase services/outsource/use suppliers?*
        - Jos käytetään niin millaista? */ If yes, then what kind?*
        - Jos ei käytetä niin onko kuitenkin tarvetta? */ If not, then is there a need for it?*
            - Jos on tarvetta niin miksi ei käytetä? */ If there is a need, then why they are not used?*
    - Mitä asioita tulee huomioida palvelua tai laitetta hankittaessa? */ What aspects one needs to consider while purchasing a service or a product?*
        - Hankinta */ Purchase*
        - Toimitus */ Delivery*
        - Käyttö */ Use*
        - Täydennykset/Huolto */ Supplements/Maintenance*
        - Luopuminen */ Disposal*
- Mitä haasteita tai kehityskohteita löytyy? */ What are the challenges or where is there a room for improvement in…*
    - Liiketoiminnassa? */ Business*
    - Tutkimustoiminnassa? */ R&D*
    - Hankintatoimesta? */ Procurement*
- Käytetäänkö visuaalista tarkastelua tutkimus- tai muussa toiminnassa yrityksessä? (vis. tarkasteluksi voidaan lukea silmät, analyysisoftat, mikroskoopit, skannerit) */ Do you use visual inspection in R&D or other operations in the company? (visual inspection can include inspection by eye, the use of analysis software, microscopes, and scanners)*

- Millaisia käyttökohteita visuaalisella tarkastelulla on yrityksessä? */ What are the applications of visual inspection in your company?*
    - Minkälainen prosessi visuaalisen tarkastelun ympärillä on? */ What is the process around visual inspection?*
        - Näytteiden otto */ Taking the sample*
        - Näytteiden valmistelu */ Preparation of the sample*
        - Kuvien otto */ Acquiring images*
        - Kuvien kerääminen */ Collecting images*
        - Kuvien analyysi */ Image analysis*
        - Kuvien säilytys */ Storing the images*
    - Miten ja missä yhteydessä henkilö itse on visuaalista tarkastelua tehnyt? */ What kind of visual inspection have the interviewees done and in what context?*
    - Mikä teidän näkemyksenne on visuaalisen tarkastelun käyttökohteista yleisesti alalla? */ What is your view on the application areas of visual inspection in the industry?*
- Kuinka yleistä visuaalinen tarkastelu on yrityksessä? */ How widely is visual inspection used in the company?*
    - Entä yleisesti alalla? */ What about in the industry in general?*
- Mitkä asiat siinä ovat tärkeitä? */ What factors are important in visual inspection?*
    - Nopeus */ Speed*
    - Joustavuus */ Flexibility*
    - Toistettavuus/automaatio */ Repeatability/Automation*
    - Luotettavuus */ Reliability*
    - Helppokäyttöisyys */ Ease of use*
    - Objektiivisuus */ Objectivity*
- Mitä arvoa se tuo muuhun toimintaan? */ What value does visual inspection bring to other company operations?*
    - Varmistavaa lisätietoa vai täysin uutta tietoa? */ Confirming information or completely new information?*
    - Objektiivisuutta analyysiin */ Objectivity to analysis*
    - Tarkkuutta analyysiin */ Accuracy to analysis*
    - Tiedon kvantifiointi */ Quantification of information*

<u>Toiminta tulevaisuudessa */ Business in the future*</u>

- Onko näkyvissä muutoksia toiminnassa tulevaisuudessa (kaikki yrityksen toiminnot)? */ Are there changes in company operations in the future?*
- Mitä mahdollisuuksia toimintaympäristössä on havaittavissa? */ What opportunities are there in the business environment?*

- Mitä uhkia toimintaympäristössä on havaittavissa? */ What threats are there in the business environment?*

- Onko havaittavissa trendejä alalla yleisesti? */ What kind of trends are there in the industry?*

- Mitkä tekijät ohjaavat muutoksia alalla/yrityksessä? */ What factors direct the changes in the company and in the industry?*

- Kuinka nopeasti vakiintuneet teknologiat vaihtuvat alalla (teknologiasykli)? */ How fast are established technologies replaced in the industry (technology cycle)?*

<u>Kuva-analyysitarpeet nyt ja tulevaisuudessa */ Image analysis needs currently and in the future*</u>

- Mitä sovelluksia/työkaluja käytetään nykyisin kuva-analyysissa? */ What applications or tools are used in image analysis currently?*

- Mitä haasteita/kehityskohteita näette nykyisessä kuva-analyysissa? */ What challenges or room for improvement do you see in image analysis currently?*
    - Mitä hyötyjä kuva-analyysissa esiintyy nykyisin? */ What advantages are there in image analysis currently?*
    - Mitä haittoja kuva-analyysissa esiintyy nykyisin? */ What disadvantages are there in image analysis currently?*
    - Mitä hyötyjä tavoiteltaisiin muutettaessa toimintaa johonkin suuntaan? */ What benefits would be aimed at if current operations were changed?*
    - Mitä haittoja on odotettavissa muutettaessa toimintaa johonkin suuntaan? */ What disadvantages could be assumed if current operations were changed?*

- Millaisille palveluille/tuotteille olisi käyttöä nyt tai tulevaisuudessa? */ What kind of services or products would be useful currently or in the future?*
    - Ulkoistaminen */ Outsourcing*
    - Konsultointi */ Consulting*
    - Koulutus */ Training*
    - Räätälöidyt ratkaisut (esim. softa tai laite) */ Customized solutions (e.g. software or machine)*

- Mitä hyötyä niistä olisi muulle toiminnalle? */ What benefits could be received from the services or products in question?*

- Mitä esteitä näette kuva-analyysin käytölle/hankinnalle? */ What barriers are there for the use or purchase of image analysis services or products?*

- Millä alueella/aloilla yleisesti ottaen näkisitte tarvetta kuva-analyysille ja sen automatisoinnille? */ In which industries would you generally see a need for image analysis and its automation?*
    - Entä kansainvälisesti? */ What about internationally?*

- Onko teillä pienempiä tai suurempia visioita kuva-analyysin tarpeesta omassa toiminnassa tai alalla tulevaisuudessa? */ Do you have any visions related to the use of image analysis in your organization or in the industry in the future?*

Arvostuskysymykset */ Value questions*

- Mitkä asiat ovat tärkeitä teidän liiketoiminnassa? */ What factors do you see important in your organization's business?*
    - Joustavuus */ Flexibility*
    - Asiakaslähtöisyys */ Customer orientation*
    - Tutkimuspainotus */ Research focus*
    - Reagointikyky */ Ability to react*
    - Luovuus */ Creativity*
        - Miksi ne ovat tärkeitä? */ Why are they important?*

- Mitä asiat ovat tärkeitä tutkimusprosessissa? */ What factors do you see important in R&D?*
    - Yhteistyö muiden tahojen kanssa */ Collaboration with other organizations*
    - Luotettavuus */ Reliability*
    - Nopeus */ Speed*
    - Korkea tieto-/taitotaso */ High level of skills and knowledge*
    - Tuloslähtöisyys */ Result orientation*
    - Asiakaslähtöisyys */ Customer orientation*
    - Korkea laatu */ High quality*
        - Miksi ne ovat tärkeitä? */ Why are they important?*

- Mikä alihankkijoissa on tärkeää (mikäli käytetään)? */ What do you see important in suppliers (if used)?*
    - Miksi se on tärkeää? */ Why is it important?*

Lopettelevat kysymykset */ Closing questions*

- Haluatko sanoa vielä jotain edellisiin kohtiin liittyen? */ Would you like to add something to the subjects discussed in the interview?*

- Jäikö jokin asia käsittelemättä haastattelussa? */ Was something left out from the discussion that you would like to talk about?*

- Osaatko suositella ketä/mitä tahoja kannattaisi haastatella kuva-analyysia ajatellen? */ Can you recommend any organization or a person that would be suitable for an interview related to image analysis?*

- Onko kommentteja tehtyyn haastatteluun liittyen yleisesti? */ Do you have any comments on the interview in general?*

Interview code	Company type	Interview date
I-1	Pharmaceutical company	4.4.2011
I-2	Drug development CRO	8.4.2011
I-3	Pharmaceutical company	26.4.2011
I-4	Health care laboratory	28.4.2011
I-5	Pharmaceutical company	29.4.2011
I-6	Health care laboratory	4.5.2011
I-7	Pharmaceutical company	4.5.2011
I-8	Drug development CRO	5.5.2011
I-9	Health care laboratory	5.5.2011
I-10	Health care laboratory	9.5.2011
I-11	Pharmaceutical company	11.5.2011
I-12 (concept test)	Health care laboratory	19.8.2011
I-13 (concept test)	Pharmaceutical company	19.8.2011

Questions to be asked after presenting the designed service concept

- Mitä olet yleisesti mieltä suunnittelusta palvelukonseptista? */ What is your general opinion on the designed service concept?*
- Kumpi vaihtoehdoista vaikutti paremmalta lääkeyritysten ja terveydenhuollon laboratorioiden toimintaa ajatellen? */ Which of the two alternatives seemed to fit the operations of pharmaceutical companies and health care laboratories better?*
- Mitä tuloksia ja hyötyjä odottaisit asiakkaan saavan tällaisen palvelun myötä? */ What results and benefits would you assume the customer of the proposed service to receive?*
- Mitkä ovat palvelukonseptin vahvuudet? */ What are the strengths of the service concept?*
- Mitkä ovat palvelukonseptin heikkoudet? */ What are the weaknesses of the service concept?*
- Mitkä ovat palvelukonseptin mahdollisuudet? */ What are the opportunities of the service concept?*
- Mitkä ovat palvelukonseptin uhat? */ What are the threats of the service concept?*
- Uskotko tällaisella palvelulla olevan kysyntää Suomessa? Entä ulkomailla? */ Would you anticipate demand for this kind of service in Finland? What about abroad?*
- Mitä kehityskohteita näkisit tässä palvelukonseptissa? */ What areas for development would you see in the proposed service concept?*
- Pitäisikö joitain asioita muuttaa lisätä tai poistaa palvelukonseptiin liittyen? */ Should something be changed, added, or deleted in terms of the service concept?*
- Mihin asioihin tulisi mielestäsi kiinnittää huomiota palvelukonseptissa tai sen jatkokehityksessä? */ What issues should be focused on in the service concept and its future development?*
- Onko muita kommentteja haastatteluun liittyen tai jäikö jokin asia käsittelemättä? / *Do you have any other comments related to the service concept or was something left out from the discussion that you would like to talk about?*

APPENDIX 6 (1/1): IMAGE ANALYSIS RELATED NEEDS IN MEANS-END-CONCEPT

Value category / Class of needs	Concrete attribute	Abstract attribute	Functional utility component	Socio-psychological utility component	Instrumental value	Terminal value
Documentation	Images can be taken	Samples can be documented in images	Images can be reanalyzed later or used as examples.	One can rest assured that the analysis done can be proved later	Quality control is enhanced	Quality is high and the company is reliable
Image analysis	Analysis is faster compared to manual analysis	Fast to use	Results are received faster / The lead time of results decreases	The laborous task can be avoided	Research pipeline is faster.	Services/products are conducted/developed faster
	Interface is easily approachable (only few clicks to get results)	Simple to use	No need for extensive training	Does not increase frustration	Work morale is higher	Employees are satisfied
	Analyses are based on algorithms.	The results are user independent	More objectivity into analyses	‘Bad day’ of a user does not lead into serious consequences	The results are consistent	Reliability of the research increases
	Measurements are correct and valid	Results can be used in further research	Reliable results	One can trust the results	Customers get reliable service/products and are satisfied	Company is reliable and profitable
	Data can be extracted from the images	More information to support research/diagnosis	Information based decision making is enhanced	Less what if questions in decision making	Decisions are made based on solid and comprehensive information	More right decisions are made / Quality is high and company reliable
Data analysis	Meaningful data can be extracted from large data sets reliably	Data analysis is more effective	Information based decision making is enhanced	Less what if questions in decision making.	Decisions are made based on solid and comprehensive information	More right decision are made / Quality is high and company reliable.