

Innovation Challenge at Philips Healthcare:

“What are the Critical Success Factors at the Front end Innovation process?”

by

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Abstract

This report presents an exploratory study which investigates the critical success factors for the front end innovation process. An innovation challenge being experienced by Philips Healthcare is tackled by looking closer into the front end process of the company. Based on a literature review and a comprehensive case study; the theoretical and practical views are explored and evaluated. A critical success factors methodology is generated and used to assess the front end innovation process. Eight critical success factors are identified using a contextual innovation management approach. A simple self-assessment tool is introduced to incorporate CSFs in the front end innovation process. The findings are used to provide recommendations to Philips Healthcare to improve its front end innovation process. The contextual CSF methodology and self-assessment tool proposed in this study can also be adopted and used for different settings.

“Today, innovation is about much more than new products. It is about reinventing business processes and building entirely new markets that meet untapped customer needs.”

Business Week

Preface

This report represents the master thesis of my study in Management of Technology, Technical University of Delft. It presents the results of a seven months research into the critical success factors of the front end innovation process at Philips Healthcare. The report incorporates the comments and suggestions from the company managers and external experts.

I would like to express my gratitude to several people who supported me in different ways and contributed to my research. I would like to thank my supervisors of the Delft University of Technology for the support they gave me. First, Dr J. Roland Ortt for his knowledge and willingness to help during the whole project, second Dr Patrick A. Van der Duin and Dr Mark de Bruijne for their insights and their useful feedback during the entire thesis period. Thanks to their invaluable advices, discussions and scientific feedback to help me best improve my research.

Then, I would like to thank my supervisor at Philips Healthcare, Goof Pruijsen for his encouragement, endless patience, precious advices and the time he invested in my research. Next I want to thank Johan Bosch, Maurits Smits, Nijs Van der Vaart, Bert van Meurs, Ad Jongenelis and Frans Venker for their input, advice and nice cooperation during the project. I would also like to thank to Rick Russell for providing me information and insight on critical success factors methodology. Additionally I want to express my thanks to the internal and external experts I had interviewed; they did give me much insightful information for my thesis from practical perspectives.

Furthermore, I would like to thank the people of Philips Healthcare who gave me the opportunity to execute my master thesis at Philips Healthcare, and the people of the Cardiovascular Business Unit who were interested in my project and were willing to help.

Finally, I would like to thank my family for the patience, encouragement and support they gave me during the whole project. Last but not least, thanks to my friends for always being there for me, supporting when I needed, for cheering me up when I was down, partying with me when I needed a break, and for giving me advices when I faced some difficulties in life.

Gizem Zorba
March 2010

By Gizem Zorba

Management Summary

This section is left out for the reasons of confidentiality...

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PART I. RESEARCH OVERVIEW

An overview of the research is presented in Part I.

First, the entire project background is described. The problem statement and research questions are stated. Next, the research scope and approach are explained. Finally, the environment of the project is portrayed in this part.

CHAPTER 1. RESEARCH PLAN

An outline of the research is presented in the first chapter. The problem statement, research questions, research scope and approach are explained in this chapter.

PROJECT BACKGROUND

Over the years, innovation has been recognized as a magical phenomenon that drives success in the high tech industry, including the medical technology industry. However the concept was documented as “the *challenge* and the *solution* in medical device, diagnostics and equipment industries” by Windhover Information Inc. in 2004.¹ Likewise the results of the Booz Allen Hamilton European Innovation Survey (2005) showed that European executives believe that innovation is a core business skill and a powerful competitive advantage which results in better financial performance and value growth.

Executives use innovation in a conscious search for opportunities to improve the economic and social potential of their enterprises (Drucker, 1998). Porter and Stern (1999) declared that innovation is more than science and technology; it involves improvements in marketing, distribution, services in addition to new products and processes. The boundaries of the firms are very important for innovating firms as they identify the winners and the losers of innovation games (Teece, 1986). At the IBM innovation leadership forum in 2006, IBM CEO Samuel J. Palmisano summarized the broad focus of innovation in the 21st century as: “The way you will thrive in this environment is by innovating -- innovating in technologies, innovating in strategies, innovating in business models².” The statement highlighted the importance of updating innovation processes and capabilities complementary to new product introductions. Though innovation is very important for high tech companies, changing market situations and advancement in technologies are forcing companies to innovate differently (Ortt and Van der Duin, 2007). Previous studies showed that the number of companies which apply the contingency approach to their innovation management is increasing (Ortt and Van der Duin, 2007). The contingency approach to innovation management believes that there is no one best way to manage and that the innovation activities must be tailored to the particular circumstances faced by an organization to be effective.

PROBLEM STATEMENT

Following Rontgen’s discovery of X-ray in 1895³, CHF Muller of Hamburg starts the X-ray business and manufactures the first commercial X-ray tube in 1918⁴. Medical application of X-ray was made known

¹ In Vivo, The Business and Medicine Report. Windhover Information INC. Vol.22, No.4, April 2004.

² SPECIAL REPORT – INNOVATION : ‘The World’s Most Innovative Companies’, the Business Week Magazine, www.businessweek.com, APRIL 24, 2006.

³ X-Ray In Wikipedia. Retrieved February 19th, 2010. From <https://mail.google.com/mail/?shva=1#search/mark/1267927ccod1179f>

soon after its discovery. Print of Wilhelm Roentgen's first "medical" X-ray of his wife's hand taken on 22 December 1895 is illustrated in Figure 1. During World War I Germans need another company to repair their X-ray tubes and come into an agreement with Philips, a leading manufacturer of luminescent lamps. With this initiative Philips sets the first step towards turning X-ray research into practical applications in Eindhoven, The Netherlands. Later on the company takes over Muller and focuses on X-ray tube manufacturing. By 1933⁴ Philips starts manufacturing X-ray equipment dedicated to medical applications in Europe and the USA. Philips Healthcare has always been the innovation leader of the X-ray industry since then. However the changing dynamics of the healthcare market is challenging the company's leadership position.

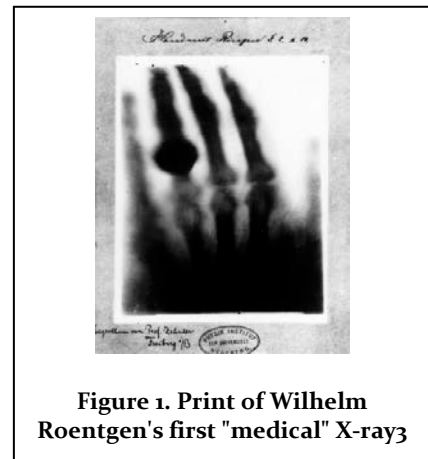


Figure 1. Print of Wilhelm Roentgen's first "medical" X-ray

Up until 1990s, Philips was composed of a variety of different businesses with different images, strategies and cultures with a main focus on innovation. Customers accepted the company as a technology leader and were willing to pay for the value. Thus "cost + margin" pricing strategy of Philips was working smoothly during these years. However diverse activities running simultaneously were not presenting Philips as a global company. During the 1990s, competition in the healthcare market increased. Philips started paying attention to market demand and customer value to keep its high-rank position. In 1995, the company came up with a slogan "Let's make things better" to unite all of its activities under one roof. The changing markets pushed company to evolve to keep up with the fast-paced environment. In consequence, a new brand name "Sense and Simplicity" was introduced in 2004. The pillars of the motto were established to fulfill the expectations in all activities: their products, services and businesses. Hence the company started changing its position from a technology-driven to a market-driven company. Originating from this strategic movement, Philips Healthcare (PH) began to concentrate on the needs of hospitals and clinics to make their work flow easier, quicker and more productive. Though the company could benefit from high price margins in the past, the recent emergence of price erosions in the healthcare industry have been pressuring the company. Hence Philips Healthcare is giving a higher importance for innovation to maintain its leadership position and stay competitive in the market.

While innovations can introduce new opportunities for the companies, they also bring along new challenges. Like most of the other companies, Philips Healthcare has been experiencing some difficulties while handling their innovation activities. They are either missing out windows of opportunities along the way or delaying to launch new products. For instance, 1.5 years ago, a new systems concept was introduced to the market by the competition which showed their breakthrough ideas to healthcare professionals claiming their innovation leadership position to the medical device market with their new product. What is even worse is that the same idea was turned down by PH 6 years before its market introduction. Philips Healthcare found the idea too demanding to make a success and decided not to proceed with it.

⁴ Philips Healthcare Official Website. Retrieved February 19th 2010. From http://www.healthcare.philips.com/au_en/about/company/historyandtimeline.wpd

PH is experiencing an image problem as it is overlooking innovativeness while concentrating on differentiation and adaptation in the highly competitive healthcare market. PH's market position is under attack by the competitors. To maintain its innovation leadership position, PH adopted a new strategic objective to be the clear innovation leader. However the company lacks a thorough procedure to assess innovations. Studying the innovation activities at a generic level will not be sufficient to understand the pitfalls of the innovation activities at PH as they are embedded within different phases at a lower aggregation level. Therefore PH is seeking ground-breaking concepts which can be used as a guidance to improve its innovation processes.

From a theoretical perspective, this study is a valuable contribution for both innovation related research and for studies related to medical device industry. It provides insight on how generic innovation theories can be applied to the medical device industry and how they are handled in this market. Furthermore this research also gives a perspective on how innovation activities can be explored in detail at different settings.

RESEARCH QUESTION

For Philips Healthcare, maintaining its innovation leadership position is very important as they believe that market leadership position can be retained by having an innovation leadership position. However Siemens Healthcare is challenging the innovation leadership position lately. The Cardiovascular Business Unit Innovation Department of PH is well aware of the dynamic competitive environment and the need for an in-depth study into innovation activities conducted in the business unit. The majority of the people at the organization are very much focused on products and some people look into the process. However not many people ask why things work or do not work. Exploring and establishing a proper innovation process constitutes a big challenge in itself. The reason for this is not only because of the numerous internal and external parties that are involved in the process, but also because of the high uncertainty level being experienced for innovation activities. Therefore a well grounded understanding of the innovation process and elements influencing the process may assist the company in ongoing efforts to improve its innovation process.

The goal of this research is to identify the critical success factors of innovation process at PH and provide recommendations in order to improve the innovation process at PH. Exploring the innovation process at a generic level will not bring in enough value for the department as most of the pitfalls are within different phases at a lower aggregation level. Hence an in depth study into the process is necessary to assess the innovation process at the CV business unit. The main research question to be answered in my thesis work is:

“What are the critical success factors at the front end innovation process for PH CV?”

To attain the objective of identifying critical innovation success factors at PH and making use of them to improve innovation processes, the following sub questions need to be answered:

- ✓ What is the front end innovation process?
- ✓ What are the critical success factors (CSFs) in the front end of innovation processes in the healthcare industry?
- ✓ How are the innovation processes and the front end innovation process organized at PH CV?
- ✓ What aspects of the innovation process can be improved for the PH CV unit?
- ✓ How can these CSFs be implemented in the innovation process?

RESEARCH SCOPE

The scope of the research is limited to the front end of the innovation process aimed at identifying potential success factors of the front end innovation process at PH, particularly PH CV BU. We simply focus on the front end innovation process because we think that it has the biggest influence on the innovation process.

The study mostly concentrates on the firm related innovation success factors at the front end of the innovation cycle while exploring the general critical success factors of the front end innovation processes. Critical success factors for the front end innovation process in general and front end innovation process in medical device industry are explored in this study. The innovation of the competition is also taken into consideration as a benchmark study.

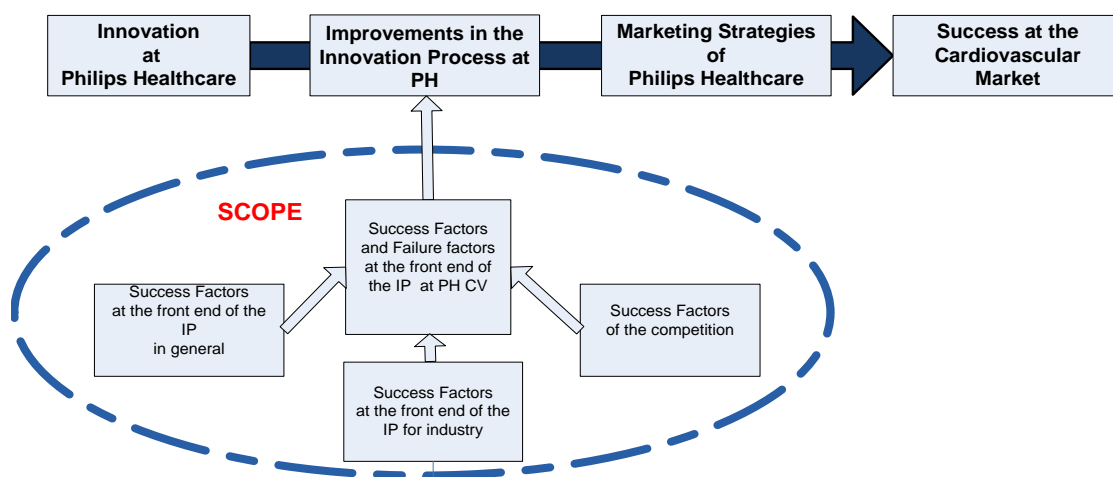


Figure 2. The Scope of the Research

An auditing tool is proposed but the implementation of its use is out of our scope. A benchmark study is conducted however an in depth competitor analysis is kept out of scope as obtaining internal information from competitors is demanding.

RESEARCH APPROACH

The approach used for this research is presented in this section.

METHODOLOGY

The aim of the research is to find a solution to a concrete problem instead of acquiring more general knowledge. Therefore an explorative research strategy is chosen to identify the success factors at the front end innovation process and improve the innovation processes at PH by using a case study of PH CV BU.

The approach of this project is illustrated in the following figure.

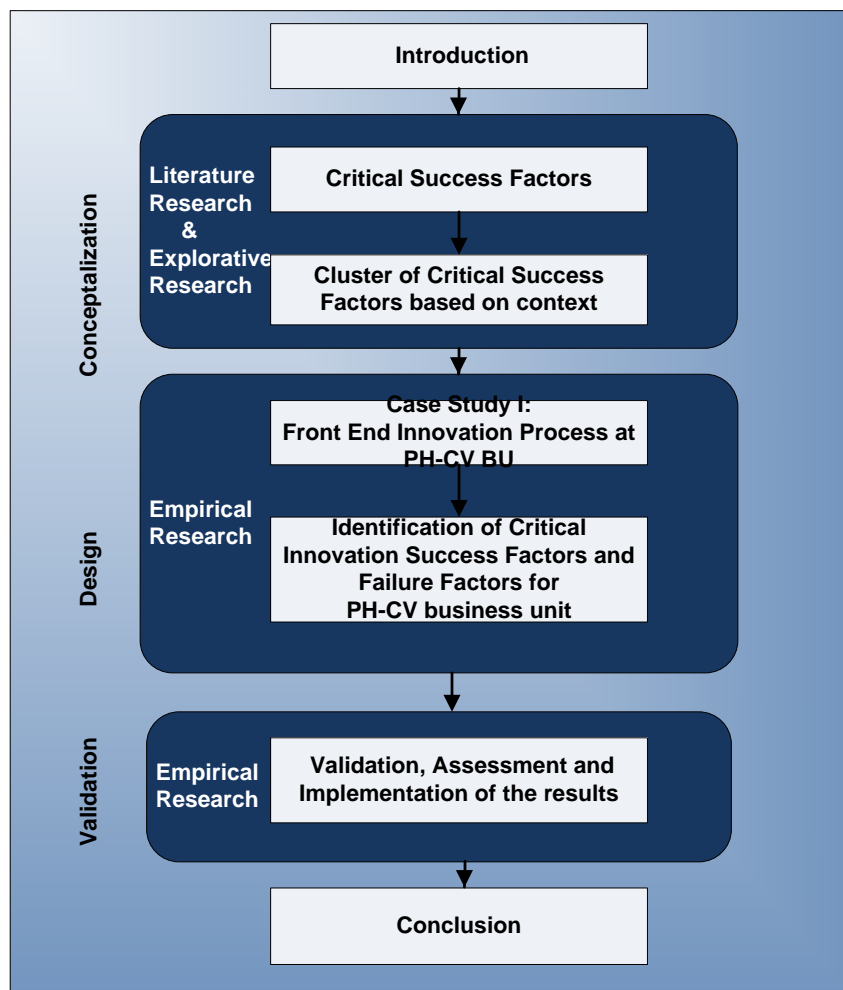


Figure 3. The Research Framework

The research framework consists of three steps. The first step is to explore current theoretical knowledge about innovation processes and success factors as well as their relationship. At this stage, a literature study was used since there was already significant research available about these concepts. Furthermore, unstructured interviews were conducted in order to understand the importance of these concepts for the

company unit. The interview subjects were selected due to two reasons. First, they are the ones who work at the innovation department of PH CV unit thus; they are already a part of the system. Second, they are the ones who will be using the findings of this study. When general information on concepts and the scope of the study were clarified, an in-depth literature search was conducted considering the context of the environment. Theoretical research was conducted to reveal the general critical success factors of innovation, front end innovation process, medical device industry, and front end medical device industry. Going one step further; a desk study was conducted to explore the innovation strategy and innovation process of the closest competitor of PH CV BU, Siemens. Publications, conference papers, internal documents/reports, and studies of the business intelligence department were used as information sources at this stage.

As a second step a case study was carried out to investigate the success/failure factors of the PH-CV. Key personnel who are directly involved in the front end process was interviewed formally. To get the complete picture of the front end activities, all parties who are involved in the front end phase at the PH BU were interviewed. The interview group was made up of 10-12 managers who are familiar with the process. Interview subjects were chosen by considering their roles in the front end process and their departments. To avoid biased information, all departments which contribute to the front end process were consulted. Moreover, since the organization of the front end process will be changing by the beginning of 2010, the personnel who will be involved in the new process were also interviewed.

Studies related to the case, reasons of success/failure were explored. With all empirical information gathered and theoretical understanding, critical innovation success factors for the business unit were identified. The findings were compared to the CSFs found in benchmark studies and assessed by the degree they fit in the context. To filter and re-shape the raw data into basic components, a normalization process carried out for obtaining data which is:

- isolated from the personnel who provided it
- condensed to its essential meaning
- structured into manageable pieces

The proposed success factors were validated externally and internally. The findings of the study were presented to a number of external consultants and PH employees for the validations. A self assessment tool was used to evaluate the front end taking into account the identified critical success factors.

COLLECTING DATA

Qualitative data is gathered and employed throughout this study:

A. Existing material/database

To define CSFs of the innovation processes, first of all the following business unit documents were reviewed:

- The documented mission and vision of the BU
- The documented goals and objectives of BU
- The documented performance metrics of the BU
- Long term and short term strategic plans of the BU
- Annual reports, industry reports and competitive analysis

Databases, literature reviews, marketing intelligence reports were studied in order to articulate the evolution of the medical device activities and understand the innovation process of PH.

B. Observations

The intention of this research is to get a clear picture of the company's structure and front end processes. Observations were used to collect and organize the empirical facts about the organization. The daily observations assisted the researcher to become familiar with the company's culture and organization, communication and synergies across departments and the management style.

C. Interviews

The interviewees were invited for an interview by an email including information related to the goal of the interview, its duration and the expectations from the interview. The interviews were structured in the sense that the outline of the main topics was drawn in advance and all of the interview subjects were asked the same questions. However interviewees were provided an opportunity to share their personal opinions, suggestions and feelings about the innovation process. During the interviews, first of all the important concepts regarding to this study were explained and a number of open questions were asked to help the personnel to identify their CSFs. The goal of this step was to obtain company information where the individuals are approached purely as a source of information. Hence questions concerning opinions, observations and attitudes were directed to the interview subjects. After each interview, the meeting notes were revised, structured in the same format and emailed back to the participants for their confirmation. A list of interviewees can be found in the Appendix.

Table 1. Interview questions

Interview Question	Intended scope
How do you define innovation?	The intention of this question is to understand the importance of innovation and evaluate the level of understanding of innovation in the BU.
How is the front end innovation process structured at PH CV BU?	This is a context setting question which is used to assess the different perspectives about the innovation processes. The responses of this question help to identify if the CSFs suggested by participants belong to the entire organization or a specific operational unit.
What are the critical success factors of the front end process?	The intention of this question is to directly obtain CSFs from the participants. However, meaningful responses are highly dependent on the participant's understanding of the CSF concept therefore the CSFs and the scope of the research are explained before asking this question.
What are the failure factors of the	The goal of this question is to understand the factors which seem to

front end process?	cause problems at the front end process.
--------------------	--

D. Questionnaires:

After completing the previous stages, a questionnaire was constructed using the CSFs found in the literature study. The questionnaire was divided into two sections and a cover page was included as the first page. The first section of the questionnaire contained company specific questions while the second section was focusing on the critical success factors in the front end of the innovation process. The surveyors were asked to express their agreement level on these critical success factors and the maturity level of each element in the front end innovation process. Noting that, the questionnaire stated that the CSFs listed were found by conducting a literature benchmark study. The presentation of the survey can be an influence on participant's agreement level on the CSFs as these are the theoretical CSFs which are already known to be important for the front end innovation process. This in turn can also influence their perception on the level of maturity of the CSFs. A copy of the questionnaire can be found in the Appendix.

THEORETICAL FRAMEWORK

The concept of the critical success factors was introduced by Rockart (1979). Rockart defended that the organization can ensure successful competitive performance as long as it can provide satisfactory results for a number of key areas. The ultimate goal of the traditional critical success factors approach is to understand the knowledge and perception of these vital topics. Furthermore such an exploration can also reveal potential failure factors which can misguide the organizations.

The front end process is the most chaotic phase of the innovation processes. Understanding the front end critical success factors of medical device companies and recognizing the factors which can cause failure bring in valuable insight in order to improve the innovation processes. However these success factors should fit in the context of the study and should take into account the case specific factors.

The theoretical framework of this research is shown in Figure 3.

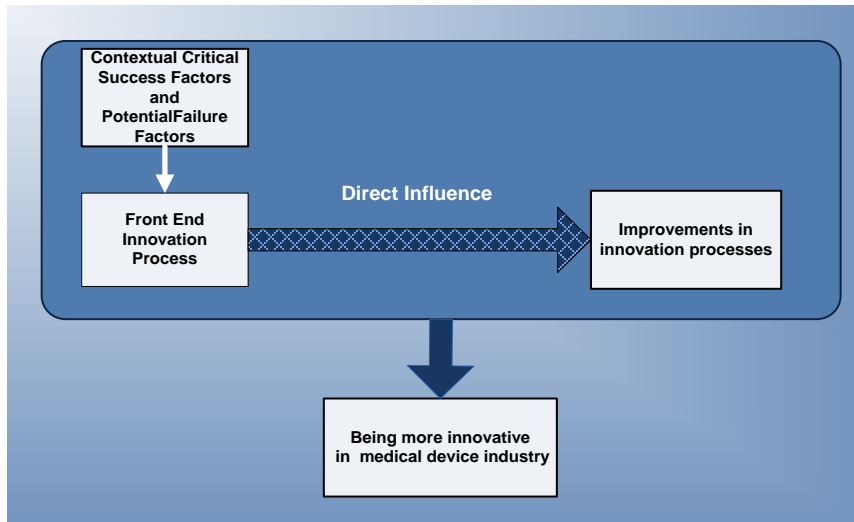


Figure 4. The theoretical framework of the research

CHAPTER 2. INTRODUCING PH CV AND THE BUSINESS ENVIRONMENT

In this chapter the project environment is presented, a description of Philips Healthcare, Cardiovascular Business unit and Business Environment is provided.

PHILIPS HEALTHCARE

Philips Healthcare (PH) is an independent product division of Royal Philips Electronics which was founded in 1891 by Gerard and Anton Philips. The company, headquartered in Amsterdam, is one of the largest global diversified industrial companies. Philips' Healthcare's core business is developing and delivering products and services for medical systems. Committed to provide meaningful innovations to improve people's lives, Philips Healthcare is a global medical device company. Through the brand's promise of "sense and simplicity", the department pledges to deliver healthcare solutions that are *'advanced'*, *'easy to use'* and *'designed around the needs of the customers'*. According to PH, simplicity is about understanding people's essential needs and using that understanding to generate solutions that add real value to people's lives. PH holds more than 80000 patents and 35% of the company's market share.⁵ PH's mission is to "Improve lives through solutions designed around the needs of care providers and their patients" and vision is to "remove the boundaries in healthcare through innovative and affordable technological solutions throughout the entire cycle of care"⁶. The company aims at differentiating itself by being a people focused and simplifying healthcare solutions.

PH has branches in every continent and has five business groups: Imaging Systems, Home Healthcare Solutions, Clinical Care Systems, Healthcare Informatics and Services. A brief illustration of the PH is shown in following figure.

⁵ In bil, PH employed more than 30000 people and had a profit of 7.4 billion Euros in sales. (Philips Healthcare, 2009)

⁶ Internal document: Philips Healthcare - GSSI One Page Strategy 2008, Final Version – 29 February 2008.



Figure 5. The organizational structure of Philips Healthcare⁷

Believing in the potential of the medical field, PH acquired aggressively in 1999-2001 but at the same time lost its market share due to integration issues and delaying in new product introductions. However the company consultants believe that PH will recover its market share and grow faster by offering a better product mix, improving its services, outsourcing its activities and carefully handling the pricing pressure. (Dresdner, Kleinwort, Wasserstein, May 2005) Currently Philips Healthcare operates in the business segments shown below.



Figure 6. Business Segments of Philips Healthcare⁶

⁷ Internal Document: Introduction to BU Intervention X-ray. Bert van Meurs. February 2010.

PHILIPS HEALTHCARE CARDIOVASCULAR BUSINESS UNIT

Cardiovascular (CV), a division of Imaging Systems, is a business unit (BU) of PH. PH CV BU operates in a business to business market working with hospitals and clinics and cooperating with physicians who work with its products and services on a daily bases. The Cardiovascular business unit develops and markets X-ray systems that are used to minimize invasive diagnostics and treatment of vascular and cardiac disease. CV is a small company by itself and is responsible for its own activities. CV's mission is to "be the recognized leader of X-Ray centered, minimally invasive solutions, designed around patient and clinician, excelling in clinical outcome & workflow efficiency"⁸. 2009 vision of CV is to "enhanced the way of working of our customers to allow them to take better care of patients"⁸. Over the years, the BU has shifted its focus from diagnosis to therapy planning and image guided interventions. Currently cardiovascular business operates in five different clinical segments:

- Interventional Cardiology - diagnostics and non-surgical treatments of the heart.
- Interventional Radiology - minimally invasive treatments performed under image guidance.
- Interventional Neuro-Radiology - minimally invasive approach in the treatment of vascular diseases of the brain and spine
- Pediatric Cardiology - diagnostics and non-surgical treatments of children with heart problems
- Electrophysiology - the study, diagnosis, and treatment of irregular heart

Furthermore, to run its operations smoothly, CV is separated into five main departments: Applications, Customer Service, Electrophysiology, Marketing, R&D and Surgery. The organizational structure of CV business unit is shown in following figure.

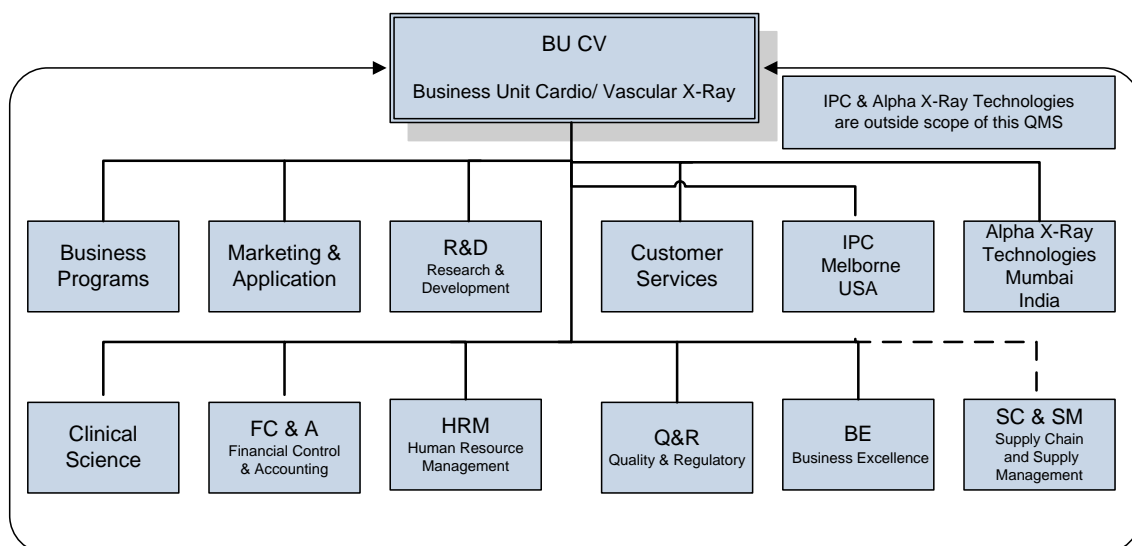


Figure 7. The organizational structure of CV Business Unit

⁸ Internal document: BU CV- One Page Strategy 2009, Approved – 18 December 2008.

Strategic objectives of CV are: increasing the speed of innovation, simplicity, highly satisfied customers, highly engaged and empowered people. The BU uses the general Philips values described as the 4 Ds, the business enablers. The 4Ds, are: Delight Customers, Deliver Great Results, Develop People, Depend on Each other⁹. These enablers are seen as a common base of values and behaviors that contributes attainment of strategic goals. The company intends to anticipate and exceed customer expectations to please the customers. To deliver great results, the company prefers to play to win big and always set ambitious targets. PH values its employees and invests significant time to coach and recognize people to get the best from them. The company believes in delivering more value by working as One Philips according codified values of PH. The X-ray department of the Imaging Systems is composed of two major business units: CV X-ray and General X-ray. On January 1st, 2010 GXR Best and CV merged into a new Business Unit. The official name of this new BU became Interventional X-Ray, or iXR. Approximately 860 employees work for the department: 800 in R&D In Customer Services, Marketing, Clinical Science in Best and 60 in R&D, Manufacturing, Marketing and Customer services at Alpha in Mumbai, India (former Alpha X-Ray Technologies)⁷. In 2008 CV X ray delivered more than 800 systems to the market and generated revenue of €871 million⁷.

BUSINESS ENVIRONMENT

The CV BU develops, produces and services X-ray centered minimally invasive solutions which diagnose and treat cardio and vascular disease. In the US, such cases are one of the top causes of death. Following graph shows projected global deaths in 2002-2030.

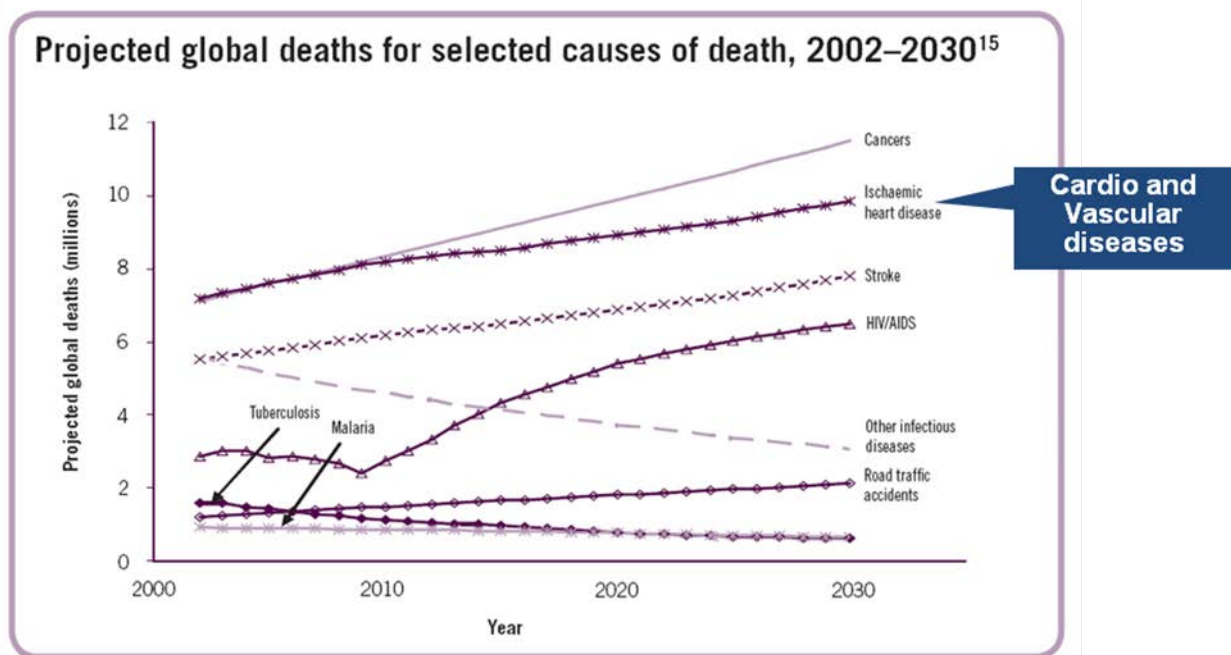


Figure 8. Selected Causes of Death⁷

⁹ Philips CV Townmeeting. BU Intervientional X-ray - What we stand for. November 18, 2009.

The medical device industry has a stable market. Traditional economic theory is not applicable for the market since demand is always present. There are some trends that influence this demand¹⁰:

- Ageing population: Over-65 age group is growing and is responsible for 40-50% of the healthcare spending. With the aging population, the number of chronically ill patients is also increasing.
- Development of technology: Technology advancements are providing faster and more accurate solutions for clinical needs. Innovation introduces both complexity and hope.
- Demand for care is growing: The worldwide healthcare spending is augmenting exponentially. Nurses and doctors are not enough to cope with the growing population any more.
- People do not take good care of themselves and expect better choices: diseases such as cardiovascular and cancer are the main causes of deaths amongst men and women. These diseases also have the most expensive healthcare costs.
- Lower market prices: Competition is able to offer lower prices.

The healthcare industry has three key distinguishing characteristics: Sustainable growth, high profitability and rapid change (Burns, 2005). Yet the industry has a demanding structure. Companies are required to have financial/intellectual capital, technological know-how and a supportive regulatory environment to be able to compete in this market. On the other hand, the healthcare industry has a completely unusual market composition compared to other industries. Different parties are involved in the entire healthcare cycle hence; consumer, customers and payers are not the same in this industry (Burns, 2005). Physicians are the main decision makers on medical procedures and products therefore they are the main customers. Conversely patients do not have the expertise to choose their own applications thus they are known as the consumers of the market. The payers of this industry are either governments or private investors/insurance companies. This market separation provides a pricing freedom and grants extraordinary economic benefits for the market players (Burns, 2005).

Over the years, the healthcare industry has gone through major changes. Developing new technologies is leading to new medical products regularly and forcing governments to establish price and quality regulations to control the market. The restrained nature of the market homogenized the companies and the products and rationalized the price behavior of the products. Evolutionary product changes followed by well-developed marketing and sales activities and created a unique industry with “above-average” profitability (Burns, 2005). A case study conducted at Harvard business school in 2003 confirmed the rapid changing structure of the healthcare industry¹¹. Due to the pressure to reduce the costs of healthcare, new healthcare plans have been emerging. Therefore healthcare providers are adapting to the system and changing their buying behavior. In earlier times, medical equipment was purchased depending on their superior technical performance and quality. The decisions were given by physicians. Conversely nowadays, the purchasing decision is focusing on economic analysis and assessing the whole life cycle of a piece of equipment. Moreover decision making processes are transforming into committee decisions instead of individual physician choice. Researchers highlighted the importance of innovation for

¹⁰ Internal Document: Healthcare overview presentation. Page Owner: Laura Tringali. Last modified: January 7, 2010.

¹¹ Internal Document: HARVARD BUSINESS SCHOOL – CASE STUDY by: Professor D. Quinn Mills and Julian Kurtz. Case #9-703-494. REV: November 10, 2003

the industry to meet the needs of market. The following table provides an overview of the medical device industry.

Table 2. An overview of medical device industry¹²

<p><u>Strengths</u></p> <p>Innovations can reduce healthcare cost Innovation improvements can quickly start to provide a steady stream of new medical devices Industry growth justifies innovation investment Innovation is respected and overall it is increasing With FDA and clinical, there are high barriers to entry Patent protection can increase profit potential Products are often used for alternate purposes Product life cycle may be explored with clinical studies</p>	<p><u>Opportunities</u></p> <p>Fragmented industry Consumers are aging and living longer High incidence of cardiovascular diseases Tend to support niche markets Commercialization of medical devices FDA is beginning to fast track true innovations Doctors may find new uses beyond claims New tech innovations tend to be profitable Consumers expect to share in decisions Partnerships proven to enhance innovation MD-SMBs produce more “true” innovations Growing market for smaller hospitals and independent practices are Growing need for mid- and low-priced equipment Increasing importance of services</p>
<p><u>Weaknesses</u></p> <p>Innovation process tends to be unpredictable Failures tend to be expensive Declining number of “true” innovations Profits are thinning Companies limited to evidence-based claims Many companies are reducing R&D spending Affordable innovations take longer Little experience in consumer marketing High barriers to exit New tech is slow to enter medical devices Lack of adequate training on new applications Lack of coordination between cardiologists&radiologists Lack of proper workflow integration of systems Need of broader sales and service coverage</p>	<p><u>Threats</u></p> <p>Rising cost of healthcare Long product life cycle of products Declining in frequency of a healthcare provider’s equipment purchases Insurers are reducing allowable claims Hospitals moving buying decisions to buying groups and hospital administrators Increased demand for refurbished systems Mergers are occurring by product class Hospital markets shifting to commercial markets Price pressure – increasing competition Increasing government regulations</p>

¹² Cheskin Life Science Perspectives 2001 "The Emerging Healthcare Consumer"; FDA 2002 "Improving Innovation in Medical Technology: Beyond 2002"; Fuchs/Garber 2003 "Medical Innovation: Promises & Pitfalls"; Conley 2005 Eureka Medical Industry Analysis; Continuum 2005 "MX: Strategies for Innovation, June 2005"; Frost&Sullivan, 2008; DresdnerKleinwortWasserstein, May 2005

CONCLUSIONS AND REFLECTIONS

The business environment of Philips Healthcare (PH) is very dynamic and challenging, yet profitable. The forces of competition of existing companies, the negotiation power of suppliers and buyers is high in medical device industry. There is always a threat for substitutes due to emerging technologies. The industry's strengths, weaknesses, opportunities and threats concerning innovation are tabulated in this section. Though this is an old method to compare business units of firms, the goal of the table is just to provide an overview for the innovation activities in the healthcare industry.

As the environment is constantly changing, Philips Healthcare has to adapt its goals and strategies accordingly if it wants to grow, and improve its earnings. Innovation is a crucial aspect in order to be competitive in this industry. Nevertheless applying right innovation approaches at right circumstances at the right times is what distinguishes the winner from the others.

PART II. THEORETICAL BACKGROUND

Theoretical background of the concepts and their relationships are presented in Part II.

Starting from the concept of innovation, importance and types of innovations are described in this section. Later on innovation management and its capabilities, innovation strategies and innovation process are explained.

Following the concept of critical success factors and the critical success factors of innovation processes and medical device industry are stated.

CHAPTER 3. BACKGROUND

As the world population is getting older, the demand for care is increasing, and the expectations are growing; people focused and care cycle driven meaningful innovations are becoming the central point of the department. Philips Healthcare believes in the power of innovation for the medical device industry. This chapter provides an overview of major innovation related theories which form the foundation elements for this study. Initially innovation, its importance, types and levels are explained. The following innovation management, innovation strategies, innovation process and front end process are described. Lastly focusing more on the healthcare industry, innovation process in the industry is illustrated.

INNOVATION

Innovation is defined numerous different ways in academic and business world. The usage of the term has been growing exponentially over the years. Despite its reputation; the concept is still immature.

Joseph Schumpeter described innovation as “the opening up of new markets, foreign or domestic, and the organizational development [...] illustrate the same process of industrial mutation, that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one” and named it “creative destruction” in 1930s (Schumpeter, 1943). However according to Porter (1990), innovation is stimulated by an environment and can only be successful if it is supported by the environment. Later on, innovation is defined as “the effort to create purposeful, focused change in an enterprise’s economic or social potential” by Drucker (1998). The concept of innovation is summed up by Rogers (2003) as “An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption.” A couple years later, Goffin and Mitchell declared that changes beyond the specific product/service are essential to sustain a competitive advantage and emphasized the importance of refining what already exists (Goffin & Mitchell, 2005). All of these perspectives are summarized in the figure below.

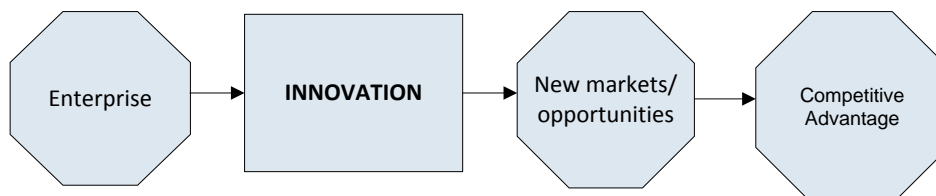


Figure 9. Basic Innovation framework

IMPORTANCE OF BEING INNOVATIVE FOR THE ORGANIZATIONS

Once, the co-founder of Apple, Steve Jobs, said: "Innovation distinguishes between a leader and a follower"¹³. It is vital to be innovative in order to be on top, competitive, effective and efficient. Innovative organizations have been rewarded elevated stock prices, higher share values and better rate of return (Bartsch&Laumann,2006). Innovation also contributes to the 'image' of an organization in a more general way. The image creates a significant impression in the customers' mind of an organization's personality. Foremost aspects of the image are disclosed by Van der Elst, Tol and Smits (2006):

- Technology leadership: "We are early and have leading-edge technology"
- Product leadership: " We create the right products efficiently and on time"
- Market leadership: " We have access to leading customers and markets"
- The right people, culture, governance: " We are world class, have a 'can do' culture, dare to take risks and support each other"

TYPES AND LEVELS OF INNOVATION

The long history of innovation witnessed many studies. However the concept has always remained challenging for many researchers. During this period, various types of innovation were distinguished. Anthony Ulwick classified innovation in four main categories which can be utilized in different situations depending on the characteristics of an organization:

1. *Product Innovation or Service Innovation* – focusing on improving products or services
2. *New Market Innovation* – aiming at creating new markets due to market needs
3. *Operational Innovation* – seeking for creative solutions to strengthen internal business process
4. *Disruptive Innovation* – disrupting an established business model in an existing market by a new technology (Ulwick, 2005)

Along the way, different levels of innovation are identified as well. Utterback and Abernathy (1978) distinguished between incremental and radical innovation, while Abernathy and Clark (1985) compared the concept of conservative and radical innovations. While a radical innovation requires completely new knowledge, large technological advancement, resources and renders existing products, an incremental innovation builds on existing knowledge and does not threaten existing products. Later on, Porter (1986) defined the concept of continuous/discontinuous technological changes. He categorized new products which are entirely new to the world as discontinuous innovation. Tushman and Anderson (1986) defined the notion of breakthrough innovation and concluded that "Organizations that are able to adopt technological change quickly maximize their probability to being able to move with a changing technological frontier".

¹³ Bessant, J; Tidd J. 'Innovation and Entrepreneurship' . Pg. 4. John Wiley & Sons,UK, 2007.

Henderson and Clark (1990) noticed that previous categorizations were not enough to explain an innovative atmosphere. They separated the technological knowledge required to introduce innovations in two new dimensions: *knowledge of the components and architectural knowledge*. According to them, incremental innovation is built on existing components and architectural knowledge and radical innovation is an advance change on both the component and architectural knowledge level. However modular innovation only requires a change in one or more components while architectural innovation is used when the linkage among components is missing. The new classifications demonstrated the organizations that the competencies and strategies required to generate innovations are not the same at different dimensions (Henderson & Clark, 1990).

Unlike Henderson-Clark predictions, Christensen (1997) found out that some radical innovations can strengthen the competitor's position in an industry. Differentiating sustaining innovation from the disruptive innovation, Christensen defined the sustaining innovations as innovations that improve product performance and disruptive technologies as innovations that result in worse product performance. Though disruptive innovations seemed to be valuable, they may not be accepted by traditional customers at first. However disruptive innovations ultimately beat sustaining technologies in satisfying market demand with lower costs. When this happens, companies which did not invest in these innovations are lagging behind and this concept is called 'Innovator's Dilemma' by Christensen. Consequently, the investigation highlighted the importance of understanding the concept of value network, 'the context within which a firm identifies and responds to customers' needs, solve problems, procure inputs, react to competitors and strive for profits', in order to flourish in innovation activities (Christensen, 1997, pg. 32).

However innovating organizations are often disappointed by the returns of an innovation while customer, imitators and other industry players benefit from it. According to Teece (1986), *imitability and complementary assets* are two key factors which can determine the profit maker of an innovation. His investigation revealed that if an innovation can be imitated easily, profits from innovation may shift to the owners of the complementary assets instead of the developers. To prevent this, *business strategy* is pinpointed as an important factor for innovations as it is associated with organizational decision to integrate and collaborate (Teece, 1986).

INNOVATION MANAGEMENT

Though 'innovation' and 'management' seem to be two controversial notions, Anthony and Christensen (2006) believed that organizations can achieve their goals by understanding innovation and the patterns. However it is not an easy process since both strategic and operational innovation management should be taken into considerations. Innovation management is a multifunctional and interdisciplinary process which requires the integration of the market, organizational structure and technological change (Tidd, Bessant, & Pavitt, 2005).

Bartsch and Laumann (2006) classified the innovation management in two main categories: Ad-hoc and Systemic Innovation Management. Ad-hoc innovation management is generally employed in small companies and start-ups. Smaller number of innovations is pursued in such organizations in which the CEO is responsible for innovation activities. However systemic innovation management is necessary in bigger organizations. With the systemic approach, a structured path is designed for innovations and all internal and external parties are involved in the process. The investigation proposed that introducing a planned innovation management process is a key success factor for being a trendsetter in an industry (Bartsch & Laumann, 2006).

Changing trends in innovation altered the innovation management approaches. Believing that innovation management is an activity in a multi-level system, Ortt and Smits(2006) conducted an extensive literature study and summarized the changes in innovation management trends as:

1. The end of the linear model
2. The rise of the systems approach
3. The inherent uncertainty and need for learning
4. Innovation becomes more entrepreneurial

The research proposed that these trends are inter-related therefore an innovation management approach which combines the effects of these trends and other external factors is ideal for survival. According to this study, the outcomes can generate completely different innovation management approaches. Two alternative approaches to innovation management are discussed in the paper: The Strategic Planning approach and Try-and –learn approach. *The strategic planning approach* prioritizes feedback cycles, inter-organizational coordination and formalized learning processes. Predetermined structure of the approach is a downside. Coordination with external parties, adoption of new technologies processes and updating learning processes are problematic with a standard structure. *The try-and-learn approach* is a more flexible approach which can adapt new developments, new actors and new information easily. However since the costs and results are not predictable, the long term planning is not possible with this approach. As a result of this research, the researchers concluded that though innovation management practices have been improving over the years, the failure rates are remaining same due to the changing conditions (Ortt & Smits, 2006).

INNOVATION STRATEGIES

Different innovation strategies are employed for different innovation management approaches. The innovation strategy is a quick look into the future. It demystifies market, technology and competitive trends which can be useful for the innovation forecasts. Bartsch and Laumann stated that the future holds opportunities as well as mine fields. The key to success is to identify the opportunities and avoid mine fields at the same time. According to the researchers the purpose of the innovation strategy is “to provide guidance and support in exactly achieving this goal and thus to optimize the future strategy of our organization by deriving future scenarios and suggesting according measures” (Bartsch & Laumann, 2006, pg.3).=

To minimize the uncertainty level of the innovation, certain tools can be used to increase the probability of success. These applications are based on six innovation strategies: process, speed, learning, market, technology and quantitative. Despite the numerous studies conducted on these strategies, the companies are still struggling to choose the right strategies for right time frames. Lynn and Akgun(1998) applied a contingency approach for new product development and studied these innovation strategies under uncertainty. The investigation proposed that tailoring the innovation strategies to the nature of the innovation and the degree of the uncertainties.

In the 1970s, Booz, Allen and Hamilton suggested that the new product development *process* is a critical factor for successful innovations. Cooper (1979) supported the idea and proposed a multi-phase systemic innovation process. Furthermore, Cooper and Kleinschmidt (1986) stated the significance of proficiency at every stage of the innovation process and recommended organizations to focus on the early stages of the process. Additionally Cooper (2001) put forward that a *dynamic decision making process* for revising and updating R&D projects is essential for an effective management of business portfolios. Realizing the importance of effective management of businesses, portfolio management has gained much interest of innovation managers during last decades (Herstatt & Verworn, 2001).

As the pace of technological change is boosted, *speed* based strategy came into the play and speed to market is viewed as the vital measure for innovation success. Takuchi and Nonaka (1986) proposed that speed and flexibility are essential in competitive environments. Millson, Raj and Wilemon (1992) highlighted the importance of simplification and elimination of steps for speed based innovation strategy.

Knowledge creating organizations that believe in continuous innovation are adopting *learning* based innovation strategy. Meyers and Wilemon (1989) advocated the important role of creating, storing and using knowledge across new product development teams. Gathering, reviewing and storing information, having a stable and clear vision, past product review and management support are main functions of such approach (Lynn & Akgun, 1998). Thomas and Hult (1998) proposed that high levels of innovativeness is associated with a model integrated with the culture of learning. Researchers stated that adopting a *creative culture* is crucial for organizations to keep up with rapidly internationalizing creative industries (Routti, 2001).

Focusing on customer perspectives, marketing departments of organizations concentrates on customer needs and wants. *Market* based strategy, also known as 'Voice of the Customer', requires a continuous communication with the customers. Though market driven approach is counteract with the concept of the innovation, Lawtoon and Parasurama (1980) found out that including customers in the new product development process can influence the outcome of radical innovations. To understand the marketing value of the innovations, Selden and Mcmillan (2006) suggested a customer centric approach for innovation and defending that 'the more customer centric you are, the longer it takes your competitors to figure out your game.' Going one step further, Ulwick (2005) introduced a new concept called 'outcome driven innovation' which considers both marketing and development strategies for innovation

processes. Ulwick’s model emphasized the significance of aligning internal and external activities for innovation processes.

On the other hand, *technology* based strategy, ‘technology-push’, does not trust marketing analyses and believes that customers are not capable of articulating new technologies. Instead they obtain the ideas from R&D departments or engineering teams. According to Elst, Tol, & Smits (2006), organizations need to have more than just technological capabilities. They should be a boundary spanner, “an entrepreneur with a reasonable knowledge of the technological basis on which innovations are based, in combination with knowledge of strategy, organization, societal needs and the economy.”¹⁴ Moreover quantitative based strategy which relies on the numbers was also proposed by Lynn&Akgun (1998). This strategy determines the metrics to assess innovation and utilizes them to evaluate the projects. The constituents of the quantitative based strategy are financial and marketing metrics.

Ortt studied innovation from a market perspective and proposed a number of scenario/strategy combinations. He stated that every scenario has a best strategy. According to his model, yield and risk of these strategies are highly related as well. For instance while wait and see strategy has a low risk/yield, mass market strategy has a high risk/yield. Following figure demonstrates Ortt’s scenario/strategy combinations. (Ortt, Chintan, & Zegveld, 2007) Scenario 1 is for technologies which will experience large-scale production and diffusion almost directly after invention. Scenario 2 is for technologies which will go through a market introduction quickly after the invention and after that a long period of trial and error before large-scale diffusion. Scenario 3 is for technologies which will experience long period of development before the first market introduction.



Strategy	Scenario 1	Scenario 2	Scenario 3
A Mass market strategy	++	--	--
B Niche market strategy	+-	++	-
C Wait-and-see strategy	-	+	++

Figure 10. Possible scenario/strategy combinations (Ortt, Chintan, & Zegveld, 2007)

INNOVATION PROCESS

Even though the term “innovation” is mostly interpreted as new products/services, it is also used to address the process by which an idea is generated, transformed into a product and introduced into a market. According to Schumpeter (1934) “innovation encompasses the entire process that starts with an

¹⁴ Elst, Tol, & Smits (2006), pg.4.

idea and continues along through all the steps from initial development to a marketable product or service that changes the economy". Years later, Watts Humphrey, the father of software quality, defined innovation as "the process of turning ideas into manufacturable and marketable form"¹⁵. Nevertheless the differentiation between process innovations and the innovation process should be clarified in order to avoid any confusion. Coombs et al. (1987) defined the innovation process as "innovation is a sequence of stages, starting from either R&D or some perception of demand and ending with a product sold on the market."¹⁶ Once this process is standardized for product innovations, process innovation can be employed to improve output productivity (Garcia & Calantone, 2002).

The Product Development and Management Association (PDMA) which accepts the innovation process as "an integrated set of unique activities" followed an easy yet effective approach for the innovation process. The PDMA ToolBook for the new product development divided the innovation process into three main areas: The fuzzy front end, the new product development and commercialization. The New Product Development activities are structured and formalized with a disciplined and goal oriented manner. The funding, commercialization date and revenue expectations are predictable and budgeted at this stage. However in the front end of innovation, the activities are less structured and the nature of the work is more experimental. At the front end of the innovation processes, the degree of uncertainty is high and the level of manageability is low. Koen et al (2001) revealed that performance level of the front end activities has a strong correlation with the degree of innovativeness in organizations and highly influential for the other stages. Hence the first phase, the front end, is considered as the vital stage where the most opportunities for improvement of the whole innovation process are hidden. According to the researcher, although the front end of the innovation cycle has a unique nature, it can be studied, evaluated and managed.

Looking at the innovation process from a market standpoint, Ortt divided the whole innovation process in four phases: Invention, innovation, market adaptation and market stabilization. S-curve illustrates the introduction, growth and maturation of innovations in the innovation management. It can also be used for technological cycles experienced by different industries. At early stages, lots of resources spent on new technology but small performance improvements are experienced. As the knowledge about the technology builds up, faster progress takes place. Once major challenges are resolved, innovation reaches an adoption level and exponential growth is observed. Incremental changes bring about large gains during this phase. In the end, the technology realizes its physical limit and it becomes very difficult to further push the performance levels.

¹⁵ Kulkarni & Sharma, 2008, pg. 95

¹⁶ Mutlu, Er, Design Innovation: Historical and Theoretical Perspectives on Product Innovation by Design, 5th European Academy of Design Conference held in Barcelona, in April 2003, pg. 8.

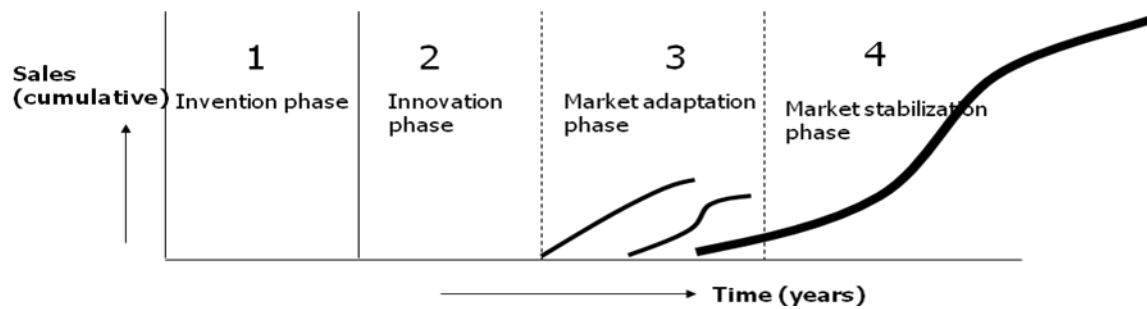


Figure 11. Ortt's Model

KEY CHARACTERISTICS OF THE FRONT END INNOVATION PROCESS

The activities at the front end of the innovation processes are chaotic and dynamic. However they display a number of common characteristics listed below:

- ❖ *Uncertainty* – New concepts are vague and difficult to structure thus; analyzing future applications and their potential is a challenging procedure (Koen, 2001).
- ❖ *Speed* – Speed and time to market have a big influence on the outcomes of the innovation projects. According to Reinertsen (1994), the front end is the cheapest phase to buy time in the innovation processes since the cost of buying time will be augmenting at the later stages (Reinertsen, 1994). However focusing on the front end activities while underestimating the right time to market will result in unfavorable outcomes for the organizations.
- ❖ *Stochastic* – As there are many uncertainties involved in the idea generation and evaluation processes, acquiring necessary resources and communicating between business units become complicated. Therefore the front end is a set of interdependent activities rather than a structured process (Koen, et al., 2002).
- ❖ *Contextual Process* – Organizations sometimes consider that imitating best-processes is the finest way to success. However innovation management practices are evolving toward a contextual approach (Ortt & Van der Duin, 2008). The front end feeds the rest of the innovation process. Therefore it is essential for the initial activities to fit in the contextual nature of the environment.

CATEGORIZATION AT THE FRONT END

Though the front end is a contextual process which differs across organizations and industries, literature suggests that a number of common variables are influential on the realization of the front end. Frishammar and Florén (2009) conducted an extensive literature review and proposed that following variables are very important for the front end activities:

1. *Product newness*. The level of product newness affects the front end activities, predictions and outcomes. For instance, discontinuous innovations require more complicated and iterative problem solving processes and different approaches are applied for concept generation and refinement steps. Because of their nature, the research and development of such innovations is

ambiguous and unstructured. Therefore the discontinuity of the innovations should be examined and the newness dimension should be taken into consideration while managing front end activities.

To classify potential projects, Booz Allen and Hamilton’s project typology introduced in 1980s has been used in product development research. Based on Ansoff’s original product/market matrix, this categorization is shown under 6 main headings (Griffin & Page, 1996) :

- New to the World (NTW) - New products which create a completely new market
- New to the Company (NTC) - New products which allow a company to enter for the first time to an established market
- Additions to Existing Product Lines (APL)- New products which supplement a company’s existing product lines.
- Improvement in/Revision to Existing Products (IM)- New product that offer enhanced performance or value and replace existing products
- Repositioning (RP)- Existing products targeted to new markets
- Cost Reduction (CR)- New products which provide similar performance at lower costs

		Newness to the Market		
		Low		High
Newness to the Firm	High	New to the Company		New to the World
		Product Improvement	Add to Existing Lines	
	Low	Cost Reduction	Repositioning	

Figure 12. Classification of Product newness ¹⁷

2. *Type of product.* Front end activities are applied differently depending on product types. Physical/assembled products (eg. Electronic devices), non-assemble products (eg. Drugs) and services necessitate particular knowledge generation and selection criteria. Hence characteristics of the products should be identified before they are exposed to the front end of the innovation process.

To reduce uncertainties, various methods and tools are used for filling the information gaps and raising the chances of success. Lynn and Akgun (1998) suggested that uncertainty is obvious in two primary

¹⁷ Griffin&Page,1996

modes: market and technical. Organizations experience difficulties about their target customers and their needs under market uncertainty. Under technical uncertainty, organizations struggle to understand forms, performance and costs of the products. As there is no universally effective innovation approach, a new product strategy is generated by considering the innovation type under development. Following two-dimensional matrix illustrates a framework of application fields for the front end. The framework builds on the Ansoff Matrix which is originally used for decision making on product and market growth strategies. The highest level of uncertainty turns out to be in radical innovations since the level of newness is also high. Innovations which are “new to the world” are categorized under radical innovation. Technology driven innovations such as customized products have already a target customer group therefore they have lower market uncertainty. Likewise, if organizations already have technologies available however the target customer is still uncertain, they need to pursue market innovations. Last but not least, sometimes the innovations are incorporated on existing technologies/products instead of creating something from scratch. These changes are classified as incremental innovations.

		Technology Uncertainty	
		Low	High
Market Uncertainty	High	Market Innovation	Radical Innovation
	Low	Incremental Innovation	Technical Innovation

Figure 13. Classification of Product type

Additionally Henderson-Clark model mentioned in previous sections can also be utilized to classify innovations more carefully and assess the risk of a particular innovation at the front end.

Component Knowledge	Architectural Knowledge	
	Satisfactory	Defective
Satisfactory	Incremental	Architectural
Defective	Modular	Radical

Figure 14. Henderson-Clark model

3. *Type of customer.* Close relationships and continuous dialogs between customers and organizations have a big impact on the outcomes of the innovation processes. Involving customer in the process lessens the formality and opens up new opportunities for the organizations.

Business strategies of companies also play a key role for the success of innovations. In order to categorize companies under investigation, a business strategy typology was developed by Miles and Snow. Considering the speed with which an organization can react to changing environment conditions, they classified the companies in 4 categories:

- Prospectors: The first priority of prospectors is “value” with new products, markets and technologies. They are fast to respond for windows of opportunities.
 - Analyzers: Though analyzers are not the innovators of the market, they are the fast followers who introduce innovation after careful monitoring of their competition.
 - Defenders: Defenders focus on secure niche markets with stable products in order to obtain the competitive advantage.
 - Reactors: Reactors are not aggressive market players, they only respond when forced by strong environmental effects (Griffin & Page, 1996).
4. *Access to relevant knowledge.* Previous investigations show that when organizations lack absorptive capacity, they either concentrate on past knowledge or they form partnerships to be able to compete in the market. These choices make the front end more complex. For this reason, the absence of relevant knowledge and the knowledge generation decisions have significant implications for the front end activities (Frishammar & Florén, 2008).

While Frishammar & Florén identified contextual front end factors from a project viewpoint, Ortt and Van der Duin (2008) distinguished four different contextual factors of the innovation processes from a market point of view: Organization (centralized, decentralized, functional, organic), innovation (incremental, radical, transformational), industry (high-tech, supplier driven, fast moving customer goods) and country/culture.

MEASUREMENT AT THE FRONT END LEVEL

Innovation is an abstract concept which cannot be quantified easily. Nevertheless researchers have sought to measure innovations by employing different methods. The most common method of measuring innovation is through the use of indicators.

Particular units are essential to evaluate the outcomes effectively. Literature shows that researchers approached innovations from different perspectives and employed different success measures to evaluate their findings. Though measurement criteria set the basis of the assessment process, they should be coherent with the context. Since the front end is exposed to continuous change, evaluation and up-dates, various units are utilized to measure the process. Organizations that exercise this practice and are able to communicate them in their culture manage to get satisfactory results from the front end. (Reinertsen, Streamlining the Fuzzy Front-end, 1994) Focusing more on the front end, a number of measurement units for the process are tabulated below.

Table 3. Process Measurement Units

Process Measurement	Description
Cycle time	Time measured for a certain activity (Reinertsen, Streamlining the Fuzzy Front-end, 1994)
Time	Cost and effectiveness of screening process (Reinertsen, 1999)

Number of suggestions	Accepted suggestions (Petri, 2000)
Importance of radical innovation in industry	Determination of importance of radical innovation in industry (Stringer, 2000)
Quality Index Metric	Checklist for a successful development (Smith, 1999)
Pipeline Revenue Projection	Projection revenue in pipeline (Smith, 1999)
Dynamic Cycle Time	Average project lifetime (Smith, 1999)
Patent Metrics	Number of applications, number of issued patents, number of disclosures (Smith, 1999)
Percentage of Revenue	Percentage of revenue derived from sales x number of years (Coyne, 2001)

INNOVATION MANAGEMENT IN HEALTHCARE

Understanding the various innovation management approaches is a prerequisite to select the best approach in a given context. However nowadays companies no longer apply best in class innovation practices to their businesses but rather adopt context based approach to their practices. With increasing competition in healthcare industries, an increasing number of companies are developing a contingency approach to innovation management and adapting their innovation management to their businesses. Ortt and van der Duin (2008) called this “contextual innovation”.

Competition in high technology industries such as medical device industry is based on performance rather than price. To keep up with the competition, medical device companies need to be innovative and continuously break technological barriers. Lobmayr (2009) suggested that organizations active in innovation and regulatory activities end up being the market leaders of the medical device industry. Innovations are originated from new technologies; they create new markets, and induce major changes in industries. Internal processes of the organizations occasionally fail to generate innovations when they have to follow up scheme outside the standard company routines (Lettl, Hienerth, & Gemuenden, 2003). Innovation activities are carried out differently across different organizations therefore; they need to be organized and managed accordingly. After studying the medical device industry, Lobmayr (2009) presented the key phases of the innovation process in medical industry as: invention, development, diffusion and approval.

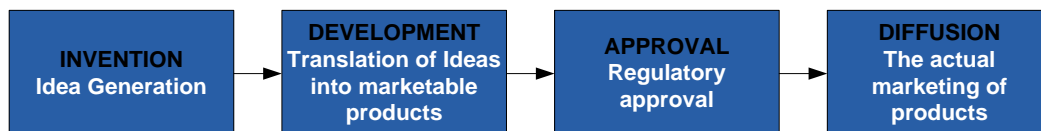


Figure 15. Innovation process of medical industry¹⁸

Despite the fact that a generic map of the innovation process is well-acknowledged, a standard method on how to operationalize these concepts does not exist. The Innovation process model of the medical/healthcare organizations varies depending on the applied technology, time, budget, and sources of information. Investigating innovation processes in small-medium medical device companies in the USA,

¹⁸ Lobmayr, Summer 2009

Rick Russell (2008) conducted an extensive literature study to understand the product lifecycle of the medical device products.

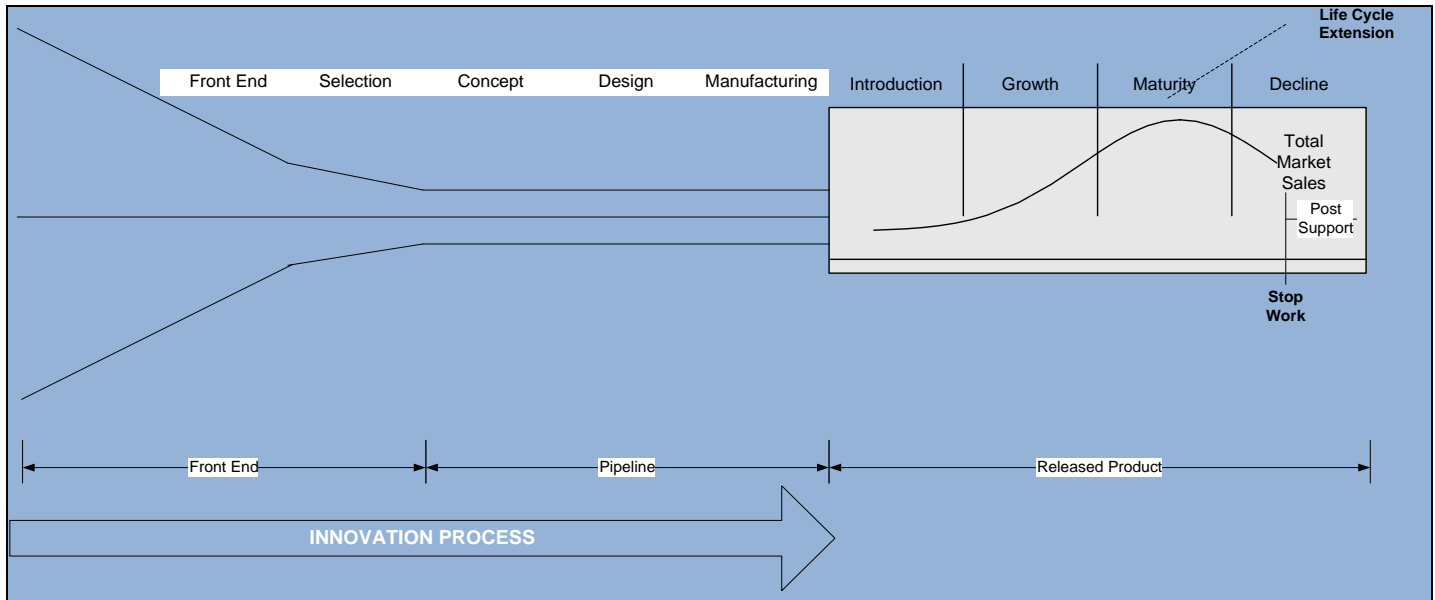


Figure 16. Innovation process in medical device industry¹⁹

The product lifecycles can be divided into three sections: The front end of innovation, the development pipeline and the product maturity phase. Initially ideas are generated at the front end of the innovation process. The front end of innovation starts with idea collection, screening and approval of projects for the release to the pipeline. Subsequently the development pipeline gets the approved projects, engineers innovations and generate new products. The product lifecycle curve starts as soon as the product is released to the market (Cooper, 1994) (Russell, 2008).

Focusing more on the front end innovation process in medical device companies, Russell (2008) gathered the activities carried out in the front end under three main phases: idea collection, idea screening and project selection. Russell illustrated the major front end front end activities as in following figure.

¹⁹ (Russell, 2008)

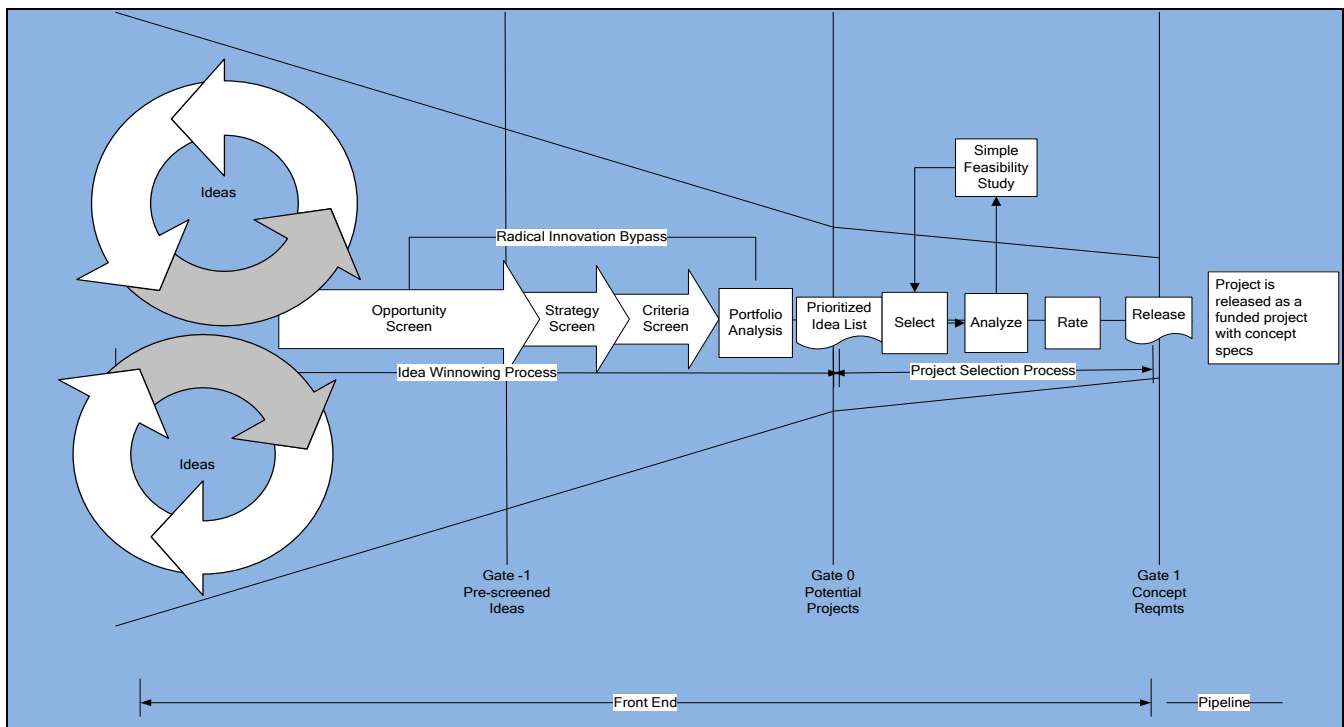


Figure 17. Front end innovation process in medical device industry ²⁰

The front end process begins with an idea collection phase in which ideas are collected, clarified and incubated. Following a three stage idea screening phase takes place: Opportunity screening, strategic fit screening and project level screening. The ideas which are out of scope for the innovation projects but can generate profitable business opportunities are identified at the opportunity screening stage. The criteria provided by the management team are used at the strategic fit screening stage in order to match the ideas with the goals of the management. Project-level screening stage evaluates the capability of the company to develop potential innovations considering finance measures, technical ability, resource availability and time to market lead-times. When the ideas are screened, they are weighted, prioritized and handed over to the project selection process. The project selection process involves four phases: selection, analysis, rating and release. The selected projects are analyzed and rated for importance and fit to the business and lastly rejected or approved.

CONCLUSIONS AND REFLECTIONS

Innovation was perceived differently by various scholars. Anthony and Christensen (2006) believe that “the new ways of doing business, making money, or understanding what customers want are often more valuable forms of innovation than technology”. Disagreeing with the notion of locking the R&D labs with innovation ideas, Hamel (2006) defends that innovation should be in the culture of the company and

²⁰ Wheelwright/Clark (1992); Robert Cooper (1990 to 2005); PDMA Handbook/Toolbook ; HBS (2000) Radical Innovation; Rick Russell(2008)

everyone must be stimulated to generate valuable ideas. While Ulwick (2006) focuses on understanding customers and outcome driven innovation, Gary (2006) believes in renovating business models for success in innovations. Considering the theories and approaches mentioned in this section, we can consider that innovation refers to every new activity which can bring in value for the businesses. It is not only limited to the products and technologies but also include business models, culture, communication techniques, strategies, approaches. The goal of this section is to provide a theoretical background on innovation and innovation management approaches. The information presented will later be used in order to study the innovation activities at PH.

The main focus of this research is the front end innovation process. Although the front end of the innovation cycle has a unique nature, it can be studied, evaluated and managed. In the front end of innovation, the degree of uncertainty is high and the level of manageability is low. Previous research shows that performance level of the front end activities has a strong correlation with the degree of innovativeness in organizations and highly influential for the later stages. Hence the front end is considered as the vital stage where the most opportunities for improvement of the whole innovation process are hidden.

To keep up with the competition, medical device companies need to be innovative and break technological barriers. Though innovation contributes to the image of an organization, assuming that innovation leadership is significant to achieve market leadership may be a mistake. It can distinguish a pioneer and a follower however this does not mean that innovativeness can grant a golden trophy in the market. In other words, sometimes innovating organizations can be disappointed by the returns of an innovation while customers, imitators and other industry players benefit from it.

Going to the core of the cardiovascular applications, we can see that X-ray is the central technology used. Referring back to Ortt's diffusion model explained in the theoretical background section, the exceptional nature of X-ray technology is revealed. After its invention, the X-ray technology was sold, traded and stolen across companies for various applications. Because modules for this technology were already available, it was easy to assemble X-ray appliances (Ortt, Shah, & Zagveld, 2007). Therefore there was already large scale diffusion before there was a large scale factory. Meaning X-ray technology diffused in a mass market directly after its invention, which indicates that both innovation and market adaptation phases almost faded away. In such models, the value of the technology increases with the number of customers. Hence some kind of standards by means of patents or holding unique knowledge should be owned for the pioneers to protect the market.

CHAPTER 4. EXPLORING INNOVATION ACTIVITIES

The aim of this study is to improve innovation process at PH CV BU. If the innovation process at PH is studied at a generic level, the elements which are needed to be improved will not be recognized. Believing that the pitfalls of the innovation process are within different phases at a lower aggregation level, critical success factor method is used to provide a feedback for the innovation activities of PH CV BU. This chapter provides an overview of critical success factors and presents a contextual approach for critical success factors for the front end innovation process.

CRITICAL SUCCESS FACTORS

In 1961, Daniel proposed the existence and the determinacy of promising factors which lead to success for a company. Later on, Anthony (1972) expanded the concept by emphasizing the need to tailor these factors to a company's strategical objective and its managers. The critical success factors (CSFs) were first introduced by John Rockart (1979) as an instrument for defining executives' information needs in 1979 (Boynton & Zmud, 1984) (Dobbins, 2002). Elaborating Daniel and Anthony's ideas, Rockart aimed to ascertain the information needs of managers and link them to the information system. He defined the term as:

“CSFs are the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department or organization. CSFs are the few key areas where "things must go right" for the business to flourish and for the manager's goals to be attained.”
(Rockart & Bullen. June 1981. Pg.7)

Leidecker and Bruno (1984) broadened the concept by paying more attention to variety instead of validity. They redefined CSFs as the characteristics, conditions or variables that can have a major impact on the success if managed properly. Looking deeper into the issue, Grunnert and Ellegard (1992) brought in a more comprehensive notion, “Key Success Factors” (KSF), and stated it as a skill or resource that a company can invest in, which in turn, results in a significant part of the observable differences in perceived value and/or relative costs in the companies' relevant markets. The KSF can be distinguished by their level of imitability and changeability which can grant competitive advantages for companies in various markets.

Perspective, application and functionality of the key success factors are imperative aspects while exploring critical success factors. Grunnert and Ellegard believed in the causal relationships between success and cause of success. In 1993, the researchers distinguished three main schools in which the key success factor concept is used differently. *Key Success Factors (KSF) are used as a business characteristic* in the design school in which every business is considered unique and had its own matching environment. This perspective enlightens an organization about its business ecology and assists with its future predictions. *Key Success Factors are used as a planning tool* in the planning school which facilitates

organizations in finding the right strategy for their goals. Identifying a number of factors help decision makers to improve their strategies in this case. Lastly, *Key Success Factors are used as a market description in the shared experience school* which believes that the business strategies are open to research aiming at finding how different strategy types are linked to success under various conditions (Ellegard & Grunert, 1992). In literature, the terms CSF and KSF are often alternately used. However while the concept of CSFs is inspired by the issue of optimum match between environmental conditions and business characteristics, KSFs are statements about causal relationships between success and some causes of success.

On the other hand, Pinto and Prescott (1988) argued against the assumption of static degree of importance of the CSFs throughout the lifecycle of a project. On the contrary to other studies which chose to define different sets for CSF for each phase, their approach is based on the same set of CSFs while examining their individual degree of criticality along the different phases. For their perspective the degree of criticality of CSFs varies during different phases of a project therefore the phases of projects should be examined more thoroughly (Pinto & Prescott, 1988).

SOURCES AND DIMENSIONS OF THE CSFs

Focusing on vital aspects which really make the difference between success and failure is the key to success for most managers. Therefore these fundamental areas should be monitored and evaluated constantly. Rockart (1981) distinguished CSFs into five major sources:

- *The industry* – Characteristics of an industry determines the success factors of the companies within the industry. Eg. Supply-demand characteristics, technology, product characteristics, concentration.
- *Competitive strategy and company's position* – Company's history and competitive strategy determine its position in an industry. Eg. Niche strategy, imitation, emerging markets.
- *Environmental factors* – These are macroeconomic factors over which an organization has little or no influence. Eg. Economic, governmental policies, laws, demographics.
- *Temporal factors* – Areas which all of a sudden appeared an unexpected happening. Eg. Lack of managers or specialized employees.
- *Managerial position* – Various functional managerial positions have generic sets of CSFs. Eg. Most R&D managers have similar CSFs for their position.

Critical success factors are also placed in various dimensions to further clarify the focus and the position of the organization. Initially Rockart (1981) categorized CSFs by four dimensions: *Internal, External, Monitoring, Adapting*. In the case of internal versus external dimension; while internal CSFs are actions within the organization, external CSFs are activities performed outside the organization. The management team can directly influence the issues if they face with internal problems whereas the management can only have an indirect effect on issues by being proactive or reactive if they face with external problems. On the other hand, monitoring versus adapting CSFs is of assistance for the ongoing and new activities in organizations. Monitoring CSFs are employed while following known issues.

Adapting CSFs are used for improving and growing organizations (Boynton & Zmud, 1984) (Bullen & Rockart, 1981) (Caralli R, 2004).

HIERARCHICAL NATURE OF CSFs

Critical success factors are very important for a company's success however the management of an organization is not limited by only these factors. A company's strategy, objectives, goals, measures and problems are all complementary to each other. Aligning all of these concepts opens many doors for a company (Bullen & Rockart, 1981). Moreover different CSFs are required at different levels of the company's hierarchy. While an individual manager has his own CSFs for a particular goal, dissimilar CSFs are necessary at different hierarchical levels of a company. Rockart and Bullen (1981) came up with four main levels which are essential to be considered. *Industry CSFs* are general industry value drivers that influence each organization in an industry in the development of its strategy, objective and goals. In response, an organization develops its own success factors to be successful in that industry. (*Corporate CSFs*) However taking into account environment of each department and its business, every suborganization construct their own CSFs to attain their goals in their own league. Hence the CSFs should be customized to the industry, company and the manager's position. Figure illustrates the position of CSFs within the perspective of basic terms of management.

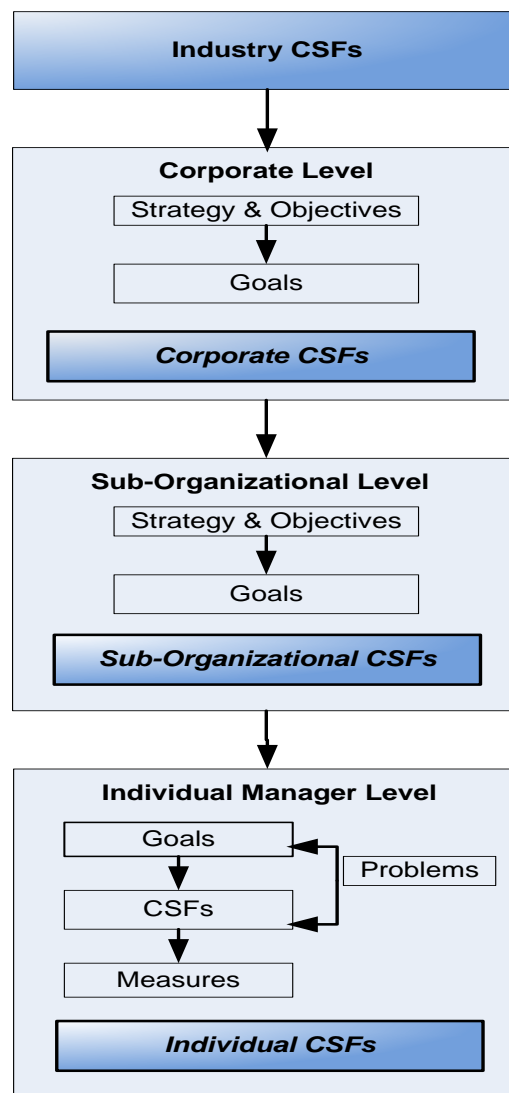


Figure 18. Hierarchical Nature of CSFs ²¹

The sources of CSFs can provide numerous CSFs at the corporate or operational unit level of an organization. Some sources are more useful at the corporate level than the operational unit level. For instance industry CSFs brings in more CSFs at the corporate level than any other level in the hierarchy. Therefore a good fit is necessary for CSFs on both corporate and operational unit level. As each level of an organization has its own focus and responsibilities, the strict balancing and leveling is not a typical property for CSFs . (Caralli R, July 2004)

²¹ Bullen & Rockart (June 1981)

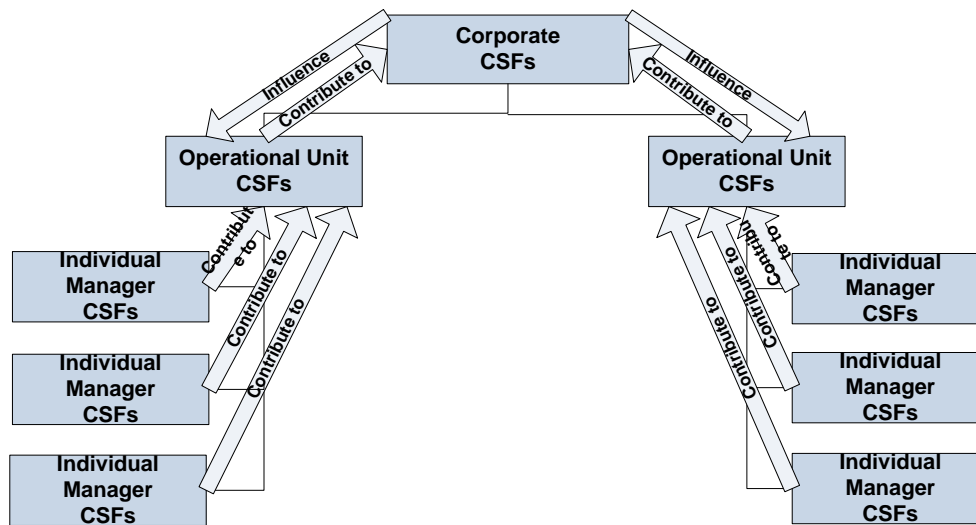


Figure 19. Relationship between Hierarchy Units ²²

CONTEXTUAL APPROACH FOR CSFs

Innovation gives rise to “newness” and “change” which increases the uncertainty of the outcome significantly. The process of innovation is used to manage uncertainty about technical performance, market response, and organizational capabilities (Kleine & Rosenberg, 1986) In their April 2004 issue, In Vivo Business and Medicine Report proposed that “the innovation process must be fundamentally realigned to deliver greater efficiency, speed, and higher-quality output in R&D.” The organization must perform well in key areas on a consistent basis to achieve the mission. Cooper (1999) stated that exploring the invisible factors which can lead to success in innovation activities is very important to understand the innovation mechanisms. Therefore identifying CSFs does not only influence business goals and objectives but also assists organizations for choosing right process measures.

Balachandra (1997) opposed the idea of general critical success factors in R&D projects when he came across with contradictory findings in old researches. He defended his argument by underlining the long list of factors, the differences in the author’s interpretations and the differences of the meanings of similar factors in different context. Therefore as the importance of different factors changes depending on the situation; CSFs of front end innovation process should be categorized with a contingent approach in market, technology, environment and organizational dimensions.

²² Caralli R (July 2004)

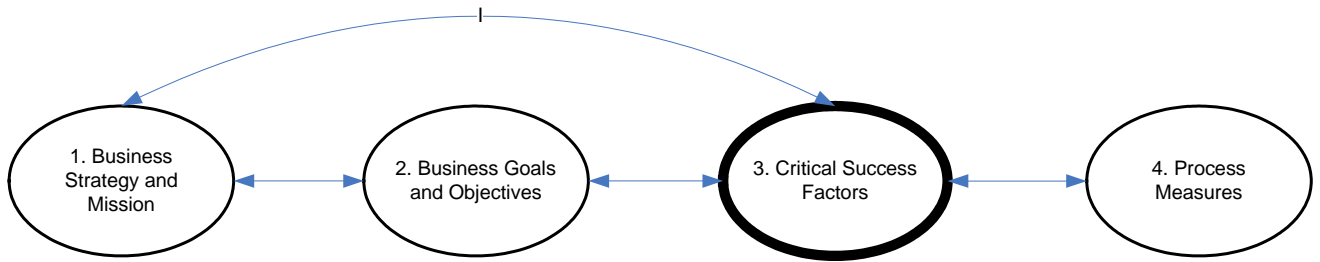


Figure 20. Relationships between Critical Success Factors and Innovation Processes

CSFs AND INNOVATION PROCESSES

For decades, innovations have been a requirement for the growth and prosperity of most organizations. Innovations create new opportunities for the organizations however; they also bring high risks of failure along. Therefore managers are decidedly interested in exploring factors which influence the success of new products (Ernst, March 2002). Although managing innovation is a controversial concept, most researchers believe that the organizations can be reshaped to have a structure, culture and processes that are favorable to innovation (Baker, 2002). Bearing that in mind, the researchers are focusing more on the process side of the new product development, believing in its importance for a successful new product programs (Cooper & Kleinschmidt, 1986). Nevertheless, ignoring soft aspects of innovation while focusing on formal structures do not bring success for innovation processes. As soft and hard aspects are complementary to each other, only a balance between these factors triggers innovation success (Ahmed, 1998).

In early 1970s, Scientific Activity Predictor from Patterns with Heuristic Origins contacted a study on success factors of innovations in the UK. The research identified 27 characteristics of the innovation processes that differentiated between success and failure of the innovations. According to Freeman (1972), these success factors are associated with understanding customers' needs, marketing capabilities, and the efficiency of process, company's management skills and ability to absorb external information (Van der Panne, van Beers, & Kleinknecht, 2003). In 1980, Cooper's study on 200 Canadian innovations presented three factors that determine the viability of an innovation as the *nature of the product, the market environment and the synergy among product-technology-firm*. Rothwell's research (1992) broadened the Cooper's CSFs and created an updated list of the key success factors for innovation processes.

Table 4. Rothwell's CSFs (1992)

Rothwell's (1992) CSFs of innovation:

- Creating good internal and external communication
- Treating innovation as a corporate task
- Implementing effective screening, planning and project control procedures
- Stressing efficiency and high quality work with quality control and up to date production
- Building strong market orientation through customer involvement
- Providing a good technical service to customers
- Possessing the presence of certain key attributes such as product champions
- Having high quality management: Dynamic and open minded

Later on, Cooper (1999) carried out a more extensive study on hundreds of innovation cases aiming at clarifying the difference between winners and losers. Recalling the meta analysis conducted by Mitzi Montoya-Weiss and Roger Calantone(1994) on new product performance, Cooper revealed two types of success factors: *'Doing the right projects'* and *'Doing the projects right'*. *'Doing the right projects'* deals with external success factors which cannot be controlled by the organization such as the market, technologies, competitive situation. Even though the organizations do not have power over these projects, they are useful to consider for selection and prioritizing projects. *'Doing the projects right'* takes care of the factors which affect innovation processes. Although these can be managed by the project teams, they are the 'invisible' ones which can only be identified from time to time. After studying these controllable factors Cooper generated a list of critical success factors and a list of blocker factors which are influential on innovation processes (Cooper R. , 1999).

Table 5. Cooper's CSFs and Blocker Factors for Innovation

<u>Actionable Critical Success Factors of Innovation Processes:</u>	<u>Blockers of Innovation Processes:</u>
<ol style="list-style-type: none"> 1. Reliable up-front homework – Define product and project 2. Voice of the customer – Market and customer inputs 3. Product advantage – Differentiated, unique, high value 4. Stable and early product definition 5. A well planned launch 6. Strong go/kill decision points – Funnels 7. Cross functional teams 8. An international orientation 	<ol style="list-style-type: none"> 1. Ignorance for innovation activities 2. Lack of skills – Not knowing how to do the key tasks 3. Faulty in new product process 4. Over confident attitude towards innovation 5. Big rush to innovate 6. Too many projects and not enough resources

Kleinknecht’s extensive literature review on critical success factors of innovation reviewed 43 studies on determinants of success and failure of innovation. He classified the major causes of success under four main categories and summarized critical success factors of innovation in the following figure. Studying the rank order of these factors, Kleinknecht underlined a significant finding about the on success factors of innovation: “Companies agree on the positive impact of factors such as firm culture, experience from innovation, multidisciplinary teams or the advantages of the matrix organizations however; on factors such as competition, R&D intensity, top management support, and the degree to which a project is innovative or technologically advanced, ambiguity remains” (Van der Panne, van Beers, & Kleinknecht, 2003).

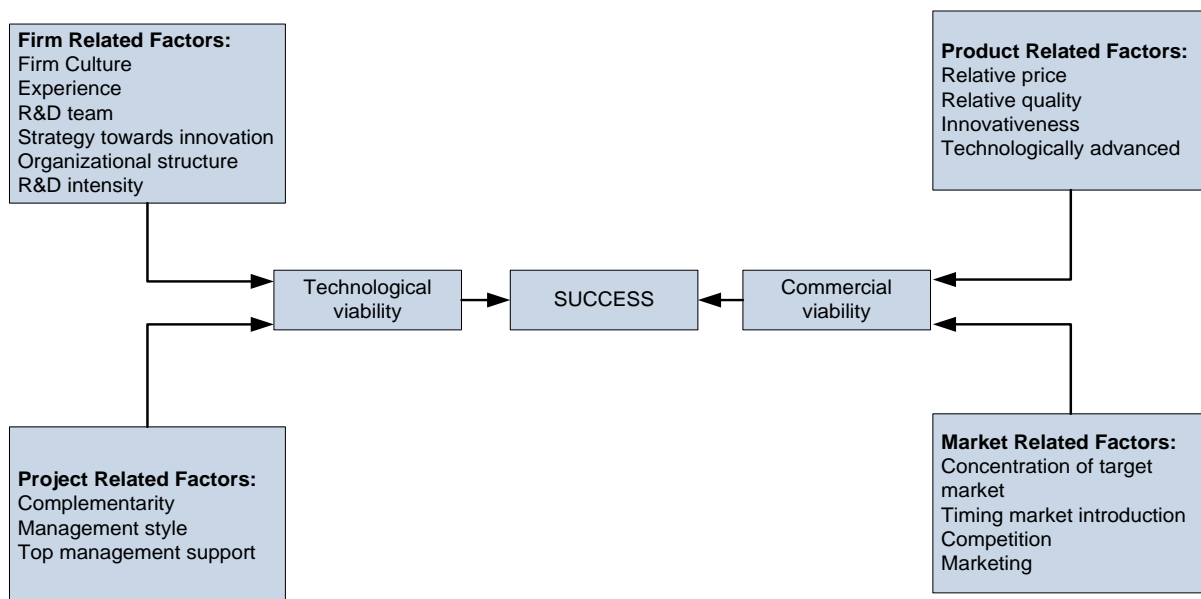


Figure 21. Critical Success Factors for Innovation ²³

While Kleinknecht studied the CSFs by investigating the ranking of success factors by importance, Read(2000) specifically focused on the organizational innovation and studied the determinant of the successful organizational innovations. Furthermore, Baker (2002) examined the success factors which can promote innovative capacity of an organization at different levels. Defending the complexity of innovation processes at large and hierarchical organizations, Baker generated a list of success factors at individual level, project level, organization level and environment levels (Baker, 2002).

²³ van der Panne, van Beers, & Kleinknecht (2003)

Table 6. CSFs at different levels of an organization

<u>The Individual Level:</u>	<u>The Project Level:</u>	<u>The Organizational Level:</u>	<u>The Environmental Level:</u>
<ul style="list-style-type: none"> - Employee empowerment - Engagement - Trust - Training - Job rotation - Individual networks 	<ul style="list-style-type: none"> - Team diversity - Management - Openness to new ideas - Differentiation of Phase I versus Phase II activities 	<p>Effective, speedy and efficient systems and processes for:</p> <ul style="list-style-type: none"> - Environmental scanning - Knowledge absorption & sharing - Classification, screening, prioritization - Innovation stream management - Innovation project management - Innovation diffusion - Change management - Definition of the business boundaries - Motivating innovation 	<ul style="list-style-type: none"> - Level of competition - Extent of customers - Geographical co-location - Inter-organizational associations - Communities of practice - Partnerships - Alliances - Regulatory context - Stakeholder engagement

Subsequent to his review of empirical literature on success factors of new product development, Ernst (2002) emphasized the significance of the existence of a formal or informal new product development process in an organization. Success factors of Ernst (2002) are tabulated below.

Table 7. Ernst's CSFs (2002)

<p><u>Ernst's CSFs:</u></p> <ul style="list-style-type: none"> - High-quality planning in activities - Initial, rough evaluation of ideas and selection be - The project concept and target market studies - Ongoing control mechanism - Up-date market information - Dedicated project organization - Cross functional project teams with high motivation and commitment - Senior management's value recognition and support - Effective and long term strategy
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CSFs AND THE FRONT END OF THE INNOVATION PROCESSES

An extensive literature review was conducted to assemble the most important critical success factors of the front end innovation process. To present an overview and transparency, the success factors which are mentioned frequently in the literature are described in this section. Following table summarizes the success factors and the literature corresponding to these factors.

Table 8. CSFs of Front End Innovation Process

Success Factors for Front End Innovation Process	Reference
The presence of idea visionaries or product champions	Conway and McGuinnes (1986); Griffiths-Hemans and Grover (2006); Heller (2000)
Idea refinement and adequate screening of ideas	Boeddrich (2004); Bröring et al. (2006); Conway and McGuinnes (1986); Cooper (1988); Cooper and Kleinschmidt (1987); Elmquist and Segrestin (2007); Griffiths-Hemans and Grover (2006); Khurana and Rosenthal (1997); Kohn (2005); Lin and Chen (2004); McAdam and Leonar (2004); Murphy and Kumar (1996; 1997); Rosenthal and Capper (2006); Zien and Buckler (1997)
An adequate degree of formalization	Boeddrich (2004); de Brentani (2001); Gassmann et al. (2006); Khurana and Rosenthal (1997; 1998)
Early customer involvement	Alam (2006); Bacon et al. (1994); Cooper (1988); Cooper and Kleinschmidt (1987); Gassmann et al. (2006); Langerak et al. (2004); Murphy and Kumar (1997); Verworn (2006)
Internal cooperation among functions and departments	Bacon et al. (1994); Conway and McGuinnes (1986); Gassmann et al. (2006); Heller (2000); McAdam and Leonar (2004); Moenaert et al. (1995); Murmann (1994); Kohn (2006); Verganti (1997); Verworn (2006)
Competitive analysis	Bacon et al. (1994); Börjesson et al. (2006)
Senior management involvement	Koen et al. (2001); Khurana and Rosenthal (1998); McAdam and Leonar (2004); Murphy and Kumar (1997);
Preliminary technology assessment	Bacon et al. (1994); Cooper (1988); Cooper and Kleinschmidt (1987); Murmann (1994); Verworn (2006)
Alignment between innovation process and strategy	Bacon et al. (1994); Khurana and Rosenthal (1997; 1998)
An early and well defined product definition	Backman et al. (2007); Bacon et al. (1994); Cooper (1988); Cooper and Kleinschmidt (1987); Dickinson and Wilby (1997); Khurana and Rosenthal (1997); Kohn (2006); Montoya-Weiss and Calantone (1994); Montoya-Weiss and O'Driscoll (2000); Parish and Moore (1996); Seidel (2007); Song and Parry (1996)
External cooperation with others except customers	Khurana and Rosenthal (1997); Murmann (1994)
Learning from experience capabilities of the pre- project team	Verganti (1997)
Project prioritization, project management and the presence of a project manager	Khurana and Rosenthal (1997); Murphy and Kumar (1997); Nobelius and Trygg (2002)
A creative organizational culture	Murphy and Kumar (1997)
A cross-functional executive review committee	Khurana and Rosenthal (1997)
Product portfolio planning and effective portfolio management	Khurana and Rosenthal (1997); Koen et al. (2001)
Constancy of Purpose	Koen et al. (2001)
Detailed environment and future analysis	Koen et al. (2001)
Rapidly developing actionable plans and effective risk management	Koen et al. (2001)
Business-Technology interspersing	Koen et al. (2001)
Marketing and technological synergy	Link (1987)
Efficient concept generation, selection	Dooley (2002)

and design

Quantified objectives and measure of performance Dooley (2002)

The Presence of Idea Visionaries or Product Champions

Innovative ideas can only emerge if there are committed enthusiasts who can show leadership. Conway and Mcguinnes (1986) referred to these enthusiasts as 'product champions' while Griffiths-Hemans and Grover (2006) called them 'idea visionaries'. Though idea visionaries are more on the abstract level, product champions are more involved with tangible activities. According to these researches different actors can be responsible for this function. Thus although idea originators can lead championing, they need the assistance of others to promote and develop the concept (Conway & Mcguinnes, 1986).

Idea Refinement and Adequate Screening of Ideas

Front end innovation process starts with an idea (Khurana and Rosenthal, 1997). Products are outcomes of ideas which are generated from thinking processes of various parties (Boeddrich, 2004). As not all ideas can result in success, Cooper (1988) stated that evaluation of the ideas is as important as high quality ideas. Therefore successful idea generation process and effective screening process are essential to chase the ideas with high potential.

New ideas can originate from environmental scanning, customer interaction and internal personnel yet; Murphy and Khumar (1996) demonstrated that the ideas generated by internal personnel have bigger success rates. According to Cooper and Kleinschmidt, although the initial screening is highly correlated with new product performance, it is inadequate in many organizations. Furthermore, early termination of ideas diminishes costs and brings about cost savings (Lin and Chen, 2004).

Murphy and Khumar proposed that idea screening should take place in two steps: Business analysis and feasibility analysis. Business analysis is used to screen new ideas in terms of viability as business propositions. Feasibility analysis assesses if sufficient company resources are available for a development process.

An adequate degree of formalization

As front end processes are quite ambiguous, order and predictability can generate better outcomes. Khurana and Rosenthal (1998) illustrated importance of a formal front end process and highlighted its significance on stability of the development process. However the researchers noticed two kinds of risks: an absence of formality and an excessive dependence on it. Therefore chaos and order should be balanced appropriately.

Early Customer Involvement

Market driven approach seems to be essential for front end processes. Rothwell (1974) stated that understanding consumer needs is the key differentiator between success and failure projects. Furthermore a market orientation has a positive effect on the number of new products and innovation process performance (Lukas and Ferrell, 2000)(Pelham and Wilson, 1996). The early customer

involvement boosts up the product success rates and customer knowledge flow into the front end process (Cooper and Kleinschmidt)(Gassman et al, 2006).

Nonetheless customer involvement may also generate problems. Ulwick (2002) introduced outcome driven innovation and suggested that it is more feasible to find out value and benefits of what customers want instead of focusing on a specific solution. For Ulwick, exploring the requirements and capturing desired outcomes provide better results than asking customers for new product recommendations.

Internal Cooperation among Functions and Departments

Internal collaboration plays a key role in the front end phase as early involvement of major functional units results in promising benefits (Verganti, 1997). Besides working in cross functional teams in front end can take control of resistance to change and promote innovation (McAdam and Leonard, 2004). By this means, the ideas are not only exposed to the review of knowledgeable individuals from different units but also the knowledge generation process is also contributed. According to Verganti (1997), cross functional integration:

- Expands knowledge base and reduce uncertainties
- Ensures alignment between product concepts and company strategy
- Facilitates the communication between upstream and downstream phases of the innovation process

Though Kohn (2006) identified the strongest interdependency of front end as the link between R&D and marketing activities, Verganti(1997) put forward that more departments should be involved in this process. Additionally Bacon's research (1994) highlighted the importance of trust and effective communication among members of the multifunctional teams.

Competitive Analysis

Cross functional integration and early customer involvement are very important for the front end processes however are not sufficient. Bacon et al (1994) emphasized the importance of benchmarking competitors and analyzing their activities. However these analyses are not sufficient if the results are not communicated across different functional units and departments. Furthermore regulatory and standards assessments are worthwhile to avoid legal complications.

Senior Management Involvement

Most of the activities in the front end of the innovation process are performed by small teams or functional groups however; literature shows that these teams need support from senior management in order to succeed. The involvement of senior management in the front end process is important because:

- Overcoming opposition to change lays a better foundation of initial resourcing and public support (McAdam and Leonard, 2004)
- Personal involvement of executive champions increases the chances of new idea development (Murphy and Kumar 1997)

- Top management support of the front end results in increased levels of innovation (Koen et al. 2001)
- Senior management involvement is influential for the alignment of individual activities (Khurana and Rosenthal)

Preliminary Technology Assessment

Carrying out high-quality preliminary technology assessment is strongly associated with the success in innovation processes (Cooper and Klinschmidt, 1997). Prior to investment, it is essential to reduce uncertainty through technology assessment and technical viability of the project. According to Cooper (1988), technology assessment enlightens the questions of whether the product can be developed and manufactured, what kind of technical solution is required and how much does it cost to develop the product. Bacon et al (1994) suggested that the results are more satisfactory if the technology is both available and reliable. Therefore successful innovation is not only a consequence of market pull approach; a well characterized and existing technology is also essential.

Alignment between Innovation Process and Strategy

It is crucial to have an alignment between innovation process and overall business strategy. As projects need to capitalize on the core competences of the companies, projects which do not meet this criterion are less successful (Bacon, 1994). Furthermore, Khurana and Rosenthal (1997) concluded the importance between innovation process and product strategy. Product strategy including product platform strategy and product line strategy should be aligned with the new product development to function effectively. What is worse is Khurana and Rosenthal (1997) reported that there are very few companies with clear product strategies to guide decision making in the front end innovation process. Instead, the decision making mechanism of innovation processes were based on project-specific criteria rather than strategic fit and R&D funding was given depending on the technology superiority. According to this research, successful companies were capable of linking business strategy, product strategy and product-specific decisions.

An Early and Well Defined Product Definition

Literature confirms the importance of an early and well defined product concept on top of expected customer benefits and target markets. Product concepts can be technology or customer/ market driven. While technology driven concepts are more tangible, market driven concepts are less obvious (Backman, 2007). According to Khurana and Rosenthal (1997) a clear product concept facilitates the understanding of what and how to prioritize during the development phase.

As a strong product definition involves information and feedback from all main functions of a company, companies have been experiencing challenges in clarifying product concepts and definitions in the front end (Khurana and Rosenthal 1997). Though some changes may be necessary during development, they have to be very well managed (Bacon, 1994). Poorly managed changes may result in delays, higher costs and even product failures. In case changes are essential, successful companies only carry out selective changes and use priority criteria list to change as few elements as possible. Alternatively, such

unmanaged changes may result in ambiguity which in return generates decision delays and lower market results (Seidel, 2007).

CSFs IN THE FRONT END OF MEDICAL DEVICE INDUSTRY

In 2008, Russell and Tippett conducted an extensive study to identify the industry level critical success factors that influence front end innovation process in medical device industry in the USA. The researchers used 250 documents in order to gather CSFs for the Front end of innovation, small to medium companies, and medical devices industry. 185 CSFs were extracted in this literature study which was made up of 74 high frequency and 111 low-to-medium frequency topics. Caralli's CSF Methodology was used to evaluate the list of CSFs found in the literature. A survey was created to evaluate 74 high frequency CSFs using a 5 point Likert-scale based on their importance level on innovation. A number of experts in medical device innovation evaluated 74 high frequency potential CSFs. Likewise remaining 111 CSFs were also evaluated by the same expert team. Consequently, 21 critical success factors were identified as a result of this study.

Table 9. CSFs in the front end of medical device industry

Critical Success Factors for Front End Innovation Process

1. **Clear documentation of resources**
2. **Clear documentation of projected project outcome to meet customer needs.**
3. **Training project personnel in order to develop potential projects from new ideas**
4. **Appropriate personnel selection for the early stages of the innovation process**
5. **Enforcement of company values by management**
6. **Development and support of innovation culture by management**
7. **Having an idea hub**
8. **Assigning a project leader early in the process**
9. **Right people are active at the right places at the right time during the process**
10. **Cross functional project teams**
11. **Ability of the project team to flexibly support alternative development methods**
12. **Scheduling review points and criteria to promote or kill projects**
13. **Active process for a fair evaluation of ideas**
14. **Support by a flexible and adaptable business process**
15. **Rapid process active to screen ideas/concepts**
16. **Idea collection system active to support internal and external ideas**
17. **Ability to get new ideas from outside the company**
18. **Integration of partners, suppliers and vendors into the process**
19. **Clear and well communicated new product strategy by management**
20. **Sound business strategy and clear documentation of financial objectives at the start of the project**
21. **Clear identification of the competitive advantage potential**

CONCLUSIONS AND REFLECTIONS

Giving high importance to innovation, PH CV BU is aiming at becoming the innovation leader of the market. In order to designate what is important and valuable for the BU's innovation process, critical success factor approach is used in this project. Understanding critical success factors for the innovation processes contributes to a strategic plan that must be achieved in addition to the BU's goals and drive the BU toward accomplishing its mission. Making these critical elements of success explicit is a powerful tool to stay competitive.

Various sets of critical success factors are listed in this section. As the importance of different factors changes depending on the situation; CSFs of front end innovation process are evaluated with a contingent approach in market related, organizational related and process related dimensions. Taking into consideration diverse sources of CSFs in context of front end innovation process of medical device industry, following list of CSFs is generated. The following table summarizes theoretically derived CSFs for the front end of the medical device industry. The theoretically derived CSFs are used as a part of survey study to assess the front end process of the PH CV BU.

Table 10. Theoretically derived CSFs applicable for front end innovation process of medical device industry

A. Firm Related CSFs
1. The involvement of the senior management is important for the front end of the innovation process.
2. The alignment of the innovation process with the business unit strategy is crucial for the front end.
3. The right people should be active in the right places timely during the front end of the innovation process.
4. Management should develop and support a culture of innovation.
5. Effective communication across different departments is very important.
B. Process Related CSFs
1. Early customer involvement is essential for the front end of the innovation process.
2. Internal cooperation among functions and departments is important at the front end.
3. Preliminary technology assessment is important for the front end process.
4. An adequate degree of formalization should be employed for the front end activities.
5. Idea refinement and adequate screening of ideas have a significant role at the front end of the innovation process.
6. Efficient and effective concept generation, selection and design are important at the front end of the innovation process.
7. The flexibility of the front end process is important.
8. Partners, suppliers and vendors are integrated into the innovation process.
9. Rapidly developing actionable plans and effective risk management are imperative for the front end.
C. Product Related
1. An early and well defined product definition is important of the front end.
2. My management distributed a clear and well communicated a new product strategy.
3. The presence of idea visionaries or product champions is important for the front end.
4. Product portfolio planning and effective portfolio management have a major effect on the outcome of the front end process.
D. Project Related
1. Cross-sectional/multidisciplinary project teams should be used in innovation projects
2. Reviews should be scheduled and clear criteria should be used to promote or kill the projects.
E. Market Related
1. The competitive advantage potential for the projects are clearly identified in the beginning of the project.

2. Detailed environment and future trend analysis is vital for the front end process.

PART III. IN DEPTH CASE STUDY

In depth case study on the critical success factors of the front end innovation process of CV BU is presented in Part III. Initially a brief background of the innovation process employed at Philips Healthcare and CV BU are presented. Subsequently the front end innovation process of PH is explained. Secondly, a competitor analysis is presented in this section. Finally, the findings are stated, analyzed and evaluated.

CHAPTER 5. INNOVATION AND INNOVATION PROCESS AT PHILIPS HEALTHCARE CARDIOVASCULAR BU

This section is left out for the reasons of confidentiality....

CHAPTER 6. COMPETITOR ANALYSIS

The particular characteristics of the healthcare industry opens up new opportunities in the market while creating a demanding competitive market structure as discussed in Chapter 2. Consumers are always free to choose any price and quality combination they like hence both quality and price can rise or fall with regard to the effect of competition. However quality cannot fall in healthcare market (Pauly, 2004). Even if there are a small number of big active players in the healthcare market, government's support to the market creates a different dynamic in the market. Referral relationships, healthcare plans, political dynamics, changing social characteristics, ever advancing technologies, marketing channels and expert customers require a special approach to the industry (Thomas, 2005; Rivers & Glover, 2008). Though conventional competition in health care involves elements such as price, quality, convenience and superior products, innovation is also a crucial driver of the competition (Rivers & Glover, 2008).

There are three main players in the medical device market: GE Healthcare, Siemens Healthcare and Philips Healthcare.²⁴ Philips is one of the top vendors of the medical device industry. Considering the main diagnostic imaging product markets that all three companies operate in MRI, CT, NM/PET, X-ray and US; the market share division is much closer: GE 27%, Siemens 25% and Philips 23%. All the big three have been growing at a significant level with the help of the revenues generated by their acquisitions. While GE is demonstrating high performance in services, their R&D budget exhibits proportionality with their sales. Siemens and Philips have similar R&D levels however Siemens' R&D invests a significant amount for healthcare IT which is not the case for Philips (DresdnerKleinwortWasserstein, May 2005).

GE Healthcare is a unit of GE Technology Infrastructure which is a division of General Electric. Headquartered in the UK, GE Healthcare is organized in two primary business segments: GE Healthcare Technologies and GE Healthcare Bio-Sciences. The company employs 46000 people in more than 100 countries and is a \$17 billion unit of GE. 17 Currently GE Healthcare operates in six main business units: GE Healthcare Global Diagnostic Imaging, GE Healthcare Clinical Systems, GE Healthcare IT, GE Healthcare Medical Diagnostics, GE Healthcare Life Sciences, GE Healthcare Surgery.²⁵ GE Healthcare's broad vision for the future is "to enable a new "early health" model of care focused on earlier diagnosis, pre-symptomatic disease detection and disease prevention"²⁶. The strong point of GE Healthcare is that the company is a good business partner prepares complete solutions (including finance) for the medical institutes and hospitals capable of preparing a full . Siemens Healthcare (formerly Siemens MED), headquartered in German, is one of the six sectors of Siemens Business Sectors. Siemens Healthcare has 49000 employees globally. The company operates in three main segments: Imaging & IT, Diagnostics and Workflow & Solutions. Siemens Healthcare aims at providing comprehensive healthcare from a single source, combining the laboratory diagnostics with imaging systems and specialized information

²⁴ DresdnerKleinwortWasserstein, May 2005.

²⁵ GE Healthcare. In Wikipedia. Retrieved February 2, 2010. http://en.wikipedia.org/wiki/GE_Healthcare.

²⁶ GE Healthcare Official Website, Retrieved February 2, 2010. <http://www.gehealthcare.com/>

technology.²⁷ Siemens Healthcare possesses a technology leadership position and claims to be the strong innovator of the market. Last but not least, Toshiba, a Japanese multinational corporation, is a niche player of the market. The company has a strong technology and performs well in the market of value products. Following graph illustrates the market position of Philips CV in the market. The preliminary results for the market shares and sizes for 2009 are presented by Market Intelligence as following:

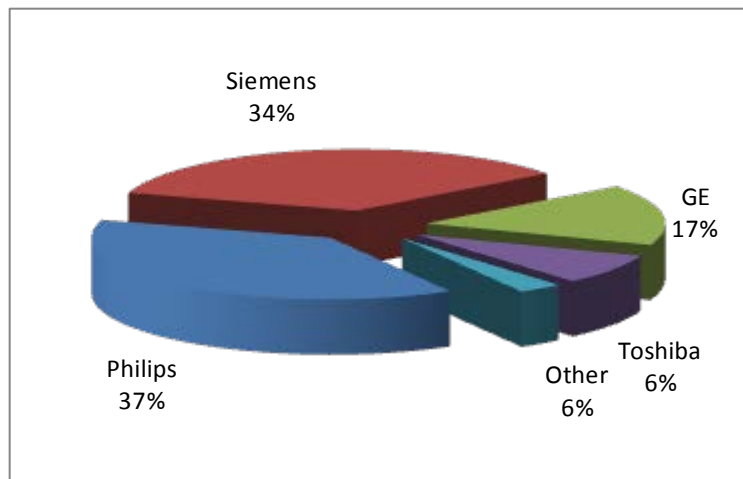


Figure 22. Cardiovascular Market (2009)

THE CLOSEST COMPETITOR: SIEMENS

Philips Healthcare has an innovation leadership position and wants to protect its power in the market. However PH's position is under attack by the competitors, particularly the closest competitor Siemens Healthcare. The founder of Siemens Medical Solutions Group Erwin Moritz Reiniger started manufacturing electro-medical and physical apparatuses in Erlangen in 1877²⁸. Reiniger and his partner Gebbert and Schall established a company called RGS in 1886²⁸. Soon after the discovery of X-ray, RGS began to manufacture X-ray tubes and equipment in 1895³³. By 1925, Siemens & Halske became the majority stockholder of RGS. Later on Siemens & Reiniger Werke AG Berlin was formed in 1932. The company was named as Medical Engineering Group with the establishment of Siemens AG in 1969. In 1990s the Group expanded determinedly and renamed as Siemens Medical solution in 2001. In 2008 the company went through reorganization and was named as Siemens Healthcare³¹.

Siemens HC's goal is to integrate imaging, laboratory diagnostics, and healthcare IT, to own and improve the workflow to create efficiencies for providers. The value proposition of Siemens HC is to improve the accuracy of diagnosis, improve outcomes and save time and money for hospitals and medical institutions.

²⁷ Siemens Healthcare Official Website, Retrieved February 2, 2010.
<http://w1.siemens.com/about/en/businesses/healthcare.htm>

²⁸ Siemens official website: 125 years of Siemens Medical solutions- Providing the Future in Healthcare. By B.Braun Siemens AG, Medical Solutions, Erlangen, Germany. Electromedica 70 (2002) no.1.

The business group divided its products in four divisions: Imaging, Diagnostics, IT and Workflow Solutions.

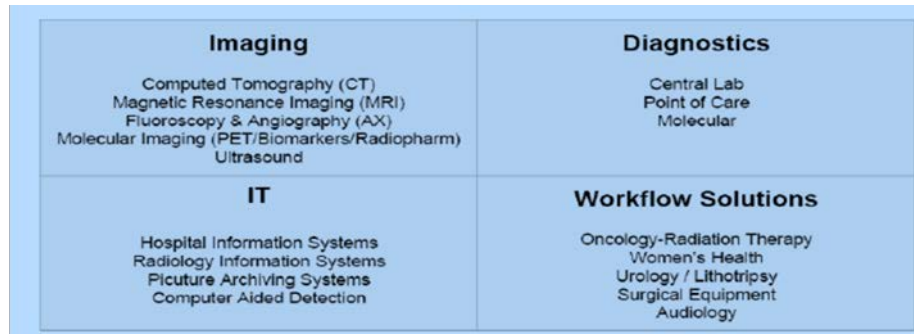


Figure 23. Products and Divisions of Siemens

Siemens HC has a well established organization. The organizational hierarchy of Siemens HC CEOs is shown below. As the figure shows, Siemens Healthcare adopts a well-organized hierarchical organizational structure.

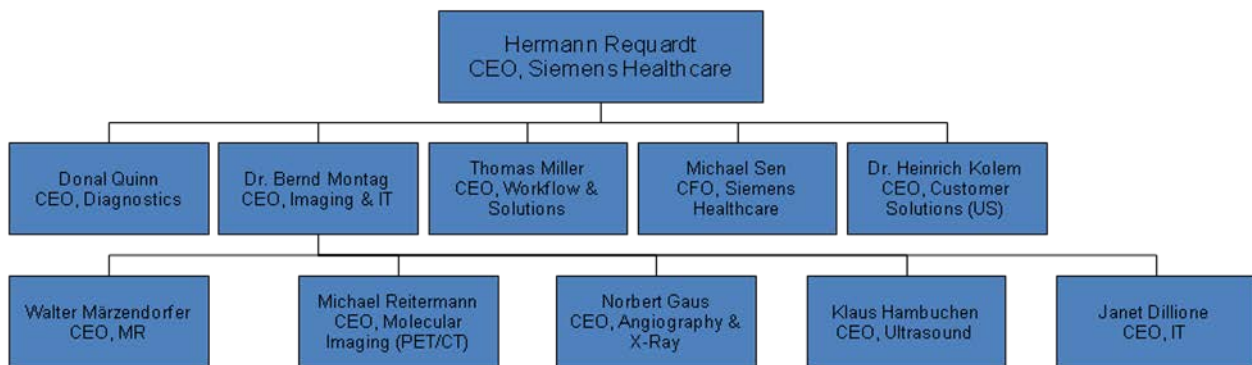


Figure 24. Organization of Siemens HC

In late 1990s, Professor Reinhardt, the president and CEO of Siemens MED, proposed a comprehensive plan which boosted up the company's situation. This strategic program is called "P" which is interpreted as centered around People, Processes and Products. The new CEO reinforced the improvement of leadership qualities and customer-oriented mindset of employees. On the process side, reduction of costly production capacity was the main focus. Business processes were improved and redefined from a customer satisfaction perspective instead of a customer need perspective. The product development process was standardized and simplified. 'Just in time' approach and key process parameters were used while carrying out the processes. Siemens HC started using 'design to cost' concept²⁹, and introduced 'Syngo' platform for its products. Syngo is a standardized software platform offered by Siemens for all medical imaging systems. It was specially designed to improve clinical workflow and ensure the flawless information exchange. The Syngo is claimed to be a user friendly and efficient interface which utilizes a common identity across modalities. Siemens employs the Syngo concept and manufactures Syngo based systems not only because it provides benefits for its users but also because new applications can easily be

²⁹ Realizing lower cost structure than existing products

integrated into the unique software concept.³⁰ Furthermore product lines were also thinned out in order to address different market segments. For instance instead of offering a broad range of differentiated products, Siemens Healthcare chose to focus on a number of specific products. Nowadays, Siemens Healthcare started applying selected approaches for key regions and essential customer requirements. The company seeks to meet the needs of several market segments rather than only concentrating on high-end (innovator) customers with this application.

Additionally, Siemens Healthcare reorganized its Sales and Services activities by cooperating with local and global partners to improve their sales forces. The new process organization was generated for the Sales and Service which is split into five processes: acquisition, offer, order, call management/field support, business management and support. (PMSBusinessIntelligence, 2003)

Trusting in the power of innovation, Siemens wants to create the right climate for innovators and inventors. For that reason, the company has implemented a culture of innovation which involves:

- Top corporate innovation program-
- Top innovation award
- “Inventor of the year award”
- Top innovators
- 3i suggestion program and award
- Innovation benchmarking
- Community of Practice innovation management
- Best –practice sharing (Siemens official website, 2009)

Siemens HC’s innovation strategy is to “Be a trendsetter in all our business to secure the most competitive edge”. The company has a consistent innovation strategy across the organization and takes into account its technologies, patents, R&D resources, processes, people/skills/culture while giving innovation related decisions. Siemens HC believes that innovations help the cut costs, increase sales and achieve higher earnings. To achieve its goals, Siemens HC:

- *Adopts a trendsetter strategy:* As mentioned in the theoretical background section, different businesses implements different approaches for innovation. The first movers, highly innovative and rapidly reacting companies, are first to market a new technology or business model. Then there are fast followers who avoid high and risky start up costs for research and development but know how to get the customers through prices, quality or services. Siemens HC adopts a ‘trendsetter’ innovation strategy. Such companies are good at establishing a new technology on the market by controlling the main conditions. They aim for high profits hence; having a strong technological position which can determine the competitive advantages for today and tomorrow is essential for them. According to Siemens, trendsetters do not only focus on pace setting technologies but also align their R&D activities with their business strategies in order to realize their goals.

³⁰Siemens Healthcare Official Website. Retrieved February 2, 2010. <http://www.siemens.com/medical>

- *Exploits synergies:* The top+ Innovation program introduced by Siemens helps the company increase the efficiency and effectiveness for their R&D activities as well as exploiting potential synergies across businesses. In addition to these programs, Siemens employs applications like benchmarking, best practice sharing, active patent management, joint development and platform strategies to take the full leverage of its capabilities and assets to tap further potential.
- *Strategic Patent Management:* Like technology planning, Siemens uses an active strategic patent management approach to handle its patents. Siemens currently possesses more than 40000 patents and renews its portfolio every five to six years. The company focuses on the quality and value of its patents and judges the quality of its patents by the value placed upon it in cross licensing agreements with outside companies.
- *Global networks:* Siemens makes use of interdisciplinary solutions and employees who can think in an interdisciplinary manner to deal with future challenges such as increase in healthcare costs or an aging population. For developing innovations, Siemens trusts their global knowledge networks which consist of projects with universities, R&D laboratories, innovation teams, customers, internal departments and suppliers.
- *Navigation System of the future:* Siemens generated a method called 'the Pictures of the Future' for gaining a clear idea of the best way to pursue in the future. The method combines the roadmapping activities with scenarios of the future which are systematically developed. This combination assists the company to identify technologies with high growth potential and broad scope as well as predict future customer expectations and business possibilities.

(Mr. Dr. U Eberl, Trendsetter in Innovation, Siemens official website, 2010)

On top of these, Siemens HC believes the in effective planning and intergration of activities maximizes success over the long term. Therefore the company invests in effective planning and interlinking of activities in order to generate as much profits as possible.

INNOVATION PROCESS AT SIEMENS

The vision of Siemens is to offer innovations that have a high added value for its customers, to develop solutions for major growth markets and set trends with these innovations. Siemens believes that research is essential yet insufficient for innovations since economic value can only be driven by success of the innovations. Therefore Siemens sets its R&D strategy based on its business strategy to obtain value from the innovation activities. Siemens adopts a strategic innovation planning scheme for all areas of its businesses. The company organizes the innovation activities by taking into account its capabilities, resources, technologies, market, customers and strategic vision. Following diagram presents how Siemens pictures its future innovation activities (Siemens official website, 2009).

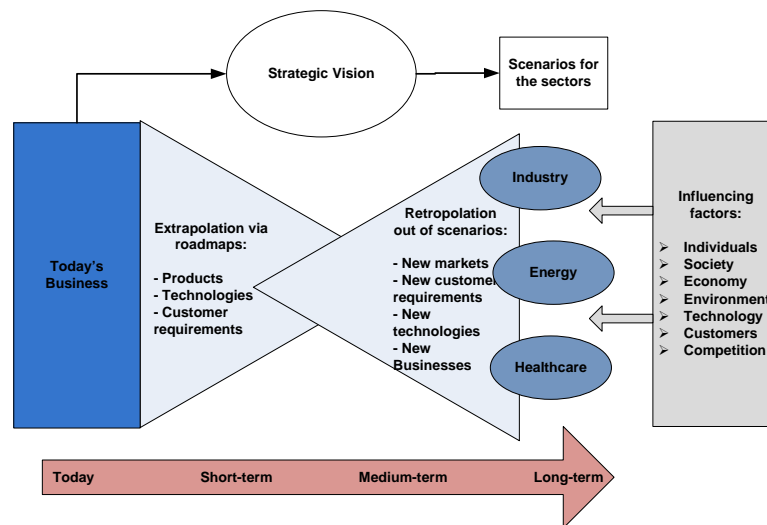


Figure 25. Strategic innovation planning by Siemens ³¹

In order to set the basis for defining measures for improvement, Siemens employs an ‘innovation radar’ which highlights strengths and weaknesses of the company. The innovation radar evaluates the company’s strategy, budget, innovation at core processes, patents and standards, corporate culture, qualification and ability, technology and budget. It determines, compared with competitors, how well developed the skills of the company are for successfully implementing the innovation strategy. (Siemens official website, 2009)

Siemens’s innovation process is customer oriented. The general approach of Siemens’s innovation process is presented below.

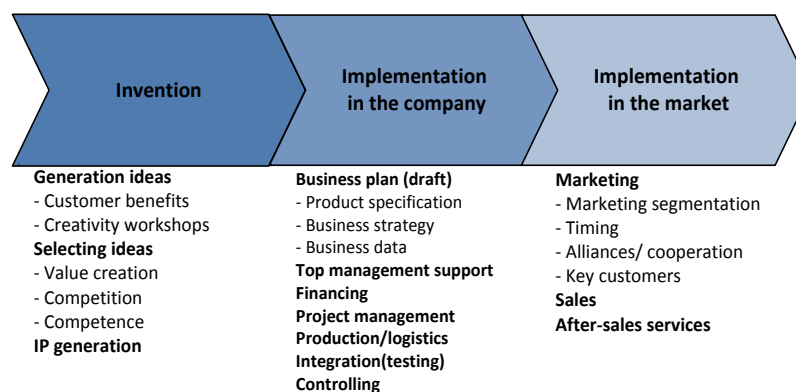


Figure 26. Innovation process of Siemens

There is a strong correlation between the success factors of Siemens’s innovation framework. Siemens disclosed the success factors of its innovation processes as:

- Stable framework which enables and supports the quality of the innovation process
- Knowledge of customer demand and market trends
- Sector expertise through feedback from lead customers

³¹ Siemens official website, 2009

- Expertise in trendsetting technologies by benchmarking innovation and picturing future
- Culture of innovation which is supported by processes and employees

(Siemens official website, 2009)

Second international Conference on Bioelectromagnetism which took place in 1998 disclosed a different innovation process approach used by Siemens HC. Siemens is well aware that the developments in technology do not only promote medical advancement but also provide means of lowering costs and streamlining procedures for healthcare providers. As the economic considerations and technological challenges are growing in the healthcare industry, Siemens HC decided to apply a systematical innovation and technology assessment management process. Complementary to the continuous technology assessment in the existing business units conducted through technology roadmaps and strategic business plans, Siemens HC also takes into consideration the ideas which do not belong to the company's traditional product areas. With this new process, Siemens separated its new innovation processes from existing innovation process and named it "New Business Opportunities". The major advantage of this separation is to offer basic, cross unit and cross functional innovations the opportunity to develop better rather than being a part of an environment which operates a day-by-day business in order to optimize productivity.

The new innovation process is based on Venture capital and entrepreneurial thinking concepts believing that basic, cross-unit and cross functional innovations have a better opportunity to develop. As a strategic innovation plan, Siemens HC established: Innovation management process, innovation assessment team, internal venture capital board, innovator trainee program, and innovation contest. The systematical innovation management approach assisted company to build an innovation process which can transform bright ideas into profitable new businesses. *Innovation assessment team* is responsible for finding and assessing new technology trends, finding new solutions for customers and developing new business ideas internationally. Moreover the innovation assessment team is the liaison force among customers, Siemens employees and inventors. The venture capital board is responsible for awarding initial funding for the realization of a promising idea after evaluating the business plans. The Innovator training program and the innovation contest stimulate the innovation activities in the company and facilitate turning emerging technologies into new products.

Siemens HC combined a systematic innovation process approach with technology assessment management process as shown in following figures. (Stroetmann, Beier, Kirchner, & Redel, 1998)

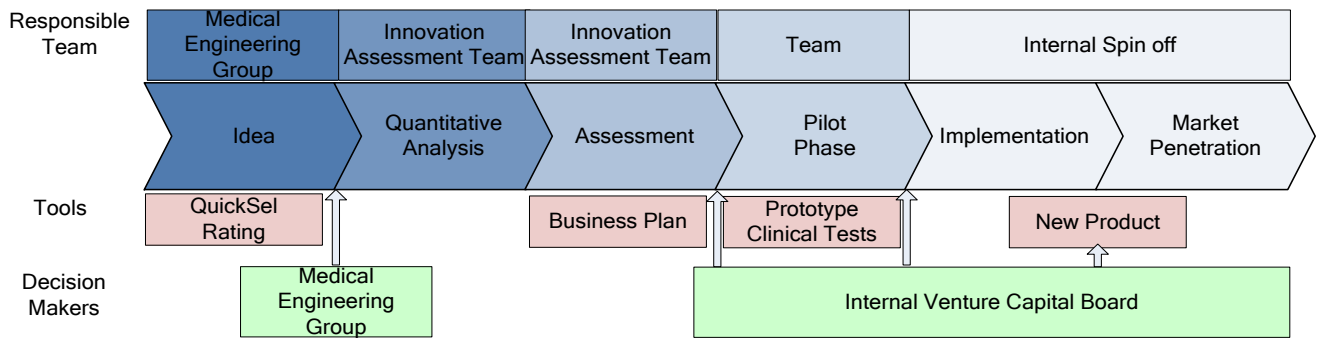


Figure 27. Innovation Process at Siemens Medical Group ³²

As shown in the figure, several teams are involved in the front end of the innovation process at Siemens HC. Siemens HC takes into account filtering out the right ideas at an early stage and employs a three phase procedure called Rapid Innovation and Technology Assessment (RITA) for the analysis of ideas. RITA process starts with an initial estimation. A one page user questionnaire is used to assess the ideas of the user. The users are asked questions about: possible customer benefits, business opportunities, possible implementation problems, and company’s strengths and weaknesses. Depending on the outcomes of these questionnaires, an innovation opportunity chart is generated. If an idea is far from realization, it is placed into a different file called “ideas for the future”. The ideas which are most promising in the portfolio are ideas are chosen by the innovation team. In the next step, the ideas are assessed quantitatively. The market is analyzed, necessary investment is calculated and implementation costs are determined. In return, the innovation team predicts the possible revenues, profits and risks. Lastly, business plans are generated and presented to the internal Venture and Capital board (VCB) for the most promising ideas and the board grants financial funding for the realization of a promising idea.

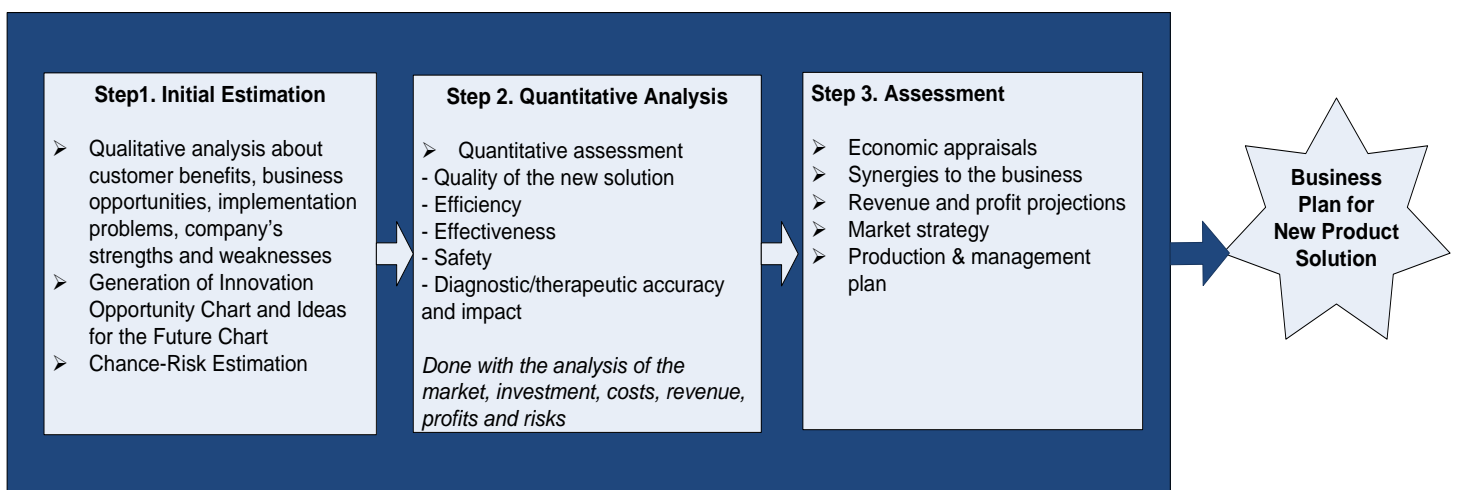


Figure 28. Screening and Assessment Process at the Front End of Siemens MED³²

³² Stroetmann, Beier, Kirchner, & Redel, 1998

STRATEGIC DIRECTION OF SIEMENS HC

Siemens HC believes that Information Technology (IT) is the backbone of the whole system therefore they are making long term investments on IT and refocusing on architectural structure. The company is aiming to combine components from different products to provide better solutions for its customers. Complementary to products related to diagnostics and treatment, workflow and solutions are leading the trend towards disease oriented structure.³³

In 2009, Siemens HC stated that they gained detailed knowledge about the products and market and have stopped all of their acquisitions activities. The company is using its stable install base as an effective selling point and way to success. Mentioning the changing customers, Siemens HC is working towards “solutions matched to specific customer’s needs” perspective.

Siemens HC trusts innovation as the key to success and invests in both product and its internal process innovation. (Claimed leader in process innovation).³³ According to the company, innovation is what is economically feasible and understanding what customers really want. Siemens HC pursues a customer driven innovation strategy which utilizes clinical work, provides efficient work flow and considers costs at the same time. Believing in the transparency in innovation, the company intends to forecast long term trends in medicine by focusing on three main pillars in the sector:

1. Understand the patients’ disease – Diagnosis of a disease and localization of the disease by imaging and diagnostic applications
2. Understand the patients’ biology – Genetic pre-disposition, patient metabolism, molecular specifications, and treatment stratifications by molecular applications
3. Access state of the art of data bases on how to cure the disease by a personalized approach – Assessment of similar cases, structured outcome analysis, decisions support system and standards of care by Healthcare IT

(Siemens Capital Market Day Healthcare, London, 29th September 2009)

Siemens Healthcare attach importance to intelligent allocation of R&D resources. The company invests in growing and profitable businesses and sees this as the main source of competitive advantage. 65% of total R&D investments are allocated to new product development and breakthrough technologies. Platform synergies are significant for the company hence software and hardware product platforms are leveraged. 15% of total R&D investment is spent for cross modality technologies. Siemens HC adopted a customer oriented product portfolio which offers successful products for local markets. More than 80% of MR equipment sales are younger than 3 years.³³

On Siemens Market Day which took place in 29th September 2009, Siemens HC revealed their business principles as:³³

³³ Siemens Capital Market Day Healthcare. London. 29th September 2009. Siemens Corporate Website, Speeches and Presentations

- Focusing on value (financial targets) – Siemens HC has set financial targets to achieve. The company pursues capital efficiency as its top priority. Additionally an aggressive cost management with a focus on cash generation is followed at Siemens HC.
- Effective product portfolio planning – Siemens HC claims to have the best product portfolio in the industry. An unparalleled understanding of customer needs is applied by the company. A multi-domestic approach which is employed to replicate the proven optimization concepts globally is used to increase the value added to the company’s structure.
- Increasing transparency across stakeholders – Siemens HC is committed to realize its margin targets by sharing its internal processes and approaches with the shareholders..

CONCLUSIONS AND REFLECTIONS

This chapter presents an overview of the competitive landscape for PH. Though PH is one of the top three vendors of the medical device industry, the company is experiencing challenges in the highly dynamic healthcare market. While GE and Siemens are highly investing in IT-architecture, PH also has an approach to invest in a common architecture however this is done at a multi modality level at the company.

Philips Healthcare Cardiovascular Business Unit has an innovation leadership position in the CV market and wants to remain as the innovation leader of the market. Siemens Healthcare is challenging this market position by introducing innovative products to the market. Siemens Healthcare is the closest competitor of PH in CV market at the moment hence it is beneficial to take the competition into account. As acquiring company specific information is demanding, the data related to Siemens was gathered through public documents and websites. Though this gives an insight about the company’s activities it can be only a marketing story of Siemens Healthcare. However Siemens Healthcare has a different culture and organization hence adopting their approaches without considering internal activities at PH will not bring in any value for the company. Furthermore, smaller or less visible companies should also be followed up to have a full picture of the market orientation.

This chapter presents an overview of Siemens Healthcare and their innovation activities. While studying the company, a number of important factors were recognized. These factors are believed to be influential for the success of the company. Following table illustrates a number of success factors for Siemens. Valuable lessons can be learned from these factors to improve the innovation process at PH. As these findings are gathered through public resources, they are not comparable to the internal activities of Philips.

Table 11. Lessons Learnt from Siemens MED

Siemens Healthcare

<i>Strategy</i>	<ul style="list-style-type: none"> • A consistent strategy over many years • Innovation is Key -- Innovation is the foundation to market leadership • High added value for the customers develop solutions for major growth markets and set trends with innovations • Realized early on the importance of platform concepts • Stick to direction and execution over a multiple year period • Customers inputs – in meeting with executives – to drive choices and selection of investments • Expertise in trendsetting technology by benchmarking innovation and picturing future • Increasing transparency across stakeholders
<i>Culture and Organization</i>	<ul style="list-style-type: none"> • Very strong top down strategy deployment with few, non-negotiable initiatives • Disciplined innovation • Integral responsibility -- equipment and service accountability in one hand, but keep visibility on both aspects • Aim for stretched targets (e.g. cost price reduction) • One organization to provide technology and components to different businesses
<i>Execution</i>	<ul style="list-style-type: none"> • Never cut R&D to make a quarter – realize the importance of innovation • Harmonized and stable innovation process • Drive efficiency and consistency throughout the business when applied with the right level of discipline • Exploit pockets of excellence by cross sharing best practices
<i>Quality and Cost</i>	<ul style="list-style-type: none"> • Aim for significant cost price reduction for each new generation of products • Siemens is well ahead with low cost country strategy • Aggressive, cross BU effort
<i>Other</i>	<ul style="list-style-type: none"> • Siemens didn't take action until after FDA caused them significant issues at multiple locations • Siemens employs 'innovation radar' to highlight the strengths and weaknesses of the company • Siemens separates its new innovation processes from existing innovation processes and handles them differently

CHAPTER 7. EVALUATION OF CSFs FOR THE FRONT END PROCESS

In this chapter, the process used to evaluate the front end of the innovation process is described. Later on the results are presented. At the end the analysis from all interviews' results and observations is presented as well.

PROBLEM ANALYSIS OF THE CASE STUDY

This section is left out for the reasons of confidentiality....

APPROACH

The purpose of critical success factor (CSF) method is to tap the knowledge and intuition of the organization's managers. Munro and Wheeler proposed that CSFs can be used to guide organizations in developing strategic plans (Munro & Wheeler, December 1980). They can also be used to recognize critical issues associated with implementing a plan (Boynton & Zmud, Summer 1984). Anderson suggested that identifying CSFs can help the managers to utilize their resources toward important areas and achieving a high performance (Anderson, 1984). On the other hand they can also be used to establish guidelines to monitor a corporation's activities (Ferguson & Dickinson, May-June 1982). In this study, CSFs are derived from the perception of those working in the organization rather than created artificially. The CSFs are shaped by reviewing and analyzing the goals and objectives of key personnel, important pitfalls and challenges in the innovation process. Company documents, surveys and interviews provide the basic data for organizational CSFs. By revealing organizational CSFs, this methodology enlightens the PH CV about its strategic direction, innovation goal alignment and resource management activities.

A number of CSFs methodologies were discovered while conducting a literature study on Critical Success Factor methodology. In 1979, Rockart used interview/survey method to determine individual CSFs and analyzed individual CSFs to identify organizational CSFs. Rockart and Bullen (1981) followed the same methodology while carrying out their CSF study. Baket (1983) preferred to follow a survey methodology to involve more people in his study. In sharp contrast to these methodologies, Caralli (2002) chose to conduct only interviews and derive CSFs from activity statements developed during these interviews. He also determined the significance by frequency. Focusing more on the project aspects, Esteves (2002) used interviews to determine project phases and identify CSFs by phase using frequencies. Furthermore Dyrhaug (2002) concentrated on a core team and analyzed CSFs generated by interviewed team members to reveal the organizational CSFs. A hybrid methodology is generated for this research. Initially

open interviews are conducted in order to obtain the perceived critical success factors from the managers. Later on critical success factors gathered from theory are evaluated by the managers to understand if general theoretical CSFs are applicable for the innovation process at PH. Following steps are followed to in this case study:

Step 1. Defining Scope of the project

The details are left out for the reasons of confidentiality....

Step 2. Defining Scope of the CSFs

The details are left out for the reasons of confidentiality....

Step 3. Collecting Primary Data

The details are left out for the reasons of confidentiality....

Step 4. Deciding on Population and Sample

The details are left out for the reasons of confidentiality....

Step 5. Collecting Case Specific Data

The details are left out for the reasons of confidentiality....

Step 6. Analyzing Data and Deriving CSFs

The details are left out for the reasons of confidentiality....

Step 7. Validation of the findings

The details are left out for the reasons of confidentiality....

SUMMARIZED RESULTS

This section is left out for the reasons of confidentiality...

ANALYSIS OF THE FINDINGS

This section is left out for the reasons of confidentiality....

IMPLEMENTATION OF THE CSFs IN FRONT END INNOVATION PROCESS

This section is left out for the reasons of confidentiality....

CONCLUSIONS

This section is left out for the reasons of confidentiality....

DISCUSSIONS

Discussions section is divided into two parts. Initially the results of this study are discussed. Later on the methodology employed for the study is discussed under a separate title.

DISCUSSIONS ON RESULTS

This section is left out for the reasons of confidentiality....

DISCUSSIONS ON METHODOLOGY

Exploring critical success factors for healthcare industry is not a well-documented method. Though studies present interesting results on CSF approach, there are methodological weaknesses in this area. Operational definitions are often vague or inconsistent. For example the definitions of 'success' and 'performance' of the projects can be interpreted in many ways. Furthermore the importance of the CSFs varies depending on the researcher's values and choices. To avoid such weaknesses, a methodology of obtaining contextual CSFs was drawn for this study.

Critical success factors (CSFs) are used to distinguish limited number of areas in which satisfactory results will enhance competitive performance of the front end process for PH CV BU. When made explicit, a CSF can be used as a point of reference and direct the organization toward accomplishing its mission. In other words, according to this methodology managers are the origin of CSFs. This can be a pitfall for this approach. The managers implicitly know and consider CSFs when they set goals and while they direct operational activities and tasks that are important to achieving goals. It can provide valuable information to understand how the managers behave in the companies; they also have their biased opinions depending on their positions and values. Furthermore, it has to be noted that the managers are not the only responsible party for the performance overall. There are certain other factors which are influential to results such as the organization of the processes, workflow, the culture of the company, and the environment of the business.

Although CSFs can reduce organizational ambiguity, they can also lead to erroneous directions if not analyzed accurately. Analyzing CSFs is not easy as there are masses of data to transcribe and interpret. There is a lack of descriptive model and the data are not very reliable. Though the data was assessed in by using various steps, scaled measures of evaluation were still missing. Additionally, since the data gathered during this research was more on the nominal level, it was not quantifiable. Two different approaches could have been taken for this research. On one hand, a comprehensive in-depth theoretical study for the CSFs of innovation, front end of innovation and medical device industry could have been

studied and a subset of CSFs could have been generated. The approach would provide a gross average of an overall generalized set of CSFs. However this would not be an ideal solution for the study. To generate a list of contextual CSFs a number of interviews were conducted. Directly consulting various managers to understand the CSFs of a process was not reliable by itself. Because they also carry the rank, file and perspective of a specific position, they may present biased information. The factors suggested by the managers had to be filtered out using the literature and reasoning.

A standard method to analyze the CSFs does not exist. During the course of this study, a hybrid method was developed in order to investigate the CSFs of the front end process and ensure that the interpretations were made as objectively as possible. Interviews and surveys were only used as a source of inspiration for theory. The questionnaire used for the research was very simple and basic. Constructing a questionnaire is an art by itself. If more time and resources available were available, a more professional survey would be created. Consequently the open questions directed during the interviews generated a big pool success factors and closed questions and the surveys forced me to create a small number of CSFs. Also, it helped me to see that there are other CSFs that were missed out in the previous steps. The outcomes of these steps were evaluated by re-considering theoretical findings. Additionally they were validated by consulting external and internal parties. What is even more is that the identified CSFs were incorporated in the front end process of the company to make the findings more tangible.

RECOMMENDATIONS AND FUTURE RESEARCH

Some parts of this section are left out for the reasons of confidentiality....

The main focus of study is medical device industry however some findings can be enlightening for other industries as well. Innovation is an open concept and different industries can learn from each other's successes and failures. Hence other industries can be benchmarked to enlighten PH about different aspects of innovation. These industries do not have to deal with physicians or medicines but they can have many similarities and relationships with the medical device industry. For instance chemical industry can provide useful information on how to deal with regulations and risks of the medical device industry. Moreover electronics and IT industry can be beneficial to look into to understand different innovation and entrepreneurship strategies of different parties.

This research presented a contextual study for the critical success factors of the front end innovation processes in medical device industry. The evidence gathered through the literature and the case study used effectively to establish a CSF methodology in a business environment. The CSFs methodology used in this setting can be adapted and used for different processes to understand the critical success factors for various processes. Additionally the scope of the CSF-related research can be broadened and applied at industry level studies.

There is always a gap on how a research is conducted and how it is used in practice. This gap has to be crossed by an instrument which can assist a number of people on how to assess the CSFs and innovation projects. In this study, a simple self-assessment tool is built to enlighten the company about its innovation activities. The self-assessment tool can be used as a building block of an audit tool on how to assess a particular project in the front end process. Furthermore the self-assessment tool generated in this study can also be used for different processes. Once the CSFs of a specific environment are identified, they can be used to map the activities in these processes. Later on, an in-depth assessment, may be a gap analysis study, can be conducted to compare an organization's actual performance with its potential performance. This provides the organizations the insight into areas which could be improved.

CSFs have a direct relationship with business goals and objectives and influence on the business strategy and mission. Process measures are also correlated with the CSFs of an organization. Such measures are used to help the organizations define and evaluate how successful they are. Although the concept of process measures is taken into consideration in this research, a comprehensive literature/benchmark study was not conducted to explore the ideal key performance indicators (KPIs) for innovation activities. As a next step the process measures for the innovation processes can be looked into and the employed KPIs can be evaluated. On the other hand, from a marketing perspective, "what makes a new product success" is another important question. Future research may aim at the development of a screening model to improve the idea selection decision of the front end innovation process.

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