Applied Open Innovation – a Case Study Analysis based on Electric Drive Technology Projects in the Automotive Industry

A Master's Thesis submitted for the degree of
"Master of Business Administration"

supervised by
Dipl.-Ing. Dr. Christoph H. Wecht, MBA

Dipl.-Ing. Dr. Dragan Simic

0127144

Vienna, April 2013

Acknowledgement

It is a pleasure to thank my supervisor Dipl.-Ing. Dr. Christoph H. Wecht, MBA!

I would like to thank many of my colleagues at Austrian Institute of Technology who have supported me with their advice.

Finally, I would like to thank my family, my childern Leonie and Laura Simic and my wife Marijana Simic for their loving support during the study period from 2010 to 2013.

Affidavit

I, **Dipl.-Ing. Dr. Dragan SIMIC**, hereby declare

1. that I am the sole autor of the present Master's Thesis, "APPLIED OPEN INNOVATION – A CASE STUDY ANALYSIS BASED ON ELECTRIC DRIVE TECHNOLOGY PROJECTS IN THE AUTOMOTIVE INDUSTRY", 77 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and

2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, April 2013 _____

Signature

Contents

List of Abbreviations

Symbol	Comment
AC	Air Conditioning
AIP	Application Innovation Park
AIT	Austrian Institute of Technology
AVERE	European Association for Battery, Hybrid and Fuel Cell Electric Vehicles
C$	Cost Structure
CAN	Controller Area Network
CFD	Computational Fluid Dynamics
CH	Channel
CLEPA	European Association of Automotive Suppliers
CO_2	Carbon Dioxide
CR	Customer Relationship
CS	Customer Segment
EARPA	European Automotive Research Partners Association
ERTRAC	European Road Transport Research Advisory Council
EUCAR	European Council for Automotive Research and Development
EV	Electric Vehicle
EVS	Electric Vehicle Symposium
FISITA	International Federation of Automotive Engineering Societies
HEV	Hybrid Electric Vehicle
ICE	Internal Combustion Engine
IP	Intellectual Property
KA	Key Activities
KP	Key Partnerships
KR	Key Resources
MMS	Multimedia Messaging Service
OEM	Original Equipment Manufacturer
R$	Revenue Streams

Symbol	Comment
R&D	Researche and Development
SAE	Society of Automobil Engineers
TOE	Technology Organization Environment
UMTS	Universal Mobile Telecommunication System
VP	Value Proposition
VPPC	Vehicle Power Propulsion Conference

Abstract

In this globalization and changing trend time companies and institutions have to be more and more active in order to keep the current position on the market. And, companies have to create the new ways to be more innovative in order to ensure the future position on the market. In order to advance the most important concentrations of each company: quality, delivery time and costs, it is necessary that companies design their own innovation processes.

This work focuses on applied open innovation and includes two case study analyses related to electric drive technology projects in the automotive industry and is based on a comprehensive literature study in combination with an analysis of practical approaches to gather valid and useful data. The practical implementation is presented on the basis of four research and development projects.

For this purpose, innovation processes and models – closed and open innovation, business models including building blocks – with all aspects were analyzed and studies. With different research analyzes about: innovation, creativity, idea finding, closed innovation, open innovation, different business models etc.; and collected literature research and sources the main research questions were analyzed and documented. Internet sources, other master thesis and different technical reports were used as well.

On the basis of the projects, conclusions are drawn how to design and improve innovation process related to open innovation- and open business models. Finally, the results of the master thesis were analyzed to real live works in two case studies based on electric drive technology projects.

Keywords:

innovation, creativity, invention, closed innovation, open innovation, innovation processes, open business model

Chapter 1

Introduction

1.1 Motivation

I have been working for the biggest research center in Austria – *AIT Austrian Institute of Technology* since 2003. In the time of the master thesis creation, when I was thinking and researching the topic and research question I always had in mind the practical processes of the projects I had in the last 10 years. How can I support my institute to accelerate creating new ideas, innovation processes and analyses, novel technologies, market screening, and development of future business cases.

I got the idea for my master thesis during the *Professional MBA Automotive Industry* lecture about innovation in Vienna, when Dr. Wecht explained and presented us *Management of Technology and Innovation*, (Wecht 2010: 1). During this lecture when I experienced more about differences between innovation, creativity and invention I realized that analyzing and using better understanding about innovation processes could be one way how to accelerating research and development time at my institute.

The knowledge, being central for innovation and business agility, is a multi-faceted wonder. It has to be considered from various processes and perspective. This section gives an overview about perspectives, which can be also seen as motivation of this work.

For me, an important question related to this work is: what is a model or process that more and more companies are adopting in response to a world increasingly characterized by global business entities and open sharing of information?

One of the most important trends in the automotive industry in the next few years will be introduction more innovation in electric drivetrain with focus on reducing emissions

and carbon dioxide (CO_2) pollution, increasing efficiency of electric components used in electric vehicles. Using innovation in electric drive technology several questions and problems can be quickly released such as:

- Which components of the alternative drivetrain will be needed in the future in automotive sector?
- How can development and research costs be reduced?
- What will be innovation and business models of the future mobility look like?

I think, the area of production technology related to research and development will see dramatically changes due to alternative and electric mobility. Through the use of alternative components, new innovation will be used in the future mobility which have been rarely at all in the automotive industry. This change will represent the main challenge for OEM's and suppliers, which are today's world leaders in the conventional production and transforming of innovations and technologies for the automotive industry, according to (cf. Schlick & Hertel 2011: 3).

1.2 Definition of the Central Research Question

Duo the rapidly increasing speed of technological changes especially in mobility and automotive research area, technology based new development of the innovative vehicles such as electric vehicles (EV) and hybrid electric vehicles (HEV) cannot longer be achieved through internal corporate venturing only. External corporate venturing regarding to open innovation and open business model has therefore become a more critical part of long-term growth strategy of the companies. This work deals based on this knowledge with following thematically issues and matters:

- How works organization of open innovation and business model with focus on electric drive technologies?
- Which concept and methodology of innovation models are used in automotive projects?
- How much are innovative the ongoing projects today?
- How are generated and transformed innovation processes?
- How are created today's co-financed and customer projects?
- What are the processes and mechanisms through which internal innovation is commercialized outside the company?

- How can external sources and knowledge of innovation used in automotive projects?
- How is organized open sources and open innovation strategy?
- What are capabilities to profit from open innovation and business model?

1.3 Research Methodology

This work will be completed based on two mean approaches: theoretical and practical approach. The theoretical approach deals with analysis and research of the innovation, creativity and invention as well as with different innovation models – closed and open innovation – to win the basic know-how about innovation. However, different innovation processes such as outside-in, inside-out and coupled process have to be analyzed and described. The practical part of this work consists of analysis and comparison of open innovation- and open business models based on automotive related projects with focus on electric drive technologies. For the analysis four projects – two co-financed and two customer projects – will be used. Based on the theoretical part of this work, the innovation and business models will be evaluated, investigated and finally discussed.

The main topic of the master thesis is do compare and analyze open innovation- and open business models using selected projects. The clear distinction of the two models of the idea generation in co-financed projects and transformation of innovation in customer projects has to be analyzes. The analyzed processes related to innovation and based on this comparison have to support my institute to be even more flexible and motivate in future projects.

The different emerging innovation processes will be discussed and analyzed during theoretical and practical part of this work. The objectives of the open innovation and the associated “platform thinking” offerings, such as speed, cost, design quality, reference-ability, coherence and option value will be taken to achieve general overview about innovation processes.

The key elements of innovation will be observed to evaluate the state of the art and core competency of my daily work. The theoretical part will additionally be consists of meta-analysis of materials about different innovation- and business modes. Some of the activities related to research question will be collected and documented. For example in the table 1.1, some key elements and drivers of innovation are documented.

Table 1.1: Key drivers of *innovation*. (cf. Lisaboncouncil 2012: 1-6)

Key drivers of *Innovation*	**Competencies and/or questions**
Market	Commercialization - Business exploitation. What is viable in business?
Technology	Create new topologies, tools, methods. What is possible with new technologies?
Society	Community. What is sustainable in society?
Design	New vitrual processes. What is desirable for poeple?

1.4 Literature Study

Detailed literature study is very important for theoretical and practical section of a scientific work. However, it is very significant to have a right and quality data and information. For my master thesis I collected and analyzed about 40 papers (scientific articles) and more as 10 master theses. I also used electronica information from about 15 internet sites and bought about 20 books. Altogether there are more than 100 literary set, which I used during creation of this work. For me, it was helpful to organize at the beginning a base list of all relevant bibliography related to my research problem and question.

1.5 Outline of the Thesis

In approaching the outlined research purpose, the present study includes seven chapters and the structure of the work is organized as represented in figure 1.1. The introductory remarks in this first chapter start with description of the motivation, description of the central research question finish with research methodology.

Chapter 1: The introduction is organized according to the topics listed in conclusions. At the one hand, motivation and central research question are described in the first introduction-section. At the other hand, research methodology and structure of this work are documented in the second section.

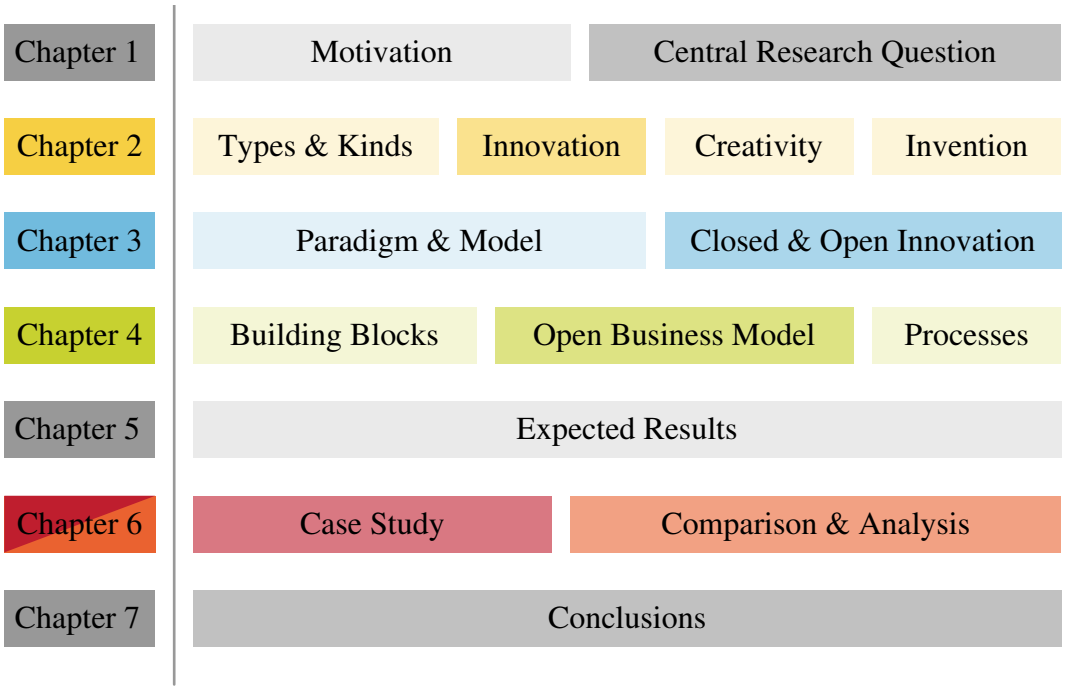

Figure 1.1: Overview of master thesis structure

Chapter 2: The fundamental study of innovation and of the terms like creativity and invention is performed. First, the word innovation is studied and documented and second, a comparison of two kinds of innovation is investigated. Analysis and study of different terms and definitions are researched: innovation definition; meaning of innovation; components of innovation; innovating innovation; continual innovation; globalization influence of innovation; etc.

Chapter 3: The description in this chapter gives a detailed and fundamental overview about closed and open innovation as well as about interpretation about innovation paradigm. This chapter finishes with contrasting principle of closed and open innovation including core processes of the open innovation concept.

Chapter 4: This chapter deals with details related to business model definition and analysis. In this chapter, the nine building blocks, which are the basically structure of a business model are highlighted: key partners; key activities; key resources; value proposition; customer relationships; channels; customer segments, cost structure; and revenue streams. The mean processes – outside-in and inside-out – are shortly analyzed and described.

Chapter 5: This sub-part of the work focuses on expected research results based on used case studies and analyzed projects.

Chapter 6: The case study begins with technical overview about research projects: two co-financed- and two customer projects. The innovation transforming and generating in different project is explained. This chapter gives an overview about comparison of analyzed open innovation- and open business models. Finally, analyzed and compared case studies are summarized.

Chapter 7: This chapter consists of conclusions of work.

Chapter 2

What is Innovation?

In this chapter, the meaning of *innovation* and difference between other key terms related to the *innovation* like *invention* and *creativity* aspects are described. First of all, the meaning of the word *innovation* is studied. Second, the phrase *innovation* is considered during this study of the word *innovation*. And finaly, the meaning of the phrase is documented.

2.1 What is the Meaning of Innovation?

During study of literature related to the word *innovation*, I found so many definitions, phrases and explanations about this. In this sub chapter of the work, diffrent views, definitions and opinions about *innovation* are collected. Each of the paragraph of this sub chapter represented base interpretation from for example one author, or one book which was studied by myself.

Sometimes poeple use the phrase *innovation* loosely, applying it to anything seen as completly new. In our business life, we have had to be more rigorous and severely in the definition of *innovation*. We have to describe an *innovation* as any product, process, or technology that has not been seen before, is adopted by costumer, changes the basis of compentition, and transforms the innovator's business for the better, (cf. Sage 2000: 5).

An *invention* is an idea, a sketch or model for a new or improved device, product, process or systems. An *innovation* in the economic sense is accompanied with the first commercial transaction involving the new product, process, system or device, although the word is used to describe the whole process related to the new product for example, (cf. Freeman & Soete 1997: 1f).

"Innovation takes a number of forms", (Harvard 2003: 2).

However I looked at the electronically news and the news papers like *Automotive News* and found some very interesting interviews about definition of *innovation*. The founded definitions of the *innovation* including the written documentation (Lisabon-council 2012) are collected and presented as follow:

Innovation is producing something new, however this can be a service or product or new market that has been developed for this.
– *Martin Schuurmans*, European Institute of Innovation and Technology

Invention is turning the money into ideas and *Iinnovation* is turning ideas into money.
– *Larry Hirst*, IBM EMEA

Innovation is catalyst for economic growth in order to companies to grow and suicides to be innovate.
– *Anton D. Williams*, The Lisabon Council

Innovation is the introduction of a new process or product
– *Andrew Wyckoff*, Technology & Industry - OECD

Innovation is creating the value for users and adding new ways of doing things that people has not seen before and just making this useful.
– *Rain Libenberg*, Google

The *Innovation* is everything about the sinning ideas in the commercially available opportunities, which create jobs, create new company, and create the growth that we need in industry.
– *Ben Butters*, European Affairs

The next tables present and depict also some descriptions and definitions related to the *innovation* I found in different publications, journals and other written news.

They are three stages in the process of *innovation*:
invention, translation and commercialization, (cf. Merrifield 2000: 255).

– *Bruce D. Merrifield*, Forces of Change Affecting High Technology Industries

Invention: power if inventing or being invented; ingenuity or *creativity*; something originating in an experiment
Innovation: the act or process of innovating; something newly introduced, new method, custom, or device; change in the way of doing things; renew or alter, (cf. Amidon 1995: 1).

– *Webster's New World Dictionary*, Second College Edition (1982)

An *Invention* is an idea, a sketch or model for a new or improved device, product, process or system. An *Innovation* in the economic sense is accompanied with the first commercial transaction involving the new product, process, system or device, although the word is used to describe the whole process, (cf. Freeman & Soete 1997: 1ff).

– *Christopher Freeman*, The Economics of Industrial Innovation, The MIT Press (1982)

It has long been supposed that product innovations are regularly developed by product manufacturers. Because this assumption deals with the basic matter of who the innovator really is, it has inevitably had a major impact on innovation related development and research, on government innovation policy, and on firms' management of development and research, (cf. Hippel 1988: 3).

– *Eric von Hippel*, The Sources of Innovation

Invention is the creation of a new device, process, service or product.
Innovation is the introduction of change via something definitely new, (cf. Amidon 1995: 5).

– *William B. Rouse*, Strategies for Innovation

The objective of *innovation* is to create bisiness value by researching and developing ideas from base to market. And it is, for most companies, tremendously difficult to implement. *Innovation* is not difficult beacuse employees do not have excellent ideas.

Our world is overflooded with *creativity* and technological ideas. Rather, myriad obstacles in the idea-to-cash process limit a company's ability to innovate. Training and rigour are required to overcome these obstracles. From **"the creator of new valuea"** aspect, *innovation* is not hit-or-miss, trial-and-error lateral and line orjented thinking, but a continuable and permanent process, (cf. CSC 2012: 2).

What is innovative about *innovation* today is the realization that it can be schieved systematically, and that the innovator is an obsessive problem solver, (CSC 2012: 2). During studying the books and literature a found a short and very strong definition of *innovation* based on **"The mythos of innovation"** that are described by Berkun, according to (cf. Berkun 2010: 11). For example *innovation* can be seen as creating new markets for new customer needs, (cf. Nagji & Tuff 2012: 7).

The Frascati published in 1963 this definition of *innovation* related to development and research: scientific and technological *innovation* may be considered as the transformation of an idea into a new or improved product introduced on the market, into a new or improved operational process used in industry and commerce, or into a new approach to a social service, (cf. Schauer 2008: 11).

Looking for *creativity*, I found some interest descriptions but I want to point that *creativity* exists of three main components:

- Expertise.
- Creative-thinking skills.
- Motivation.

These components can be influenced in a company by managing structure. The expertise is grounded on knowledge – technical, procedural and intellectual processes where creative-thinking skills determine how flexibly and imaginatively people approach problems. For motivation we can found that he is created equal and can be also intrinsic motivation in a company. Based on this argumentation, this component of motivation – named intrinsic motivation – is the one that can most immediately by influenced by the work environment, according to (cf. Amabile 2006: 18). The *creativity* can be also seen as the arising naturally and comprehensibly from certain everyday abilities of perception, understanding, logic, memory, and thinking style, (cf. Klemm 2007: 449).

2.2 In General about Innovation

One of the most important factors today, which affect the entrepreneurial profit and power of a company, is the capability to innovate processes, products and services. If the main concern is the creation of a modern company creating competitive positions in the market, then it cannot be just the price of existing products or services, their quality and variety of choices, but primarily the speed with which the enterprise may introduce new products. All this depends on *innovation* in manufacturing and business processes.

Introduction of *innovation* today is a matter of survival, and the time required for innovating and creating *innovation* is shorter and shorter. The scope and speed of *innovations* are the result of a large number of scientific, technological achievements, and then their application in practice. That is the reason why they invest in research and development today is closely connected with the development and future of the company. *Innovation* is a very old word. Etymologically comes from the Latin word **inovatio**, what characteristics were found to novelty or change the status quo, according to (cf. Popovic 2007: 34). Some authors point out that there are over a hundred definitions of *innovation*, according to (cf. Amidon 1995: 1-8). The *innovation* and innovation concept can be defined in various perspectives like organizational, economic, social, and technological and *innovation* can be seen as dependent value for measuring performances of the companies in large number of studies, according to (cf. Mustafa 2010: 64).

Most often, these definitions of *innovation* are classified into six groups, (cf. Allameh & Abbas 2010: 95) and (cf. Vontas & Protogeros 2009: 561):

- **Product** – What we produce and sell.
- **Service** – Exceeding customer expectation.
- **Process** – Continuous improvement of how we do things.
- **Management** – Business strategies, systems and structures.
- **Open** – Working beyond boundaries and collaborating globally.
- **Value** – Creating unique value that eliminates the cost to complete.

Based on this knowledge, the *innovation* can be also defined as shown in the table 2.1.

Table 2.1: A example, how *innovation* can be defined and classified. (cf. Popovic 2007: 35)

Process	from creating idea to commercialization
Accepting	change
Accepting	radical change in traditional process
New	instrumentality or something novel for society
Making	new products and services the old way
Making	old product and services the new way
Making	new products and services the new way

For *innovation* we can say, that represents the creative process in which two or more existing products or processes are combined in a new way. This way allows the production of a totally novel product or services and is a complex set of activities from creating new idea to application this idea in the practice, according to (cf. Popovic 2007: 35). Every *innovation* is a set of changes. These sets of changes extend from overview of the problems and possibilities over formalization of idea to finalization and realization. Here is important to see that after the occurrence of new *innovation* coming up the imitation on the competition site. This shows that the innovation process is a very dynamical and fast process which consists also of fast changes.

Innovation process contains of a lot of interlinked activities, which start with market investigation, customer problems and wishes or technological possibilities and end sometime with technological transfer to other ideas. Once taken innovation expands, he can be normally used second time in the same form or adapted. Dissemination of *innovation* becomes today style of behavior of successful companies. The best goal of today companies is creating *innovation* based on successful engineering and scientist research and development.

2.3 Has not Been Seen Before!

Whenever, if we look at a product, a service, or a process, we can ask the following questions, (cf. Sage 2000: 5f):

- Is this really different from anything we have seen before or not?
- If it is not the same as anyting we have seen before, how different is it?

This sub-chapter is described based on theory of the *innovation* and *creativity* written in Sage's book. An *innovation* is something new or diverse integrated in a product, process or services. In some examples from real business, creative and innovative change from one indistry to another shows a autorized and legitimated *innovation*. The components, modules and products of the automotive industry are very complex electrical, mechanical and electronical systems of a vehicle (car); like an air conditioning (AC) module or "Antiblokiersystem" (ABS), the today vehicles has attracted and incorporated *innovations* that bred elsewhere: electronical controls, safety components, driver asistance systems, to name just a few examples, (cf. Sage 2000: 6f).

Creativity or *Innovation*?
The difference between *creativity* and *innovation* can be very confusing. Theodore Livitt, a person that had known about both, explains it this way: "*Creativity* is thinking up new things. *Innovation* is doing new things", (Levitt 2012). The relationship between those two phases is very clear: *Innovation* is the practical application of *creativity* – both are necessary for a company to succeed and grow.

2.4 Innovating Innovation

In daily business today we need to be innovative in the area of *innovation* itself, which is what this work help me to do and what we can call *innovating innovation*. The *innovation* is something quite different from invention. The *innovation* can be seen as invention implemented and taken to market. And whereas *innovation* lies discruptive *innovation*, which actualy changes our daily business and our live, work condicions and learning process. Underlying *Substantive Innovation* – the new technology, the automobile, the new concepts of traveling and transport, or the communication – is complete disruptive, drastically altering social practice, (cf. Chesbrough 2006b: x).

Distributive Innovation ban be seen as some major challenges. Although it may be relatively easy to predict the potential capabilities of a technological breakthough in items of the products in enable, it is nearly impossible to predict the way that these products or offerings will shape social practices. For example here can be use surprising rise of different vehicle configurations.

As the base aspect of *innovating innovation*, have to be investigated the ways to experiment not only with the product *innovation* itself, but also with novel business models. The innovation strategies and logics that Chesbrough describes shows the necessity of letting ideas both flow out of the corporation in order to find better sites for their mon-

etization, and flow into the corporation as new offerings and new business models, (cf. Chesbrough 2003: 36).

Open Innovation is a timely, carefully researched, and thoughtfully articulated effort toward that end, (Chesbrough 2006b: xxi).
– John Seely Brown

2.5 Continual Innovation

A lot of major trends result to power the need for *continual innovation*, (cf. Sage 2000: 3f). This section deals with the terms, which have a directly or indirectly influence on *continual innovation* developing described from Sage, Gorodnichenko, Hasan and others. *Continual innovation* is only successful if the innovation process deals with following terms: continuity, openness, realism, empowerment of users and spontaneous, (cf. Bergvall et al. 2009: 2).

1. *Globalization*. – The global orientation of all organizations, from original equipment manufacturers (OEMs) to all suppliers, provide a significant advantage in developing new products, services, and securing important relationship between organizations in a global view. Globalization influences *innovation* in many ways. Activities of the supply chain extend now almost everywhere. Development and research processes have to be implemented to encompass the activities and needs of operations, productions and global brands. *Innovation* and technology should afford round-the-clock connection to costumers, markets and sources of new knowledge, (cf. Gorodnichenko et al. 2008: 1f).

2. *E-commerce*. – The e-commerce, which exists today, runs in a highly competitive place of the market where sustainable competitive advantage is almost impossible as there are minimal barriers to new firms and competitors in this new place of the market. The faces and areas of innovation suport chalenges of copy, imitation and erosion. There have been some different figures in literature about the benefits of first movers in the e-business place of the market. A global belife in the world of e-commerce is that it is cheaper and safer to imitate the first mover in the e-business environment. At the same time there is higher level of technical uncertainty and a rach rate of *technological innovation*, (cf. Hasan & Harris 2009: 93f).

3. *The power of new products*. – Beating competitors to market with novel product that anticipate desired of the customers is very important to creating and winning today's business. Most companies look for methods and ways to create and

innovative new development process of a product or service itself, since doing so leverages ability to introduce and create winning new products, (cf. Sage 2000: 4f). The new products and services take off easier and faster in companies which look for methods and ways to create this new development process. The companies which invest more in development and research and which have interesting on *creativity* and *innovation* achieve and fabricate faster and easier new products or service, (cf. Chandrasekaran & Tellis 2008: 3).

4. *Supply chain cost reduction*. – Realizing *innovation* in the development and management of supply chain and supply chain relationship can make the companies extremely valued as partners. Supply networks are beginning to replace supply chains, supplanting the package and module offerings preferred by manufacturers with the contributing valued by customers, (cf. Sage 2000: 5). The supply chain cost reductin can be relized by saving the sources, new technichal solutions, increasing the velocity of material in supply chain or improving the performances, (cf. Kauffman 2004: 2ff). The downstream side of *innovation* has been less intensively researched and developed but has a strong external impact on *innovation*. Integration of suppliers into the innovation process results significantly increase innovation performance in most industries as well as automotive industry (cf. Sage 2000: 2).

5. *Strategy and customers*. – A strategy is required to decide where, when, and how *innovation* will be taken within the company. A lot of companies take and utilize *innovation* when in crisis mode only. *"We have a major customer who is threatening to leave us if we cannot get him his shipment today. What are we going to do?"* Of course this level of reactive *innovation* does little to differentiate a company from the competition, and just delays the sinking of the ship. *Innovation* has to be pervasive and perpetual: everyone, everywhere, all of the time. *Innovation* has to be seen as the key currency within the company, according to (cf. Shapiro 2002: 21). *Innovation* is also an important aspect for OEMs and suppliers as well to attract new customer and achieve similar margins in the past. A lot of the novel innovative process and product features are enabled by high electronic systems and modules, according to (cf. Baier 2010: 21) and (cf. Song et al. 2010: 4).

6. *Connectivity*. – Transparency between economies, companies, industries, organizations and functions are becoming more shared. Communication and partnership are emerging where competitions once existed. Collaboration and cooperation between supply chain participants are becoming more faster. This collaboration and cooperation indicate and accelerate new form of team-working

between organizations named *innovation*, (cf. Sage 2000: 5). If a company can build a productive relationship and connectivity with suppliers early, it can initiate several benefits. On the one hand, since they work with and share ideas and problems from the beginning, participants can save time in formulating their own and cooperative technologies and requirements, which can make the process feaster. On the other hand, suppliers can provide solutions, ideas and help identify problems early, according to (cf. Kim & Wilemon 2002: 32f).

7. *Technology*. – Are groupware tools taken to help enable partnership among customers, supplier, and employees? Are decisions made grounded on gut feel, or are they supported by real life data? Are ideas lost in the ether of the business union, or are they continued in idea banks to assist the capture and dissemination of innovative and creative thinking? – according to (cf. Shapiro 2002: 22) and (cf. Melling 1993: 120).

2.6 Comparison of two Kinds of Innovation

Tom Kelly describes in his research article **"The Ten Faces of Innovation"**. He documented that the project at the right time and at the moment cam spark a culture of *Innovation* that takes on life of its own, and also that the *innovation* is very dependent on the personals which involve in innovation process. The Kellys' description show us also that *innovation* can be divided and seen from different points of views as well as innovation types, innovation faces or innovation kinds. Some definitions of types and sources of *innovation* are documented by Serrat, (cf. Serrat 2009: 3). The then types of *innovation* investigated and described by Kelly are summarized (cf. Kelley 2006: 30fff) as follow:

1. *The Anthropologist* – brings new learning and insights into the company by observing human behavior and developing and implementing a deep understanding of how people interact physically and emotionally with products, services, and customers.

2. *The Experimenter* – prototypes new ideas constantly where he learning by a process of enlightened trial, mistake and error.

3. *The Cross-Pollinator* – explores other businesses and cultures, and translates those findings to fit the unique needs of your enterprise.

4. *The Hurdlers* – create a charge based on trying to do something that is never been seen before.

5. *The Collaborator* – supports bring development and research groups together and often lead from the middle of the ideas to create novel combinations and multidisciplinary clarifications.

6. *The Director* – not only gathers together a talented cast and crew, but also assistances to spark their creative capacities.

7. *The Experience Architect* – enterprises compelling experiences that go beyond mere functionality to connect at a higher level with customers' and buyers' latent and/or expressed needs.

8. *The Set Designer* – creates a stage on which *innovation* team associates can do the best work, converting physical environments into powerful tools to influence behavior.

9. *The Caregiver* – creates on the metaphor of a health care specialized to deliver customer care in a manner that goes beyond service.

10. *The Storyteller* – forms both internal morale and external awareness through compelling narratives that transferee a fundamental human value or reinforce a specific cultural characteristic.

However, based on this overview about innovation types, I want to point and explain the comparison of two kinds or types of *innovation*. I used two examples for this comparison an example of small electric mobile vehicle named segway and an example of *Hilti* company related to a laser measurement systems. Both examples are very creative and exist of a lot of inventions but an example is very innovative and other example is relative innovative.

Segway Example

First, I want to explain something related to the segway concept. This concept is based on a very creative idea of producing a revolutionary kind of the people transportation and novel mobility. The segway is a new concept related to the powertrain component and is based on using different technical solutions and topologies. For example, this powertrain concept is constructed the same way as an electric vehicle where here for the propelling of the wheels two parallel electric machines are necessary. In general, the segway concept can be seen as a combination of design, *creativity* and a lot of *inventions*.

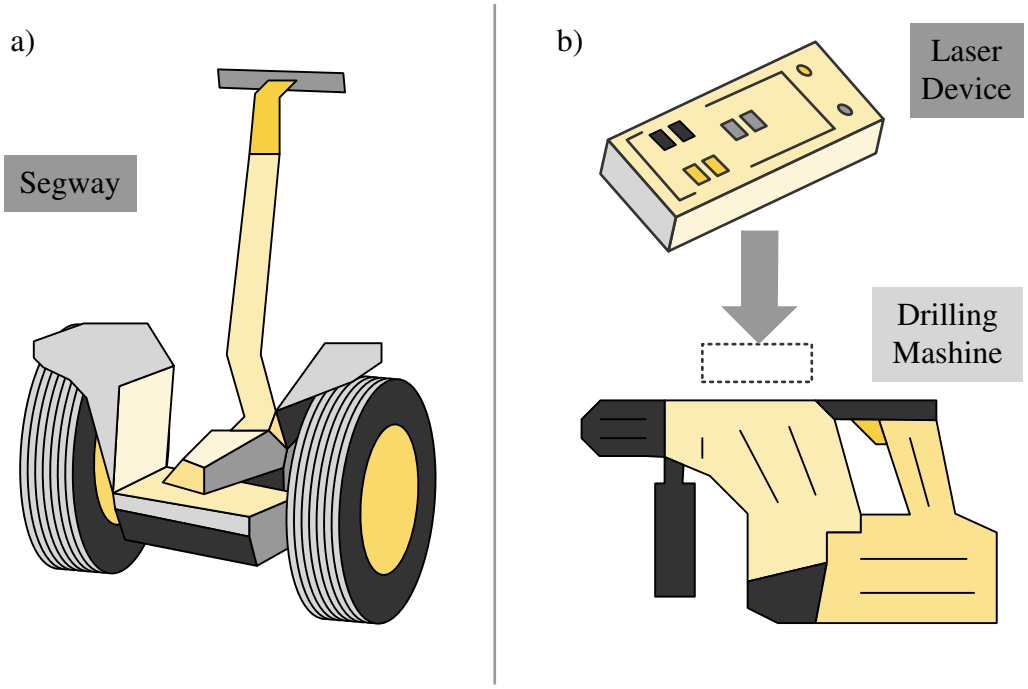

Figure 2.1: Two kinds of *innovation*; a) Segway *innovation* example and b) *Hilti innovation* example. Adapted from (cf. Technikjunkie 2013) and (cf. Hilti 2013).

In the figure 2.1, this segway concept is presented, according to (Technikjunkie 2013). I want to point some recentness and novelity of segway concept to become an overview, how much ideas are necessary to produce and implement this product. The segway development way can be seen as follow:

- New electric powertrain concept including two traction machine.
- Separate controlling of traction machines.
- Smart electric energy storage system based on lithium-ion battery.
- Stabilization control system including sensors for identification of device position.
- Active control system of accelaration, deceleration and velocity.
- Design and integration of entire powertrain.
- Electronic and electro braking system design of segway under consideration of usability and acceptance by final users.

Hilti Example

Second, I want to give some information related to the *Hilti* laser-measurement devices combined with an electrical drilling machine. The aim in this example is to identify the problems during the application of existing *Hilti* product (electrical drilling machine) which the final user or customer cannot identify or explain in a discussion or survey, according to (cf. Wecht 2010: 42) . Hilti employers just tested the market and found out that the final users have the problems during operating and using the drilling machine related to the drilling depth. They identified this customer needs and investigated the problem. Finally, they combined different solutions related to the identified problem and found an ideal combination of two devices. For drilling they used conventional tool – the drilling machine – and for measurement of the drilling depth the *Hilti* measuring laser system respectively too. Based on this combination, they created very easy a new product with high potential in the market. In figure 2.1, this Hilti example (combination of drilling machine and laser measurement system) is shown.

Comparison Summary

This section deals with a short summary related to the described examples. The segway innovation example is based on a lot of novel ideas but the concept was not so much successful as expected, according to (Oeamtc 2013). Where, the *Hilti innovation* – laser measurement system – was interconnected to the market. Here is to find out and identify that the *innovation* can be very simple but also useful and lastly successful on the market where some multi *innovations* based on different high-complex solutions can be interesting and novel but not so acceptable and successful on the market as expected.

2.7 Summary

In this chapter "*What is Innovation?*", the meaning of *innovation* and difference between other key therms related to the *innovation* like *invention* and *creativity* aspects are studien and described. At first, the different aspects and definitions of *innovation* are studied. Secondly, the general factors of business processes related to the *innovation* are described and the impacts and influences on the *innov*ation such as globalization, e-commerce, the power of new product, supply chain cost reduction, and connectivity are investigated. Finally, the two kinds of *innovation* are used for showing how different ideas can be translated into the *innovation*.

Chapter 3

Fundamental Models of Closed and Open Innovation

In this chapter, the fundamental implications of the innovation models are described. The differences between those models are explained like *closed* and *open innovation* model. The changing of the innovation model – from *closed* to *open innovation* – is studied.

3.1 Introduction

Only a part of innovations are good innovations. That means that a lot of innovations fail. And companies that are more oriented to the production and not to the innovation die. Today, innovation exists in every business model, or most companies. This chapter deals with processes and strategies of innovation, with the thematical questions like how companies utilize and advance technologies to create new products and services. The task of managing innovation is very important for companies of every size and for the companies with different types of business. Innovation is very important to sustain and advance the current business of the company. The innovation is critical and a key factor to growing new strategie for making new business, (cf. Lu & He 2010: 32). In today's business, where the changing of the products and serces is very fast, the innovation is a very difficult process to organize and manage, (cf. Chesbrough 2006b: xvii).

3.2 Innovation in the Past

In the oldest industry in the world, internal (closed) reserch and development was a valuable strategic asset, even a formidable barrier to entry by competitors in many

markets. Only large corporations could complete by doing the most researche and development in their respective industries (and subsequently reaping most of the profits as well). Rivals who sought to unseat those powerhouses had to ante up considerable resources to create their own labs, if they were to have any chance to succeeding, (cf. Chesbrough 2003: 35). In the past, agriculture, companiesvlearnd how to use generic and genomic technoligy to create crops mostly resistant to pests, drought, and diseases, even as they generate more output per acre. Yet in today's business, it is the worst of time for doing innovation by the companies. A lot of leading companies are having a terrible time sustaining their internal research and development.

In the last time period, internal research and development was interpreted as a strategic assets and even a barrier to competitive entry in many industry areas and business fields. The smalle companies without significant resources and long-term research program cannot compete any moore. Only the large companies with right resources and correct long-term research program can compete in this situation. The companies they are research based did the most research and devlopment in their common industrie, (cf. Chesbrough et al. 2006b: xix).

These days, the important leading industrial companies are looking and finding remarkably strong competition and collaboration from many newer companies. These new companies conduct little or on fundamental research on their own. In this time, where competition and collaboration was the basis by doing the research and development, they have been very innovative, these companies have innovated with the research and developmnet fields of others. This situation brought an opposite by doing collaboration, some companies that made significant long-term investment in research found thet some of the results and decisions, however excellent, was not directly or indirectly usefule for them, (cf. Chesbrough et al. 2006b: xix).

Looking to the Lindegaard book the innovation and *open innovation* is just getting started. This is a process and cycle that do not can be stopped in the future. The Lindegaard pointed out that innovation and *open innovation* ride on two global trends:

- Innovation has become a global 24/7 cycle. A lot of companies have set up research and development, and innovation labs outside of the boundary of company, stretching the possibilities for how innovation is created, and making it easier for companies to use the logic future (next) step of opening up internal innovation processes and technologies for external partners and customers, according to (cf. Lindegaard 2010: 3).

- The second trend can be also seen as megatrends and is based on transparency of technology and knowledge. Quiet, distributing technology and knowledge within companies remains challenging, and becomes even harder when you have to extend that technology and knowledge outside the corporate boundaries of the company as well. That points that the live in a global world where technology and knowledge is becoming more accessible and transparent. This global transparency makes easier to create innovation across boundary of a market or a company, according to (cf. Lindegaard 2010: 3f).

3.3 Interpretation of Innovation Paradigms

> What accounts tor the apparent decline in the innovation capabilities of so many leading companies, at a time when so many promising ideas abound? (Chesbrough 2006b: xx)
>
> *– Henry Chesbrough*

The way the company innovated new ideas and push them to customers and to market in the past is undergoing a basical change. The historian of science Thomas Kuhn commented that we need to discuss about **paradigm shift** in how companies commercialize industrial and technological knowledge, (cf. Kuhn 1970: in chapter 2). This old paradigm is called *closed innovation*. The *closed innovation* paradigm can be seen as a view that represents the following definition; successful innovation requires control. In this old strategy of innovation the companies were responsible for generating their own ideas and then develop them, build them, market them, distribute them, delivery them, service them, finance them, and support them on their own. This innovation strategy, paradigm, forces companies and firms to be very and strongly self-reliant. The self-reliant means, one cannot be sure of the avaliability, capability of other, and especially quality of the final products and services. The companies operated with strong innovation strategy: "If you want something done right, you have got to do it yourself." The old innovation strategy was internal and closed focused strategy.

In *closed innovation* strategy, a company normally inventes, generates, develops and commerzializes its own ideas. This strategy and philosophy of self-reliance dominated the researche and development operations of many leading industrial corporations for most of the 20^{th} century, (Chesbrough 2003: 36). The logic and strategy that impacted *closed innovation* thinking was an strongly concerted and internal focused logic and strategy. This focusing was not nesessary written down in any single place, but it was

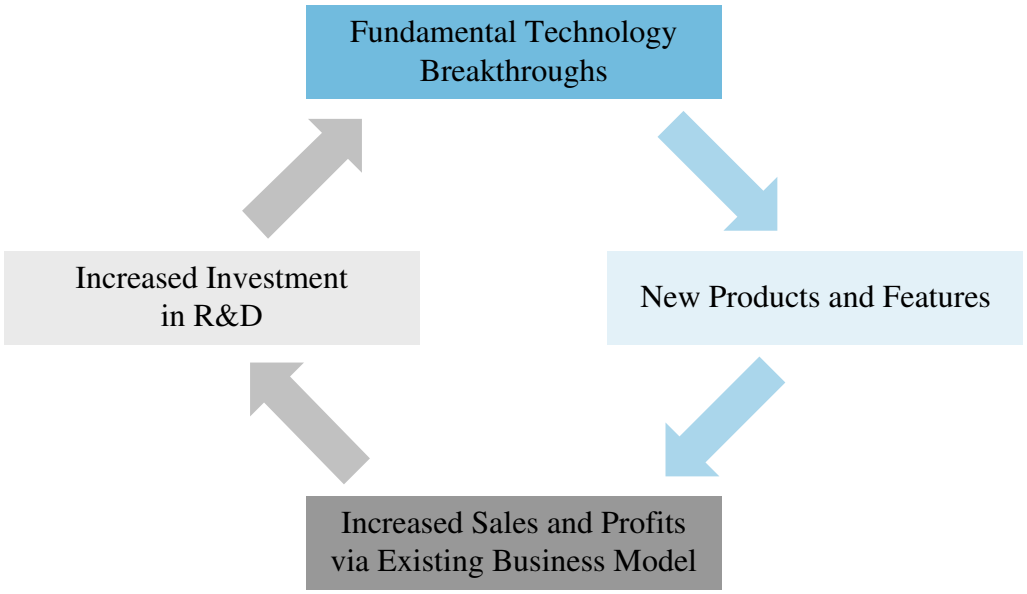

Figure 3.1: Schematic illustration of the *virtuous circle*. Adapted form *Open Innovation* by (cf. Chesbrough 2006b: xx).

tracitly held to be self-evident as the original and right way to innovative and to win. Here are a some of the implicit rules and items of *closed innovation*:

- We should hire the **best** and the **brightest poeple**, so that the smartest poeple in our company work for us.
- In order to bring new products and services to the market, we must discover and **develop them ourselves**.
- If we discover it ourselves, we will get **in to market first**.
- The company that **gets** an innovation to market **first** will usually win.
- If we lead the industry in making investment in researche and development, we **will discover** the best and the most **ideas** and will come **to lead the market** as well.
- We should control our intellectual property, so that **our competitors do not profit from our ideas**.

The logic and strategy of this type of innovation generated a virtuous circle, figure 3.1. This logic gives very exactly definition, the companies invested in internal researche and development, which led to many breakthrough discoveries. These discoveries enabled those companies to bring new products and services to market, to make more

sales and higher margins beacuse of these products, and then to reinvest strongly and only in internal researche and development, which support to further breakthroughs.

3.4 The Closed Innovation Model

Figure 3.2 represents the *closed innovation* paradigm for managing research and development. In this traditional model of innovation, the focus was mainly on research and development laboratories, where invention of new technologies and topologies were carried out tacking internal sources of information, according to (cf. Panduwawala et al. 2009: 3) and (cf. Westergren 2010: 2). In this figure, the dashed lines indicate the boundary of the firm. Created ideas flow into the firm on the left site. Separated and selected ideas flow out to the market on the right site. Selected ideas are clarified and filtered during the research process, and the surviving ideas are moved into development. At the end of this selection process, surviving ideas are taken to market. In the explained selection process of the ideas, the correlation between research and development is strongly connected and internally oriented, (cf. Chesbrough 2006b: xx).

Examples of this kind of the innovation procedure are the stage gate process, the chain link model, and the product development funnel or pipeline initiate in most literatures on managing research and development, according to (cf. Schonberger & Knod 1994: 59ff). In this case, the processes, projects and ideas start on the left at the beginning, and proceed within the firm until they are distributed to costumer and consumer on the right of the presented diagram in figure 3.2. Here, research projects are launched from the science and technology based on the company. They progress through the process, and some of the projects are stopped, while others are selected for future work, (cf. Chesbrough et al. 2006b: 2). The overcoming projects and ideas, having survived a series of internal screens, hopefully have greater chance of achievement in the market, (cf. Chesbrough 2006b: xxi). The figure 3.2 shows a representation of the innovation process under the previous *closed innovation* model, according to (cf. Chesbrough et al. 2006b: 2f).

Logic of Closed Innovation

For centuries, the logic of *closed innovatio*n was implicitly held to be self-evident as the right way to win novel ideas to market and successful companies all played by certain implicit rules. They capitalized and invested more deeply in internal research and development than their competitors and they hired only the best and the brightest, (cf. Zhang & Zhang 2009: 319). Because so much investment, they were able to discover

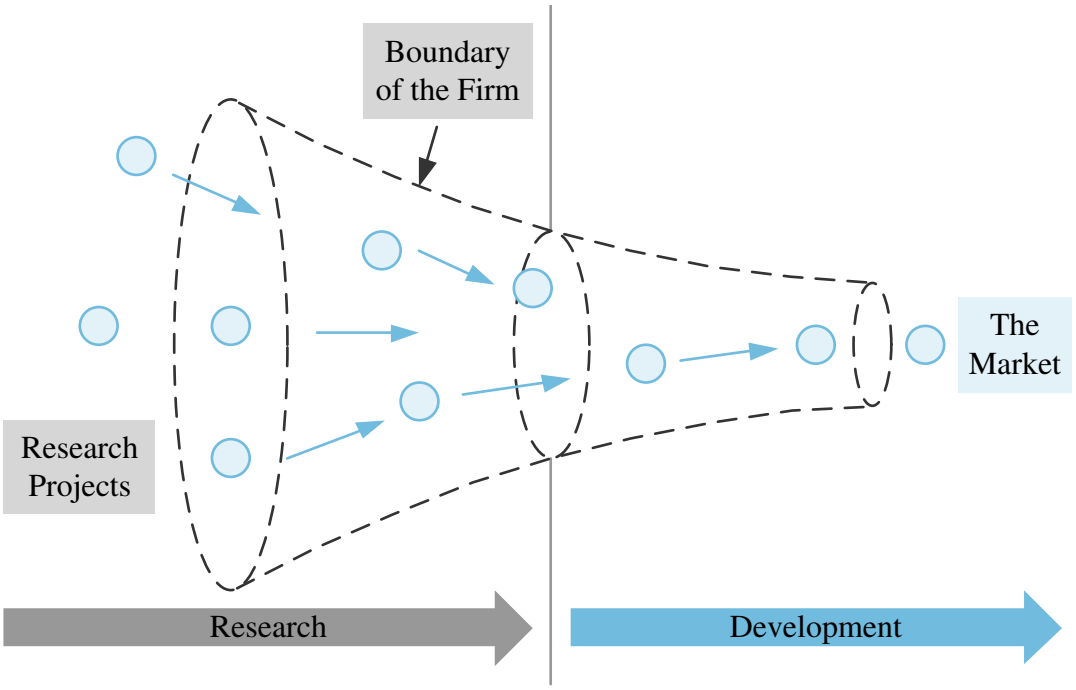

Figure 3.2: Schematic diagram of *closed innovation* model. Adapted from *Open Innovation* by (cf. Blum 2009: 7).

the best and greatest quantity and quality of ideas, which purposed them to get to the market early as other companies. This, in turn, enabled them to reap most of the profits, which they protected by aggressively controlling their intellectual property (IP) to prevent competitors from using it. They could then reinvent the profits in converting and translating more and more research and development, which then managed to additional breakthrough discoveries, creating a virtuous cycle of innovation, according to (cf. Chesbrough 2006b: xxii) and (cf. Chesbrough 2003: 36).

3.5 From Closed to Open Innovation Model

In the last period of the twentieth century, though, different factors combined to erode the structuring of *closed innovation*. One rudimentary ground was the growing of transport and mobility of higher qualified and skilled people. When people left the firm after working there for many years, they carried a good deal of that hard-won knowledge with them to their new firm or company, (cf. Chesbrough 2006b: xxii). The related erosion reason was the burgeoning amount of education and post-education time training that many people achieved. The increasing number of the educated people allowed knowledge to spill out the knowledge silos of central research labs companies and firms of all kinds and sizes in almost industries.

The way and principles of *closed innovation* was further challenges by the increasing fast time to market for almost services, products and outputs, making the shelf life of an individual technology ever shorter and shorter. However, more and more knowledgeable suppliers and customers promote and push challenged ability of companies to profit from their knowledge storages.

In the case, where these erosion factors have consequence an industry, the assumption and that once made *closed innovation* an effective method on longer applied. When basically technology breakthroughs happened, the engineers and scientists who made these breakthroughs were responsive of an outside solution that they normally lacked, (cf. Ghazawneh 2010: 4). If one company which funded these discoveries did not continue them in a timely fashion, the engineers and scientist could continue them these breakthroughs on their own in a new company, (cf. Chesbrough 2006b: xxiii) and (cf. Mueller 2010: 28). In the figure 3.3, the described and explained *virtuous circle* related to paradigm change from *closed* to *open innovation* is represented.

The influence of this outside effects broke the *virtuous circle*. The company that initially established the breakthrough did not profit any more from its investment in the research and development that led to the breakthrough, (cf. Osterwalder & Pigneur 2010: 110f). The company that did income and business from the breakthrough in general did not invest its proceeds to finance and support the next generation of discovery-oriented research, according to (cf. Chesbrough 2006b: xxiv).

In this especially situations the *closed innovation* is no longer sustainable. Related to these situations, a changed paradigm (approach) is emerging in face of *closed innovation*. This new approach is named *open innovation*. This new paradigm, which allows and defines that the company have to use and convenience external and internal ideas together, as well as internal and external paths to market, as the companies look to advance their technology and topology. The process of the *open innovation* merges external and internal ideas and technologies into modules and systems whose requirements are created by a business model. The *open innovation* enables that internal ideas and creativities can be used to market, of course over all external channels and ways, independent on the current business of the company, to create and produce additional value, according to (cf. Chesbrough 2006b: xxiv). In figure 3.4, described *open innovation* process is presented.

These changes in the paradigm of innovation are also caused by dynamic change of the market-trends and success factor based on integration of externals into innovation

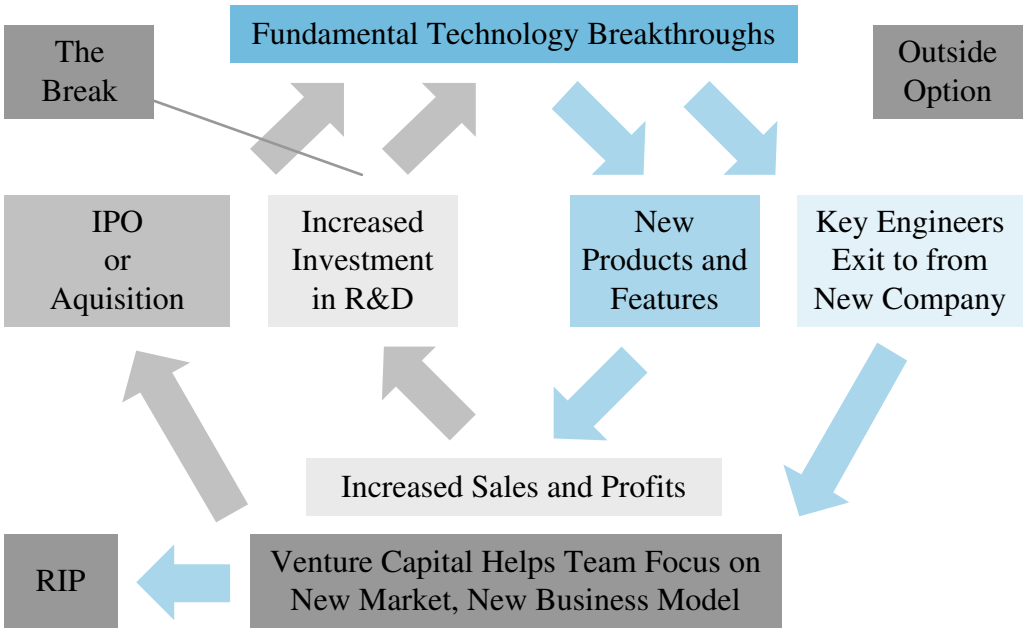

Figure 3.3: The *virtuous circle* broken. Adapted from *Open Innovation* by (cf. Chesbrough 2006b: xxiii).

process for better, more customer-oriented new products. The technical innovation driven by a culture of communication, new market, new internal training and many other trends are also an active part in generating the *open innovation* paradigm, (cf. Mayrhofer 2010: 80). Here I want to point out and mention some trends, which are collaborated during this change of innovation paradigm, according to (cf. Wecht 2010: 38), (cf. QuickMBA 2012a: 1f), (cf. Shapere 1964: 383), and (cf. QuickMBA 2012b: 2):

- Faster innovation cycles.
- Shorter products life cycle.
- Technological change.
- Globalization of markets.
- Competition increasing.
- Changin customer demands.
- Increased mobility of skilled workers.
- Expansion of venture capital.
- External options for unused technologies.

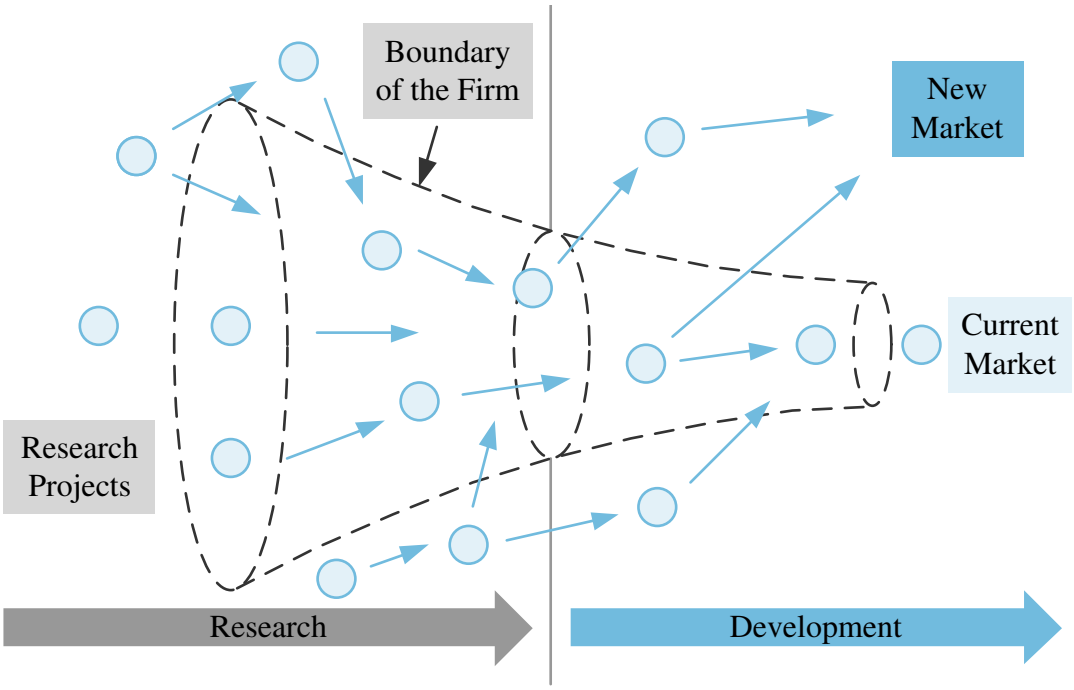

Figure 3.4: Schematic diagram of *open innovation* model. Adapted form *Business Model Generation* by (cf. Osterwalder & Pigneur 2010: 110).

- Increased avaliability of highly-capable outsoursing partners.
- Scientific revolution.

3.6 The Open Innovation Model

In figure 3.4 can be seen that the ideas can still originate from inside the company's research process and project, but also that some of generated ideas may step out of the company. These internal and external ideas can flow either in the research part phase or later in the development phase. Ideas can be created outside of the company and can flow inside. As figure 3.2 shows the solid lines of the diagram shown the boundary of the company related to the *closed innovation*. The same lines are dashed in the figure 3.4. These dashed lines represent more porous boundary of the company. The porous boundary reflects interfacing between what is done inside the company and what is accessed from outside the company, according to (cf. Chesbrough 2006b: xxivf).

Open innovation describes a new paradigm for the management of industrial innovation – and open sources innovation related to the Chesbrough's theory: **"Rethinking Your Business to Grow and Complete in a New Era"** can translate this concept to the service economy, according to (cf. Chesbrough 2011: 1f). This statement results

from a very strong motto I found in one other book described by Chesbrough: **valuable ideas and innovations can come from anywhere**, (cf. Chesbrough 2006a: xxii). Based on this motto is self-evident that the good innovation can be created and generated only using *open innovation* model.

The *open innovation* paradigm observes research and development as a transparent system. *Open innovation* proposes that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well and enhances the companie's innovativeness, (cf. Manceau et al. 2012: 10). This approach carries external ideas and external paths to market on the same level of importance as that reserved for internal ideas and paths to market in the earlier era, according to (cf. Chesbrough et al. 2006a: 2). The *open innovatio*n model is a model that supports a system based on a business citizens-government-partnership which enables users to take active part in the research, development and innovation process, according to (cf. Mavridis et al. 2009: 563).

3.7 Contrasting Principle of Closed and Open Innovation

The process of *open innovation* revises out false positives. And it disconnects the recovery of false negatives. Those are the projects that initially seem almost certainly worthless. The characteristics of those projects are the good positioning in a new market. The thinking of *open innovation* is created on architecture of abundant knowledge, which must be used readily if it is to afford value to the company that founded it, according to (cf. Chesbrough 2006b: xxv).

This perspective proposes a lot of different organizing and operating principles for research, development and innovation. Table 3.1 describes some of the principles of this new innovation paradigm and compares them with the earlier principles of the *closed innovation*. The *close innovation* model and logic has worn-out in each kind of industries, according to (cf. Chesbrough 2003: 38) and (cf. Chesbrough 2006b: xxvi).

Table 3.1: Contrasting principles of *closed* and *open innovation*. (cf. Chesbrough 2003: 38), (cf. Chesbrough 2006b: xxvi) and (cf. Osterwalder & Pigneur 2010: 111)

Closed Innovation Principles	**Open Innovation Principles**
The smart poelpe on our field work for us.	Not all the smart poeple work for us. We must find and tap into the knowledge and expertise of bright individuals outside our company. We need to work with smart poelpe inside and outside our company.
To profit from R&D, we must discover it, develop it, and ship it ourselves.	External R&D can create significant value; internal R&D ins needed to claim some portion of that value.
If we discover it ourselves, we will get it to market first.	We do not have to originate the research to profit from it.
The company that gets an innovation to market first will win.	Building a better business model is better than getting to market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control up our IP, so that our competitors do not profit from our ideas.	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our own business model.

3.8 The Core Processes of the Open Innovation Concept

Based on the open innovation concept from Chesbrough define Gassmann and Enkel the three *core processes* of the practical implementation of the open innovation, (cf. Gassmann & Enkel 2004b: 5ff). This investigation shows that the opening of the innovation process can be divided in three different activities. Gassmann and Enkel use following names for those three core processes: *outside-in*, *inside-out* and *coupled process*, (cf. Blum 2009: 12f).

The *outside-in-process* includes all forms of the integration and utilization of the external knowledge. The *inside-out-process* exists of the activities which generate and commercialize the internal knowledge outside the boundary of one company structure. The *coupled-process* supplies in general a combination of the both one-way processes,

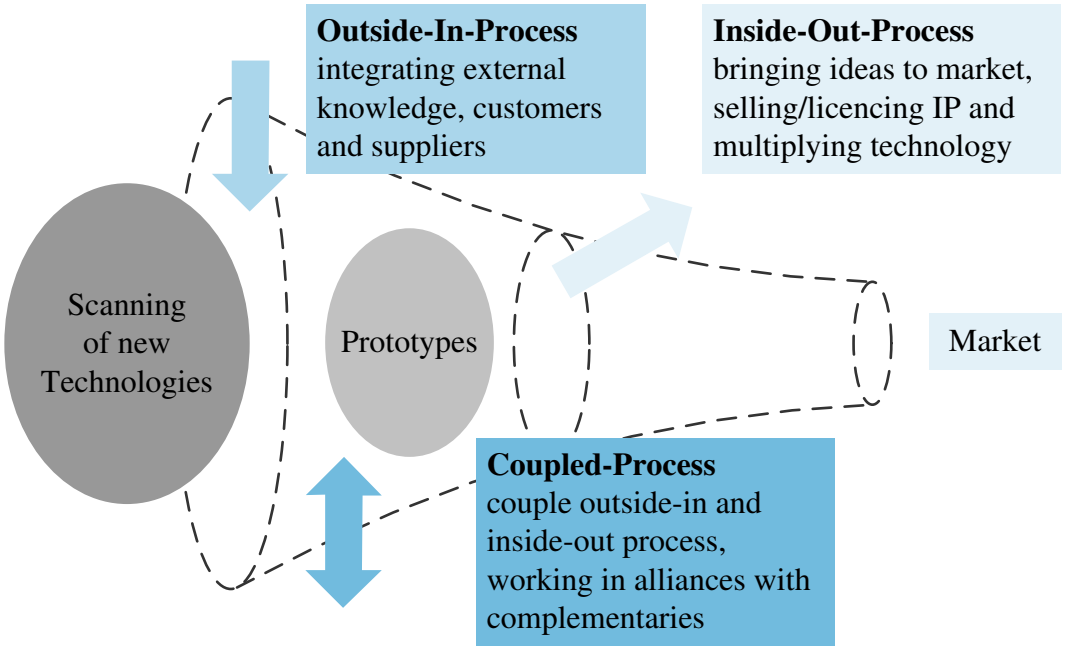

Figure 3.5: The *core processes* of the open innovation concept. Adapted form *Towards a Theory of Open Innovation* by (cf. Gassmann & Enkel 2004b: 7).

(cf. Gassmann & Enkel 2006: 7ff).

The interaction between a company and business area or market of a company is defined with one of this three *core processes*. Described core processes are depicted in figure 3.5, according to (cf. Gassmann & Enkel 2004a: 8).

All of the described processes represent a form of the open innovation strategy but in the practice are not used permanent all strategies for the implementation and realization of the open innovation. A lot of companies use only one of the three *core processes*. Only a few of companies combine two or all processes for beter implementation of open innovation in our business field, (cf. Gassmann & Enkel 2006: 6).

Why the right strategy of open innovation is important, shows the Huston's study. At the beginning of this study (article) can be found following statement: *"Procter & Gamble's strategy of Open Innovation now produce more than 35% of the company's innovations and billions of dollars in revenue"*, according to (cf. Huston & Sakkab 2006: 1).

The following subsections considere each *core process* in detail for better understanding how those processes are implemented and realized in different forms.

3.9 The Outside-In-Process

The *outside-in-proces*s (named core-process) is based on integration of the external knowledge from the market and other companies into own company. The sources for the external knowledge occur mostly from cooperation with customers, suppliers, innovation clusters, development and research companies, or market analysis and investigation. The use of the customer sources of the information and innovation overlap together with the theorem of Eric von Hippel which is named as **"User Innovation"**. This theorem is based on following definition "*the customer is indirectly innovator*" , (cf. Blum 2009: 18).

User Innovation. – Innovation by users tends to be widely showed and distributed rather than concentrated among just a very few very innovative users. As a consequence, it is important for user innovators to create ways to combine and leverage their efforts. Users achieve this by engaging in many forms of collaboration and cooperation, according to (cf. Hippel 2005: 10f).

The integration of the customers in the innovation process can have in the practice different forms and solutions. The customers are a very important role in the brainstorming and idea-evaluation process. The customers are important source of information in the research and engineering process. An early customer-oriented development and research based on this source of information can reduce the risk on the market of a novel product or service, (cf. Gassmann & Enkel 2004b: 15) and (cf. Blum 2009: 18).

By *outside-in-process* extracted capability for integration of the external knowledge is described and defined based on the *Absorptive-Capacity-Concept* developed by Cohen and Levinthal. The term **"Absortive Capacity"** is described as capability to absorb the external technologies and knowledge and to reproduce this technologies and knowledge in the adequate form. The core elements of the *Absortive-Capacity-Concepts* are screening, evaluating and using external knowledge. A minimum of the internal research and knowledge is ground requirement to utilize the external technologies in described concept which is very similar with open innovation process, which is described in the next chapter, (cf. Vanhaverbeke et al. 2007: 1f) and (cf. Harke 2012: 14).

3.10 The Inside-Out-Process

The *inside-out-process* includes all those possibilities of the commercialization, where by using an external realization of internally generated and created knowledge and idea, an additional value for the company is generates. The term **"external realization"** describes all forms of realization or commercialization outside of the existing boundary of a company or business unit. Companies that follow and use the *inside-out-process* as the core process are often active in basic research fields and areas. The *Inside-Out-Process* will primarily aim to improve the efficiency of research and development and to minimize fixed costs where as much as possible of the research results are used commercially.

Those research results are also used and translated outside of the boundary of the company. The external use of intellectual property by granting licenses, or by so-called **"Cross-Industry-Innovation"** can increase the profits of a company greatly, according to (cf. Gassmann & Enkel 2004b: 10ff). The term *Cross-Industry-Innovation* describes the industry-wide use of existing technologies or solution principles in other fields and areas, according to (cf. Gassmann & Zeschky 2007: 1f).

Beside of the commercialization through licensing there exist other external options of exploitation for unused internal technologies. Especially for technologies that are not within the technological core competencies of a company or their commercial exploitation does not fit the strategy of the company. Based on this statement exists the possibility to sell those technological core competences or to recover those competences by other companies using a **spin-off** form. This **spin-off company** may be completely independent from the parent company or still partially are in its possession. Through the establishment of the **spin-off company**, the development risk can be minimized and the creation of the **spin-offs** can amortize the invested development costs, according to (cf. Viskari 2006: 22ff) and (cf. Blum 2009: 14).

Sometimes, the expected profit of a single **spin-off company** seems insignificant related to the short-term perspective in contrast to the parent company. But in the sum and especially related to the long-term perspective, the wins produced by **spin-off company** can expand and create a important part of entire profit, according to (cf. Blum 2009: 15).

3.11 The Coupled-Process

The *coupled-process* can be extracted from *outside-in* and *inside-out-process* and characterized as a hybrid form of process. By means of cooperation with strategy partners and companies, the external technologies and ideas can be integrated and can be put on the market. The cooperation like this one occurs in general inside the strategic networks and clusters, and built the interactive long-term exchange of the technologies. Based on this knowledge, those co-operations can be classified into two groups:

- Co-operations between competitors in the research processes.
- Joint ventures and clusters between complementary companies, universities and research institutions.

Open innovation clusters communities support for easier inter-organizational collaboration and cooperation. Their key target is to take and transform external information sources, technologies and ideas as well as external paths of a company to market in addition to internal sources and paths in the case of creating innovation, according to (cf. Brocco et al. 2010: 270).

A more important point related to the co-operations is the developing and creating standards and networking which can be used by involved companies. For example, the Universal Mobile Telecommunication System (UMTS) and Multimedia Messaging Service (MMS) technologies are developed by co-operation between more telecommunication companies but at the moment, this technology can be and will be used in the future from all telecommunication institutions, related to (cf. Blum 2009: 15) and (cf. Gassmann & Enkel 2004b: 12f).

In this subsection, I want to describe the case I founded in (cf. Blum 2009: 15) related to the how the open innovation concept can be used in automotive industry. Only when companies like automotive company *BMW* first include new technologies and innovative features (like the sourcing of the brake-and-steer-by-wire technology from the TU Vienna where it was based on a bus safety system), can they differentiate themselves from their competitors and maintain their market position in the automotive industry. They therefore need to hold on the co-operation in bilateral partnerships with guaranteed exclusivity. In order to increase their innovativeness including creativity and idea-building they are heavily dependent on focusing on including external knowledge in an *outside-in-process* in their research. For both kinds of co-operations; bilateral or multilateral, open innovation can be a successful approach for a company meeting the required characteristics and implementing the *coupled-process* of the open innovation concept.

3.12 Summary

In the chapter 3, the investigation of *closed* and *open innovation* represents that there are many differences between innovation processes related to research and development. However, the process of *closed innovation* is implicitly held to be self-evident as the right way to win novel ideas and creations to market but in the last period of the twentieth century, though, different factors combined to erode the structuring of *Closed Innovation*.

These changes in innovation paradigm are also caused by dynamic change of the market-trends and success factor based on integration of externals into innovation process for better, more customer-oriented new products. Accordingly, the open innovation process including the benefits of this process and paradigm have been identified and discussed.

Finally, the interaction between a company and business area or market of a company was represented and explained. The *core processes* of this interaction are discussed and documented as well as *outside-in*, *inside-out* and *coupled-process*.

Chapter 4

Business Model Analysis

This chapter deals with definition and investigation of a *business model* and explanation of the nine *building blocks* related to investigated *business model*. During the literature studying, I found a lot of business model definitions but I believe that a *business model* can best be explained through this nine *building blocks*. Mostly information's related to the business model description are used from the book **"Business Model Generation"**.

4.1 Business Model Definition

A *business model* represents the rationale of how an company and/or organization creates, delivers, and captures value. The key question here is what a *business model* actually is. Each company needs a *business model* that everybody understands. It is very important that the business model concept is simple, easy to handle, relevant and intuitively understandable. In this sub-section, the *business model* will be described based on nine *building blocks* that show the logic of how a company and/or an organization propose to make money, according to (cf. Osterwalder & Pigneur 2010: 14).

In general, the nine *building blocks* cover the four mean fields (areas) of a business as follow:

- **Customers** – (customer relationships, channels and customer segments)
- **Offer** – (value proposition)
- **Infrastructure** – (key partners, key activities and key resources)
- **Financial viability** – (cost structure and revenue streams)

In figure 4.1 the *business model* including the nine *building blocks* is depicted.

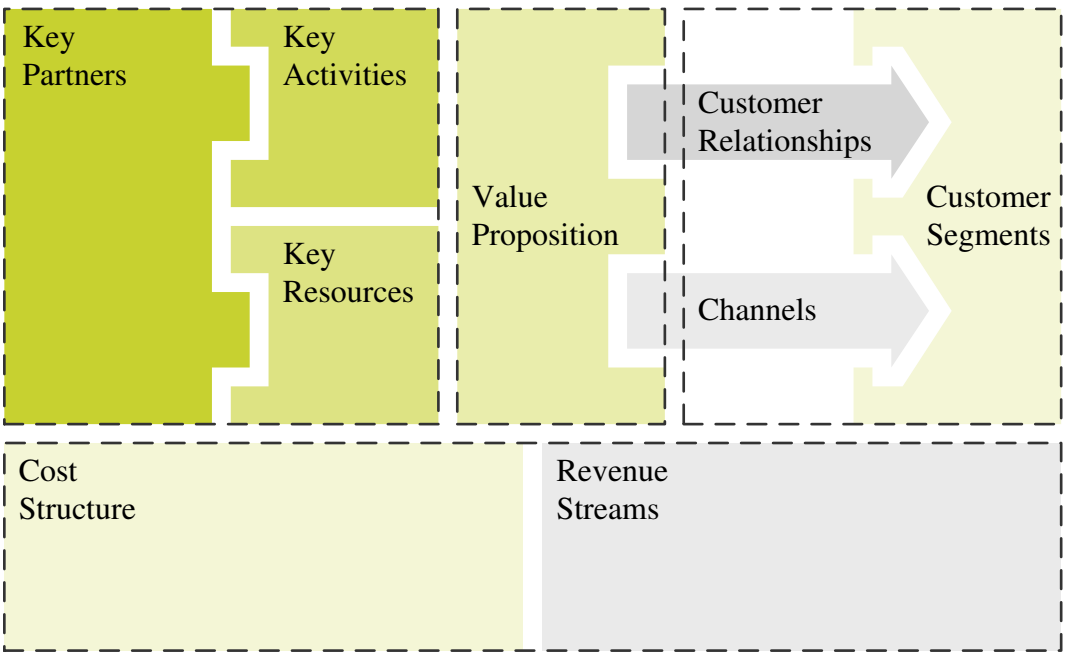

Figure 4.1: *Business model* definition. Adapted from *Business Model Generation* by (cf. Osterwalder & Pigneur 2010: 42).

4.2 The nine Building Blocks

The *Customer Segments* (CS) building block consists of different groups of people or organizations an enterprise aims to reach and serve. In general, the customers are the heart of any successful business model. Without successful business model and profitable business model, no company can exist for long. A business model can be created based on one or several large or small *customer segments*. For a company or an organization is very important to define which segments to serve and which segments to ignore. A successful business model can be only created around a strong understanding of exact customer needs, according to (cf. McGuirk 2007: 1).

The *Value Propositions* (VP) building block represents the bundle of products and services that create value for a specific *customer segments*, (cf. Osterwalder & Pigneur 2010: 22f). The *value proposition* can be defined as reason why clients and/or customers turn to one company over another. Successful solving customer needs and problems can also be seen as *value proposition*. The *value propositions* are in generally innovative, novel and qualitative.

The *Channels* (CH) building block defines a process how an organization links and/or relates with and reaches its *customer segments* to deliver a *value proposition*. Product

distribution, communication interfaces and the *channels* constitute relationships with customers. The *channels* consist of several tasks like helping customers evaluate the *value proposition* of a company, delivering a *value proposition* to customers, allowing customers to purchase specific product and services etc., according to (cf. Osterwalder & Pigneur 2010: 26).

The *Customer Relationships* (CR) building block represents the types and/or kinds of relationships a company establishes with specific *customer segments*. The *customer relationships* block allows to the way a company goes to market, how it actually reaches its customers and how it interacts with them. In order to reach new markets and/or to serve customers better companies need to introduce new distribution channels and communication ways, according to (cf. Osterwalder 2004: 59). The main motivation factors related to the driving of the *customer relationships* are customer acquisition, customer retention and boosting sales (up-selling), (cf. Osterwalder & Pigneur 2010: 26).

The *Revenue Streams* (R$) building block describes the cash of a company which is generated from each *customer segment*, (cf. Osterwalder & Pigneur 2010: 30). The *revenue streams* a company can capture from its value creating activities are pivotal to its long-term survival. A business model of a company can include one to many different *revenue streams*. Each of them can have one or several different valuing and/or pricing logics, (cf. Osterwalder 2004: 96). Different literature sources refer to more different types of *revenue streams*. In general it can be said that a business model must consist of two different types of *revenue stream*s: **a)** transaction revenues causing from one-time customer payments and **b)** recurring revenues causing from ongoing payments to either deliver a *value proposition* to customers, (cf. Osterwalder & Pigneur 2010: 30).

The *Key Resources* (KR) building block represents the mostly important assets required to make a successful business model. Every business model must consist of correspondingly *key resources*. These resources afford an enterprise to generate and offer a *value proposition*. In a company, different *key resources* are necessary depending on the kind and/or type of business model. However, *key resources* can be based on physical, strategic, financial, human and intellectual resources, (cf. Osterwalder & Pigneur 2010: 34). The *key resources* can also be seen as core competencies of a company. In generally, what a company knows, its skills and unique capabilities. Then they define the strategic assets, such as infrastructure, brands and patents activities of a company, according to (cf. Osterwalder 2004: 33).

The *Key Activities* (KA) building block represents the mostly important activities a company has to do to make a successful business model. This block can be defined as following question, what activities a company engage in that allows it to execute its strategy and establish a presence in the market. In other words, the activities include platform development and creation of tools to streamline the sales processes, internal seller education, development and implementation of different software, etc., (cf. Osterwalder & Pigneur 2010: 36). The *key activities* can also be development based on novelty processes – switching costs of production– efficiency centered design of novel product and bundling activities within a system provides more value than running activities separately, according to (cf. Zott & Amit 2009: 7f).

The *Key Partnerships* (KP) building block represents the network of partners, suppliers and associates that make the business model. The partnerships are becoming a cornerstone of many business models, where companies invent and make partnerships for many reasons. In other words, the companies try to create alliances and clusters to make better their business model. The partnership can be defined based on following four definitions: **a)** strategic clusters between non-competitors, **b)** strategic clusters (partnerships) between one or more competitors, **c)** develop new business based on joint ventures and **d)** customer-buyer-supplier relationships to guarantee reliable supplies, according to (cf. Zott & Amit 2009: 2f).

The *Cost Structure* (C$) represents all costs invited to drive a business model. In general, the costs of a company consist of fixed and variable costs. The fixed costs are costs that remain the same regardless of changes in activity such as rental costs and insurance costs where variable costs are costs that vary in direct proportion to changes in activity such as direct material costs, labor costs. Of course, this division of costs into fixed and variable costs is helpful by creating business model especially under consideration of flexible budgeting, break-even analysis and short-term decision making, according to (cf. eBoost 2013: 10).

4.3 Open Business Model

However, there have been many different implementations and pictures of *business model*. The main points by creating, developing and/or choosing of business model can be as follow: **a)** founding the ways to define mechanisms for creating value, and **b)** to define mechanisms to capture a certain proportion of that value, according to (cf. Sandulli & Chesbrough 2009: 2f).

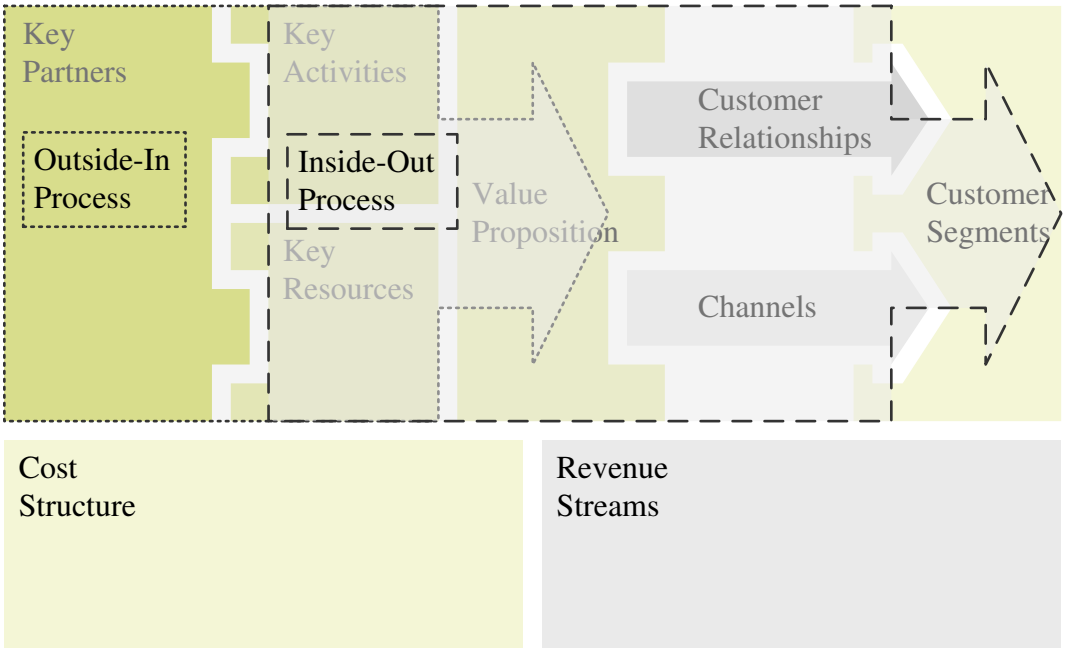

Figure 4.2: *Outside-in-* and *inside-out-process* in *open business model*. Adapted form *Business Model Generation* by (cf. Osterwalder & Pigneur 2010: 116f).

In business today, the *open business model* can be used by organizations and companies to generate and transform value by scientifically and technologically collaborating with outside partners and industry clusters. On the one hand, this can be transformed from the *outside-in* by generating external ideas within the firm. On the other hand, this *open business model* can be generated from the *inside-out* by purchasing external parties with ideas or assets lying idle within the firm, (cf. Osterwalder & Pigneur 2010: 109).

These two processes – **a)** *outside-in* (ideas are invented inside only) and **b)** *inside-out* (results are exploited inside only) – are represented and depicted in figure 4.2.

4.4 Outside-In-Process in Open Business Model

The *outside-in-process* comprehend the external development costs, the specific resources of innovation network, the activities of external organizations and companies to managing network, etc. In figure 4.2, the costs and resources can be separated and located on the left part of the business model, (cf. Osterwalder & Pigneur 2010: 116). (key partners, key activities, key resources and cost structure)

Key partners – The innovation and technological partners may be able to serve and to combine usable knowledge, patents, products, services and/or research and development activities where, for example, these products can be completely different from internal products.

Key activities – The activities that connect the entities outside a company with internal business processes and activities of the research and development groups as well as screening new technologies outside the company, networking etc. are important *key activities* of a business model related to the *outside-in-process*, (cf. Gassmann & Enkel 2004b: 15).

Key resources – Using benefit of outside innovation requires specific resources such as screening capabilities of other companies and asses to innovation network to build gateways to external network, according to (cf. Osterwalder & Pigneur 2010: 116).

Cost structure – The *cost structure* can be seen as the cost or money to win innovation from outside of the company based on external created knowledge, new technologies and advanced research programs. Using outside knowledge, a company can shorten time-to-market and increase research and development. In other words, the *cost structure* building block shows externalization of research and development costs, according to (cf. Heijden 2010: 10).

4.5 Inside-Out-Process in Open Business Model

The *inside-out-proces*s comprehend the sell information, the value of revenue streams, the internal activities of organization to managing research and development, etc.

In figure 4.2, the costs, development and resources can be separated and located on the right part of the business model diagram, (cf. Osterwalder & Pigneur 2010: 117). (beginning with key partners and finishing with revenue streams)

Value proposition – A part of research and development activities that are unusable internally can be of high value to companies in the same or other industries. In this case, the *value proposition* has to guarantee and to define the value for a customer or partner segment through a distinct mix of elements catering to that segment's needs, according to (cf. Heijden 2010: 9).

Key activities – Each company needs to accomplish a number of activities (related to

internal research and development) to successfully fulfill the customer's needs. The *key activities* are internal activities that are of the highest importance to the company and let it operate successfully, according to (cf. Heijden 2010: 9).

Customer segments– Related to the *inside-out-process*, a company must make an exact decision about which market and innovation segments to target and which market and innovation segments to ignore. Once this decision is made the open business model can be carefully created around a strong understanding of exact customer needs, according to (cf. Osterwalder & Pigneur 2010: 117) and (cf. Heijden 2010: 7).

Revenue streams – Based on the questioner; for what value is a customer segment really willing to pay, there are different ways to create revenue streams. But related to the open business model and *inside-out-process*, the revenue streams can be created based on asset sale, usage fee, subscription fee, etc., (cf. Heijden 2010: 9).

4.6 Summary

In summary, this chapter 4 has investigated *open business model* and has shown the nine *building blocks* which build the core structure of a novel business model. However, the definition of a business model is described and discussed.

After business model definition, the *open business model* structure and work-flow are investigated where two specific processes *(outside-in-* and *inside-out-process*) are also recognized. During studying of business model the question; how the *open business model* can be used in different ways under especially consideration of investigated processes.

This overview of business model and innovation processes will be used as basic idea and structure to investigate some project processes I had in the past. The studying about *innovation*, *open innovation*, *innovation processes* and *open business model* allows me to become a better understanding, how an innovation process of a project can be used at the beginning of a project.

Chapter 5

Expected Results

The research results of the master thesis is to analyze and compare *open innovation*- and *open business models* based on selected research projects I managed in the past at my institute. The general benefit of both studied models has to be explained and represented.

I expect to use the created results of in daily business processes in order to support my company and help to understand the potential and role of *open innovation*- and *open business models* in their optimization of research and development processes in future automotive projects:

- To reinvent a suggestion creating new ideas and approaches regarding *open innovation*.
- To generate an overview about community awareness to ensure better societal innovation aspects.
- To support my business unit finding the strong technology partner for the new projects which focus on strong technological competencies.

Chapter 6

Case Study

In the first sub-section in this chapter 6, I want to give you a short technical overview about two kinds of the projects I have in the past. For this overview, I used four projects I was involved. Two of these four projects are co-financed projects and two costumer projects. This overview consists of a very strong technical description and general objectives of these projects.

6.1 Klimamobil – Project Nr. 1

Zero Emission Vehicles in Public Local Transport

This project is a co-financed project and is supported by *Federal Ministry for Transport, Innovation and Technology, Austria*. In this project following companies and institutions are involved: *Filmarchiv Austria*, *Marktgemeinde Perchtoldsdorf*, *Marktgemeinde Hornstein*, *Ökostrom Vertrieb GmbH*, *Ökomobil Austria*, *TU Graz - Institut für Fahrzeugsicherheit*, *Kutsenits Handels- und Bus-Konstruktion GmbH* and the institute I have been working since 2003, *Austrian Institute of Technology*.

This project is successfully finished and two prototypes of two pure electric buses ware realized. In this project, I was responsible for entire vehicle simulation and for supporting the project partners by concept specification and development. More information about this project can be found at following link: *http://www.bmvit.gv.at/*.

Project Objectives

Since presently no multi-seat electric cars are offered on the market – in particular for the suggested application, and progressive battery systems do not yet play a dominant role in the automotive industry area. This project focuses on converting suitable con-

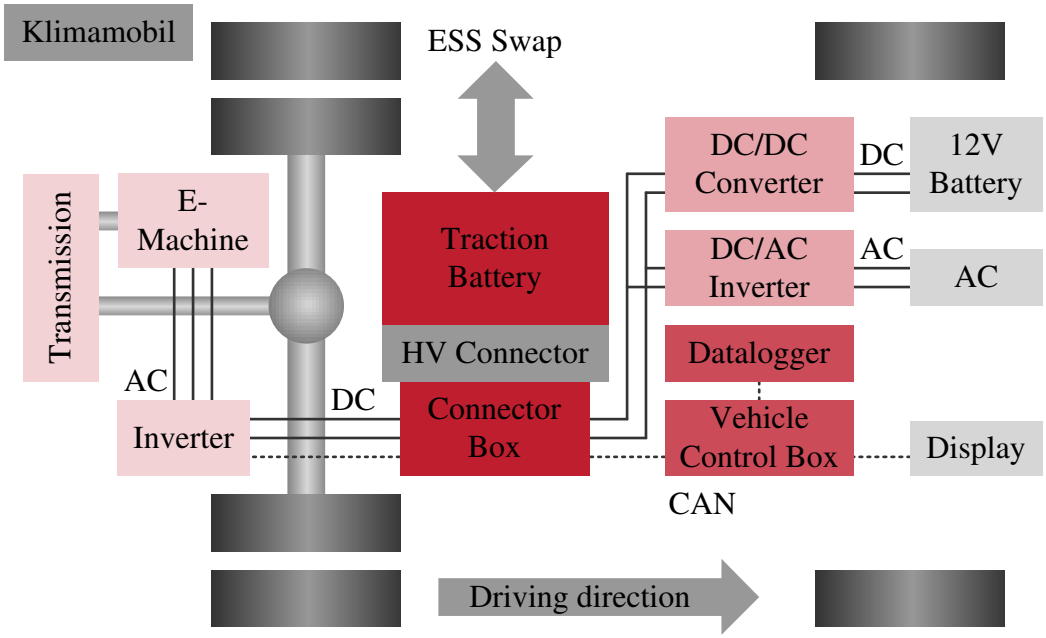

Figure 6.1: System overview (components for which *AIT* was in charge of). Adapted from *Development, Design and Realization of an Electric Powertrain for a Small Range Bus* by (cf. Simic et al. 2011: 2).

ventional vehicles – small buses realized as low-floor bus – driven with an internal combustion engines to electric drive. For that purpose special emphasis is given to the specification and optimization of the relevant powertrain components (drive train, control units, batteries and battery management) to develop a high efficient driving system. In an additional module a solar battery-charging station has to be developed, generating the annual energy consumption of the vehicles. By that the concept under investigation can be presented as zero emission driving system.

In the demonstration phase of the lead project the redesigned conventional buses are practically tested in selected pilot regions as part of the public local passenger transport. By integrating the buses in the public transport system a high amount of driven kilometers can be recognized within a very short time frame and by that a comprehensive evaluation of the vehicle concept achieved. The buses are used as a local bus in the regular service as well as a municipal bus, completing public local transport as hailed shared taxi on demand. In both pilot regions a solar battery-charging station will be installed based on optimized photovoltaic equipment.

With this suggested lead project essential information and experiences gained for development of alternative drive trains and achievement of improved climate protection.

Public local transport allows a high amount of driven kilometers and by that a comprehensive evaluation of the practical fitness of the developed electric drive train with highly efficient energy storages for the short haul application is possible. Additionally an accompanying monitoring by means of implemented data loggers allowed a detailed analysis of the entire energy support and drive systems in the different operation modes.

By integrating a novel and alternative drive concept into the public local transport system the zero emission equipment is becoming a sensual practical experience for the public. Finally it is the objective of the lead project to provide information and support decision processes concerning the economical and traffic related potential of zero emission powertrain concepts and vehicles on the whole. Particularly a comparison to conventional driven vehicles is done and a concrete viewpoint for a market penetration is given.

The Klimamobil project develops and demonstrates an energy efficient powertrain concept in a future domain of public local passenger transport and can be perceived as a flagship initiative for future mobility concepts and solutions in the name of climate protection. The schematic system overview of the concept-components for which our institute was in charge of is represented in figure 6.1, according to (cf. Simic et al. 2011: 2).

6.2 ZEMC – Project Nr. 2

Zero Emission Motorcycle – Freeride-E

This project is a co-financed project and is supported by *Federal Ministry for Transport, Innovation and Technology, Austria*. In this project following companies are involved: *KTM Sportmotorcycle AG*, *Kiska GmbH* and the institute I have been working since 2003, *Austrian Institute of Technology*.

In this project, I was responsible for feasibility investigation and concept development as well as for entire system simulation under consideration of real life driving conditions. This project is successfully finished in 2008 and a prototype of an electric motorbike was build. More information about this project can be found at following link: *http://www.bmvit.gv.at/*.

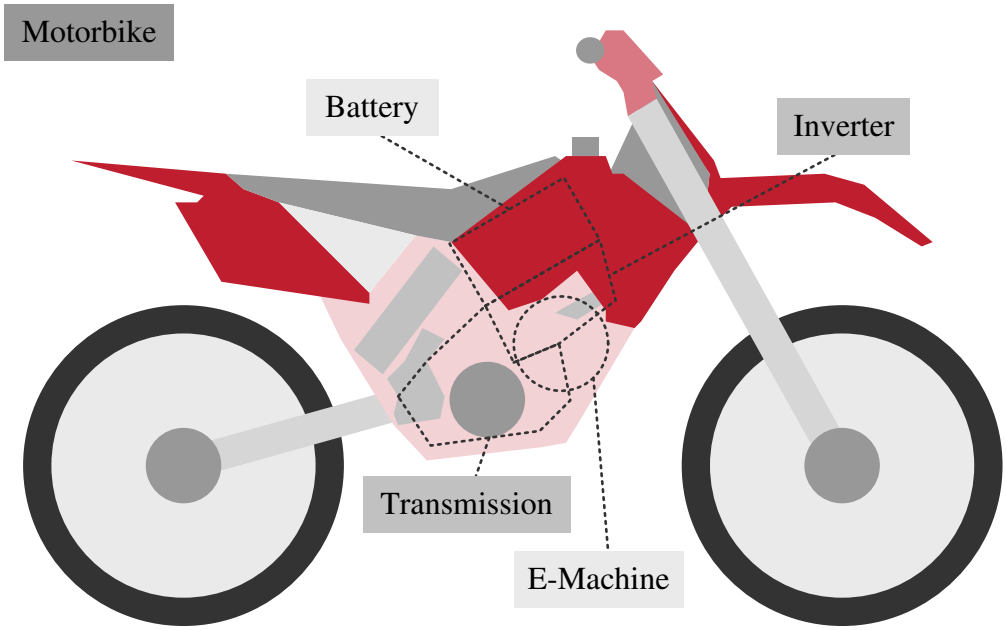

Figure 6.2: Zero emission motorcycle. Adapted from *Zero Emission Motorcycle (ZEMC) – "Freeride-E"* by (cf. Ploeckinger 2013: 1f).

Project Objectives

The main goal of the project is the development of a zero emission, electrical motorcycle in terms of a prototype as a basis for the future development of a motorcycle fit for road application. Furthermore this prototype represents a demonstrator and experiment platform for evaluation of the feasibility of state of the art technologies. In order to allow for a performance comparison with conventional driven motorcycles the electric motorcycle has to have a powerful and intelligent electric drive which supports different driving strategies. For that purpose the development of a compact electric machine, an intelligent control concept as well as the selection of an available and novel technology for the energy storage system including the development of an energy and thermal management relating to the requirements for power and duration (driving range) is necessary. The electric energy storage is one of the important (key) components of an electric driven powertrain concept. Therefore special emphasis is given to the analysis of relevant electric energy storage technologies, the packaging of the energy storage as well as the cooling concept of each powertrain component.

This requires the implementation of a development environment for the electric drive as well as the development of a suspension adapted for the new drive. Since both aspects have strong interdependencies a comprehensive consideration of the powertrain

and entire powertrain system is necessary. The consideration of the entire powertrain system is furthermore a relevant requirement for development of a powerful, efficient and optimized electric drive due to the manifold demands for an electric motorcycle.

At the one hand mass, size and weight of the drive components, especially of the electric energy storage have to be kept as small as possible while at the other hand power and duration have to be enabled. For that purpose the evaluation and selection of appropriate technologies of the different electric drive components is a crucial factor within the project.

An electric motorcycle powerful as a conventional one represents a new product segment which may open new fields of application and new target groups. For positioning in the market the target groups have to be identified, their demands have to be determined and considered in the design concepts. The figure 6.2 represents a motorbike concept which was developed based on the developed components (battery, power units, inverter, electric machine and transmission) by *Austrian Institute of Technology*.

6.3 Distillation System – Project Nr. 3

Feedback Loop Optimization for a Distillation System by applying C-Code Controllers with Dymola

This project is one of the projects that fall into the customer projects. By volume project was not large but was very interesting because it was one of the optimization of the measuring device. The project was created upon our initiative; I was also responsible for maintaining contact with customers. After getting the project I was selected as the project manager.

This project was successfully completes early 2007. The customer was satisfied with the results we gave him after the completion of the project.

Project Objectives

In figure 6.3, the measurement device for determining the distillation properties of petrochemical end products is depicted schematically. It is a measurement device in which different processes of thermodynamics, chemistry, mechanics, electrical measuring and control technology have to be measured and controlled. The mode of operation is based on the vaporization of the used and tested medium, e.g. acetone, which

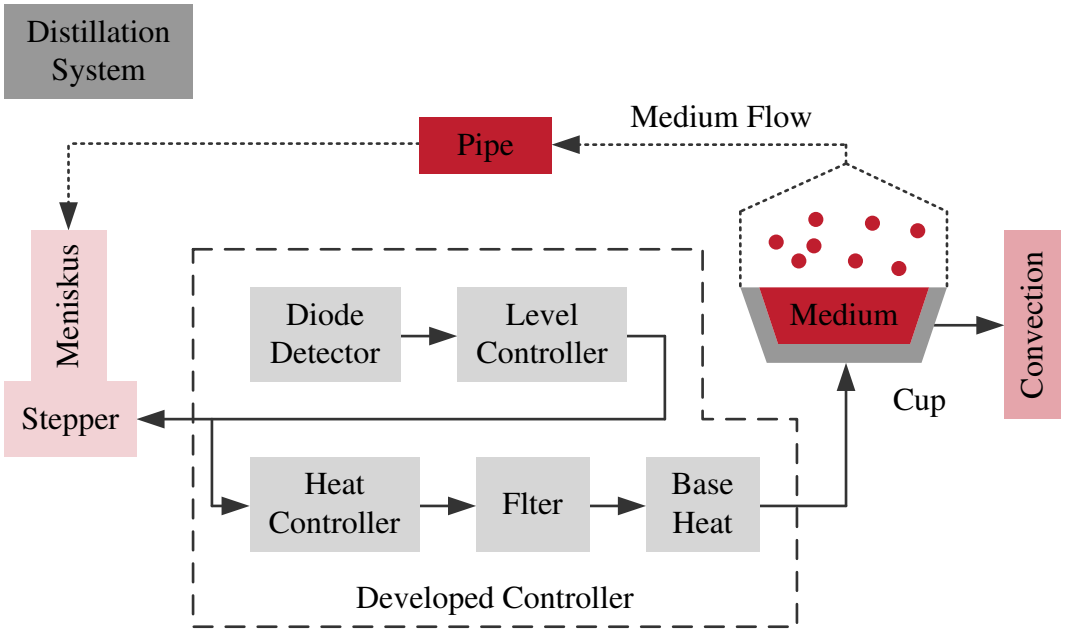

Figure 6.3: Scheme of the measurement device. Adapted from *Feedback Loop Optimization for a Distillation System by applying C-Code Controllers with Dymola"* by (cf. Kapeller & Simic 2009: 1).

condenses in a collecting vessel again.

By this measurement device, the heating energy is controlled by the heat controller and the condense level of the vessel is controlled by a stepper motor, respectively. In case of equilibrium and on condition that all controllers are working in a steady-state operating and functioning point the medium vaporizes and condensates in the vessel by keeping a constant level until all – in case of a pure substance – is exhausted or – in case of a mixture – the next component reaches the inherent evaporating temperature.

The big target and challenge in this process engineering application is to parameterize the medium level control and the heating control. Both of these two controllers (heat and level) are not independent; if the stepper motor controller does not work exactly – e.g.the motor rotates too fast, the level in the vessel sinks too quickly and the operating point becomes unstable. The incapacity inertia of the heat controller leads to an insufficient vaporization of the medium and therefore to an insufficient condensation rate with the consequence that the level decrease cannot be compensated. A flexible, timely and systematic way is to implement and model the entire measurement device using the object-oriented modeling language – in this case *Modelica* simulation language.

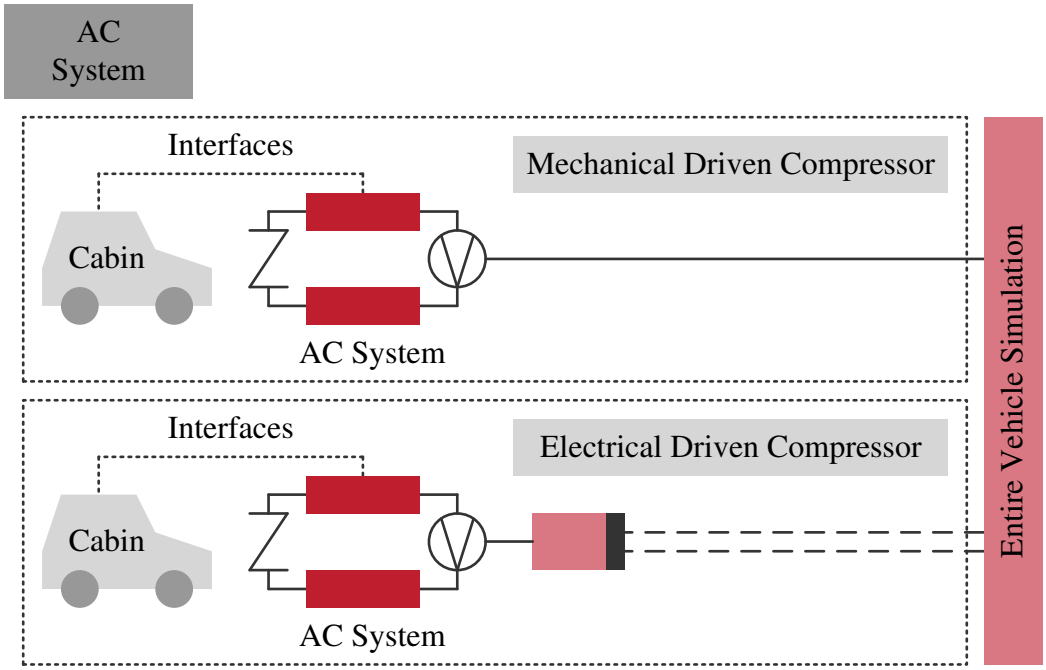

Figure 6.4: Scheme of the measurement device. Adapted from *Investigation of an Electrified Air Conditioning System for an SUV by means of Multi-Phisical Simulation"* by (cf. Gragger et al. 2009: 3).

6.4 Air Conditioning System – Project Nr. 4

Investigation and Design of an Electrified Air Conditioning System for an HEV

This project is one of the projects that fall into the customer projects by our company. By volume project was relative large and very interesting because it was one of the investigation and design of a novel (electrical) air conditioning system. The project was created upon our idea and initiative; I was also responsible for maintaining contact with customers. After getting the project I was selected as technical and organizational project manager.

This project was successfully finished in 2007. The customer was satisfied with the results we gave him after the finishing of the project.

Project Objectives

In this project, more concepts of automotive powertrains are investigated and compared using multi-physical simulation. The main focus of this analysis is the energy consumption improvement duo to the electrification of the air cooling system in a hy-

brid electric vehicle.

At the one hand, an entire vehicle model representing a real vehicle with conventional powertrain (internal combustion engine, clutch, gearbox, manual transmission, differential and driving axles) is investigated and compared with measurement data. At the other hand, this conventional vehicle gets compared with a mild hybrid electric vehicle, where the hybrid electric vehicle consists of a starter-generator, a battery and an inverter. The figure 6.4 represents a schematic diagram of the investigated vehicle concepts, one vehicle example with mechanical driven air conditioning compressor and one vehicle example with electrical driven compressor.

The results of this project shows that fuel economy in a conventional vehicle can be improved by relatively easy extension of the powertrain. The main reason for the efficiency increase is the proper control of the operation points of the air conditioning system and especially of the air conditioning compressor.

6.5 Innovation Transforming in Co-Financed Projects

In this sub-chapter, I want to describe my opinion related to the co-financed Klimamobil project. The innovation flow related to the open innovation model will be depicted and represented. For this explanation, I want to use more keywords as a basis for discussion. These key words are separately represented in investigated open innovation model. However, a schematic illustration of innovation positioning and generation in the open innovation model will be depicted.

In the chapter 3, I describe that the ideas and innovations can still originate from inside the company's research process and projects, but also that some of generated ideas may step out of the company. In this project, the idea to create a zero emission bus is generated together with our project partners.

Klimamobil Example

In the project, expected driving range of bus concept is about 250 kilometer per day. This target cannot sensibly reached by one fix integrated battery system. In order to achieve these objectives, it was necessary to develop a new battery swap system. This new swap system allows charging of one of the batteries while the other one can be driven. This swap technology is an novel solution to a complex automotive problem: positioning of battery in the low floor area; special battery design for this low

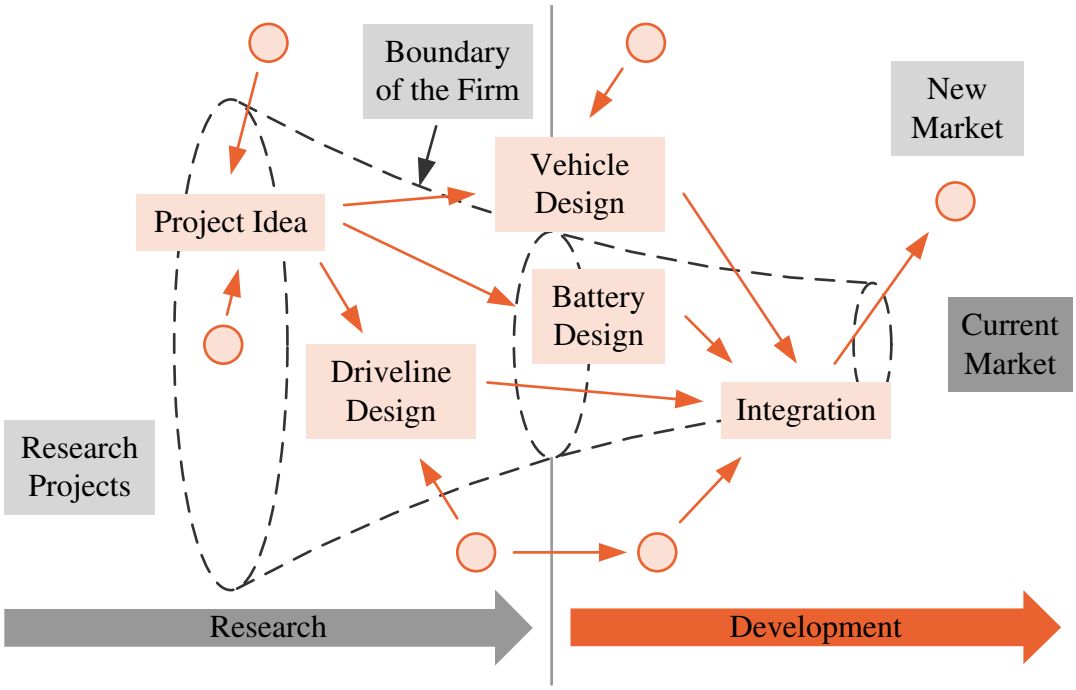

Figure 6.5: Innovation transforming related to the co-financed projects.

floor application; thermal design of battery; innovative cooling system for this new technology; battery connection to the vehicle (plug-in system); and development of a completely battery management system. In developing and realization of this battery system, *AIT* has tapped innovation resources, both internal and external. This innovation, low floor battery system, utilizes a revolutionary design that eliminates traditional using of fix battery systems. The developed battery system is a successfully example how the innovation can be created using internal and external ideas by a project consortium. Described innovation process can be seen as open innovation process and positioned across the boundary of the *AIT*.

The innovation that we generated together with our project partners is a low floor bus with the same driving characteristics as a conventional driven bus. Recognizing the need for improved thermal and energy management to reduce emissions, we developed and realized a fully electrical powertrain. Bus handling and maneuvering characteristics are virtually unchanged in this electric drive contribution. By eliminating a lot of mechanical components and using electrical powertrain for the power assist, electrical powertrain provides a number of innovative benefits; variability in development and design; elimination of mechanical and hydraulically components; reducing repair time and costs; eliminating mechanical clutch system; shifting the revolution of electric engine into areas of higher efficiency; and energy consumption save.

In general, new vehicle concept consists of several technical innovations, which are generated as open innovation in this co-finance project. In figure 6.5, several innovation activities related to this project are represented. It can be seen that all activities are connected and they can be defined as coupled-process activities. Here in this project is clearly that we are talking about open innovation process.

This example – Klimamobil case study – examines how today's companies give birth to innovative products. Used technologies are significant solutions to complex automotive problems in electric drive technology. The developed powertrain can used as a separately module or be integrated in other vehicle platforms. This project won *"Staatspreis Mobilität 2011"* and the developed powertrain can be seen as the benchmark in the electric powertrain automotive segment. In the project, *AIT* essentially improved on a different innovation, which can be declared as open innovation, on the basis of which *AIT* finally won more customer- and co-financed projects.

ZEMC Example

As I describe at the beginning of this chapter, the main goal of this project is development and realization of a zero emission motorbike. *AIT* together with other project partner has increased the basis of core competition in the segment of electric automotive industry. The developed zero emission motorbike, compact electrical motorbike concept, utilizes a revolutionary design that can eliminate traditional (conventional) powertrain system and has generated a new ways how to reach new project partners and how to win new customer and co-financed project.

In this project the development process is similar to the process of the Klimamobil project. Here also, by removing of mechanical powertrain components and using very complex and compact electrical powertrain, new concept allows a number of innovative benefits: zero emission vehicle; powertrain concept with low noise emission (usable in urban areas); optimized driving system; light weight design of powertrain components; safety-battery housing; etc.

The created motorbike concept is significant innovation to a compact automotive solution in urban areas and transportation fields. The motorbike concept can replace more complicated, complex and heavier conventional concept in very efficient electrical concept. Generated innovation of this project is extracted to other projects and will be available on the market in the next years.

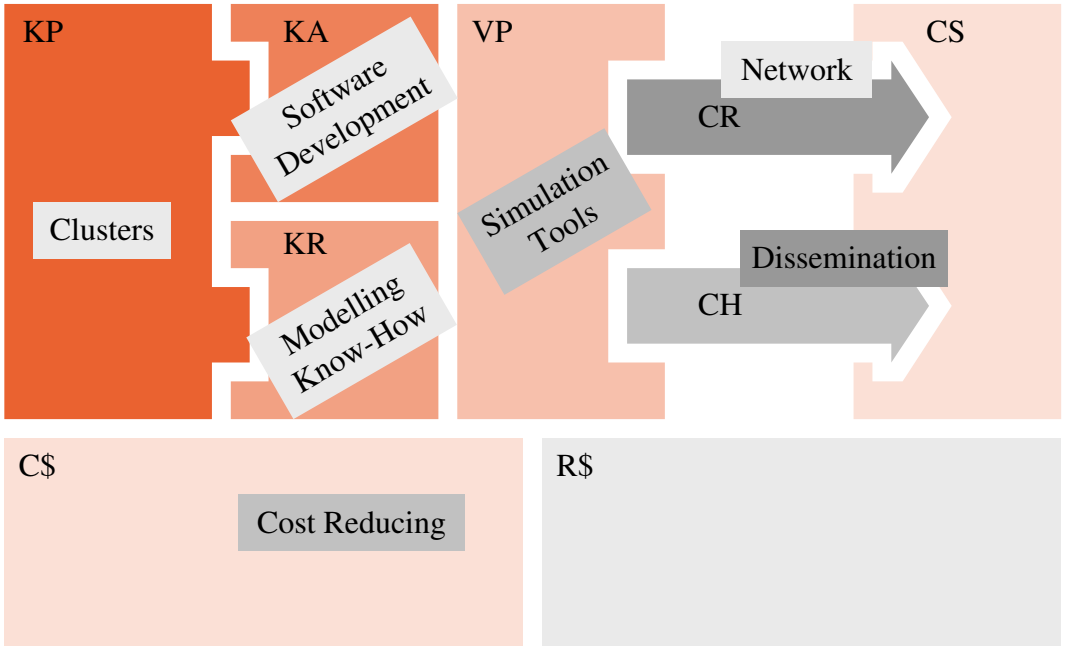

Figure 6.6: Innovation generating related to the customer projects.

6.6 Innovation Generating in Customer Projects

Distillation- and Air Conditioning System Examples

In this sub-chapter, I want to describe my opinion related to two customer projects. At first, I used described projects and conceived the keywords which can be seen in figure 6.6. Here, I want to give you a short explanation of the used keywords:

Simulation tools – represents the bundle of simulation tools and libraries that create value for our customer segments, in this case *BMW Group* and *Grabner Instruments GmbH*. These activities are the reason way the customers turn to our company over another. Successful solving simulation problems are to see as an important *value proposition*: simulation complex automotive applications; co-simulation using different simulation software; development of simulation libraries; entire vehicle and system simulation; simulation of different control algorithm; and results validation based on experimental setups. These activities are in generally innovative, creative, novel and qualitative, and this is the reason way I allocate them to the *value proposition* building block in *open business model*.

Network – The network activities supports to the way our company goes to market, how we really reach our customers and how we interact with them. The activ-

ities can be seen as types and kinds of relationships our company establishes with customers like *BMW Group* and *Grabner Instruments GmbH*. In order to reach new markets and to serve customers our company introduces new distribution channels and communication ways. The main motivation factors of our company related to the driving of the *customer relationships* are project acquisition and customer retention. The network activities are also assisted by our company with different activities related to the some associations where our company generates and transforms new ideas for customer projects. For example, active working in *Modelica Association Group* (https://www.modelica.org/association) allows our company to apply a continuous flow of innovation in customer projects like this.

Dissemination – Dissemination is an obligation in every project but our company normally turns this fact into an opportunity to increase awareness, of both scientific community and general public, about its challenging objectives. Concerning dissemination of project results, our company focuses mainly in publicizing its results among automotive industry, but due to the international dimensions of this sector, we cannot forget the diffusion of project results with an international scope. In order to best suit the dissemination to our company, we publicize our results:

- In the automotive specialized media and main sector congresses and conferences as SAE International, EVS, VPPC, FISITA and international journals.
- Through Green Cars platforms (ERTRAC) and related European Associations (EUCAR, AVERE, CLEPA and EARPA).

Through our dissemination activities *AIT* promotes communication with the general public by means of articles in both regional and national networks whereupon the *Channels* to our customers being strengthen.

Modelling know-how – Every business model must be created based on a correspondingly *Key Resources* block. In this case, simulation modeling of different automotive applications (systems, modules and components) represents the most important resources and know-how of our research group at *AIT*. This know-how is based on strategic, human and intellectual resources and can be seen as core competencies of our company which we used for creating new research ideas and acquiring customer projects.

Software development – As I noted in the theoretical part of the work, the *key activities* can be declared as the most important activities a company has to do to make a successful business model. In our case, this *software development* building block consists of

development and implementation of different software which can be used in different automotive related projects. Of course, these activities of our company include platform development, creation of novel tools and implementation of new simulation and co-simulation methods using different standard and open sources tools. The activities can be only realized based on development activities which connect the entities outside company with internal business process as well as screening novel technologies outside our company.

Clusters – AIT invent and make partnerships for main reason, in other words, *AIT* try to create alliance and clusters to make better their idea generation and transforming together with customers. The association by different clusters allows our company: strategic activities between non-competitors; develop new business model; building strategic customer-buyer relationship etc.

Cost reducing – In general, the costs of our company consist of fixed (e.g. licensing costs) and variable (e.g. testing costs). For reducing costs and acceleration of a contemporary development process, numerical simulation is an important step during concept development in a customer project. The costs can be additionally also reduced using open source tools and development of different simulation libraries based on these open sources, where automatically the internal fixed costs of our company and of our buyer can be reduced.

6.7 Creating Combined Open Innovation

In this study, we can conclude that *open innovation* can be implemented in a combined way. Figure 6.7 represents *open innovation-* and *open business models* including activities which can be used in a combination to create and analyze an innovation process.

This combination of using *open innovation* represents an example how innovation process can be used in both models. Here I want to list some ideas and suggestions which can be parallel considered by creating innovation models related to the co-financed and customer projects.

New thinking about innovation can be created only together with other companies and customers. Cost reduction can be successful realized based on adequate controlling and evaluation of existed *business models*.

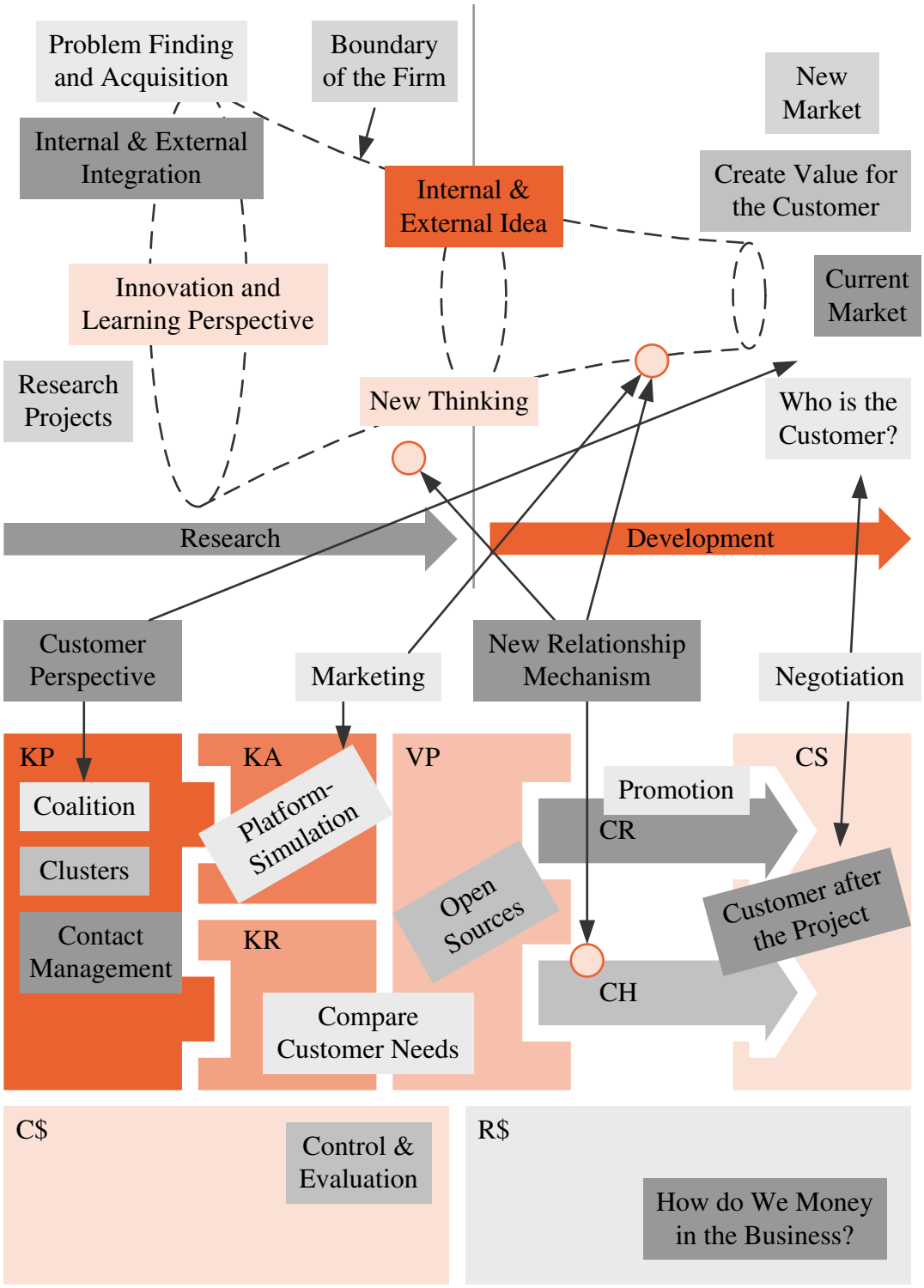

Figure 6.7: Combined *open innovation*.

Right marketing activities will allow better identification of new market related to the o*pen innovation* and using e.g. platform-simulation the *key activities* will be visible by customers related to the *open business model*. Of course, customer interfaces between *value proposition* and market segment (systems, modules and components) can be an

important decision to create a right business model. The new relationship mechanisms have to build a new infrastructure to better identifying of the customer perspective and strategically orientation under consideration of internal business perspective. Through long term partnership and creating value for the customers – reorientation to open sources tools – the *value proposition* can be increase.

Innovation and learning perspective together with customers and project partners based on coalitions and clusters the customer needs can be identified faster and earlier. However, a lot of activities connected to *open innovation-* and *open business models* can be discussed to create benefits of described models, here a some suggestions I want to note: benefits to firm and stakeholders; management model; innovative online support solutions; attention of customers; compare customer needs with the company's value proposition; give the customer possibility to test the value proposition; internal and external idea transforming and generation; promotion of developed tools; internal and external integration; problem finding and acquisition; control and evaluation; network infrastructure operating; network management; contact management; share risks in developing new markets; and differential pricing – service feature dependent – negotiation.

6.8 Summary and Discussion

Table 6.1 shows some activities identified by co-financed and customer projects. The activities are compared based on experience I won during managing of studied projects. Each of used activity was shortly recommended and evaluated based only on my opinion. It can be seen that all of described activities related to the co-financed and customer projects have a similar graduation and that some activities are very similar. This shows that the experience won by one type of the projects can be used for innovation generating and transforming by other types of the projects.

This awareness will allow me to be more concentrated on the innovation process in the future and to use all won aspects by generating new ideas. This mix of different view of innovation processes will also be helpful for me to use *open innovation-* and *open business models* by acquiring all projects in the future. The comparison like represented in the table 6.1 will be start point for creating new ideas and the awareness will flow in both innovation models – *open innovation-* and *open business models*.

Table 6.1: Comparison of innovation generating related to documented projects.

Activities	Co-financed Projects	Customer Projects
Networking	+++ Cluster and comunities	+ Customer specified
Market	+++ Future oriented – research area	+ Development area (engineering)
Implementation level	+++ Entire system investigation and realization	+ Module specificationa and optimization
Perspective	+++ Technology oriented	++ Customer oriented
Needs	+++ Efficient increasing of systems and modules	+++ System optimization and evaluation
Trends	+++ New technology	+++ New vehicle and auxiliary concepts
Innovation process	+++ Combined process	+ Inside-out process
Strategy	+++ Compared to internal strategy	+++ Customer driven strategy
Reverds and motivation	+++ High research oriented motivation	+++ Development oriented motivation
Application	+++ Technological	+++ Practice
Invest in IT training	o For tool development	o Applied know-how
Tool dependency	o Relativ dependent	+++ Used tools by customer
Idea generation	+++ Together with project partners	o Defined by customer
Problem solving	+++ Based on combined process	o Forced by customer

Chapter 7

Conclusions

The case studies have shown the generating and transforming of innovation and innovation flow for the practical research and development. In all analyzed projects (co-financed and customer projects), innovation was used in the successful and similar ways, where generated innovation by co-financed projects is based on open innovation model and transformed innovation by customer projects is based on open business model.

The main global trend (globalization) will present as an important trend in the automotive industry in the following years. This will mean that open innovation will be used around the globe in each automotive industry sector. Therefore, better understanding of innovation processes and implementing of innovation will play the main role in keeping the current market and creating the new innovation processes that can be successful on the future-global market.

However, not only innovation in research and development phase, but also successful open innovation- and open business models will be necessary to win the best project in co-financed and customer sector. This will accelerate the overall innovation process in research and development phase like innovation funding, creating good ideas, transforming ideas to innovation, project acquisition and innovation management during a project.

It can be concluded that the innovation processes of different kind of the projects are also similar and that the processes from open innovation model can be also used for idea generating in customer projects, and that the processes of the open business model can be applied during idea transforming by co-financed projects. Only a combination of both analyzed innovation processes will be a great way of a company or institute for innovation implementing and achievement in the future.

This work stressed more than a few indicators that open innovation driven from more companies, institutions, clusters and coalitions will be a big challenge in the future and that only innovation – created in an open process – will be successful in today's and future business and global market related to the automotive industry.

Bibliography

Allameh, S. & Abbas, S. (2010), The relationship between knowledge management practices and innovation level in organisations: Case study of sub-companies of selected corporations in the city of esfahan, Journal of Business Case Studies, pp. 89–98

Amabile, T. (2006), How to kill creativity, Harvadr Business Review, pp. 18–24

Amidon, D. (1995), Sample definitions of innovation, Entovation International,

Baier, C. (2010), Analysis of open source business model and its cosenquences on the value chain of automotive industry based on continentals autolinq platform, Published diploma thesis, Vienna University of Technology

Bergvall, B., Holst, M. & Stahlbroes, A. (2009), Concept design with a living lab approach, IEEE, pp. 1–10

Berkun, S. (2010), The Myths of Innovation, 1st ed., O'Reilly Media, Sebastopol

Blum, M. (2009), Open innovation - steuerung des inside-out-ansatzes mit fokus auf der venture-spin-off-gruendung, Unpublished diploma thesis, Vienna University of Technology

Brocco, M., Groh, G. & Kern, C. (2010), On the influence of social factors on team recommendations, IEEE, pp. 270–277

Chandrasekaran, D. & Tellis, G. (2008), Global takeoff of new products: Culture, wealth, or vanishing differences?, Marketing Science, No. 0, pp. 1–17

Chesbrough, H. (2003), The era of open innovation, Mit Sloan Management Review, Vol. 44, No. 3, pp. 34–42

Chesbrough, H. (2006a), Open Business Models: How to Thrive in the New Innovation Landscape, 1st ed., Harvard Business School Press, Boston

Chesbrough, H. (2006b), Open Innovation: The New Imperative for Creating and Profiting from Technology, 1st ed., Harvard Business School Press, Boston

Chesbrough, H. (2011), Open Services Innovation: Rethinking Your Business to Grow and Compete in a New Era, 1st ed., Jossey-Bass, San Francisco

Chesbrough, H., Vanhaverbeke, W. & West, J. (2006a), Open innovation: A new paradigm for understanding industrial innovation, Open Innovation: Researching a New Paradigm, pp. 1–27

Chesbrough, H., Vanhaverbeke, W. & West, J. (2006b), Open Innovation: Researching a New Paradigm, 1st ed., Oxford University Press, New York

CSC (2012), What innovation is: How companies develop operating systems for innovation
http://www.innovationtools.com/ - accessed on: February 09, 2012

eBoost (2013), Learn canvas business model
http://www.eboostconsulting.com/ - accessed on: March 06, 2013

Freeman, C. & Soete, L. (1997), The Economics of Industrial Innovation, 3rd ed., Routledge, Oxon

Gassmann, O. & Enkel, E. (2004a), Open innovation forschung, Institut fuer Technologiemanagement Universitaet St. Gallen, St. Gallen, pp. 1–21

Gassmann, O. & Enkel, E. (2004b), Towards a theory of open innovation: Three core process archetypes, R&D Management Conference, Lisabon, pp. 1–18

Gassmann, O. & Enkel, E. (2006), Open innovation: Externe hebeleffekte in der innovation erzielen, Zetschrift Führung + Organisation, No. 3, pp. 132–138

Gassmann, O. & Zeschky, M. (2007), Dem zufall auf die spruenge helfen, Technische Rundschau, Vol. 3, No. 44, pp. 1–2

Ghazawneh, A. (2010), The role of platforms and platform thinking in open innovation networks, IEEE, pp. 1–10

Gorodnichenko, Y., Svejnar, J. & Terrell, K. (2008), Globalization and innovation in emerging markets, IZA, Bonn, No. 3299, pp. 1–43

Gragger, J., Simic, D., Haumer, A. & Pirker, F. (2009), Investigation of an electrified air conditioning system for a suv by means of multi-physical simulation, SAE International, No. 2009-01-1338, pp. 1–7

Harke, S. (2012), Open innovation strategie fuer einen automobilzuliferer
http://www.ipek.hsr.ch/ - accessed on: August 21, 2012

Harvard (2003), Managing Creativity and Innovation: Practical Strategies to Encourage Creativity, 1st ed., Harvard Business School Press, Boston

Hasan, M. & Harris, E. (2009), Entrepreneurship and innovation in e-commerce, Journal af Entrepreneurship and innovation Entrepreneurship and innovation, Vol. 32, pp. 92–97

Heijden, L. (2010), The review of a business model, Published diploma thesis, University of Twente

Hilti (2013), Hilti austria gmbh
http://www.hilti.at - accessed on: February 22, 2013

Hippel, E. (1988), The Sources of Innovation, 1st ed., Oxford University Press, New York

Hippel, E. (2005), Democratizing Innovation, 1st ed., Cambridge, MA: MIT Press, London

Huston, L. & Sakkab, N. (2006), Connect and develop, Harvadr Business Review, pp. 1–9

Kapeller, H. & Simic, D. (2009), Feedback loop optimization for a distillation system by applying c-code controllers with dymola, 7th International Modelica Conference, Vol. 1, pp. 1–6

Kauffman, R. (2004), Cost saving in the supply chain, Business Briefing: Global purchasing and supply chain strategies, pp. 1–4

Kelley, T. (2006), The ten faces of innovation, Rotman Magazine Springer, No. ROT022, pp. 30–33

Kim, J. & Wilemon, D. (2002), Focusing the fuzzy front-end in new product development, R&D Management, Vol. 32, No. 4, pp. 269–279

Klemm, W. (2007), Leadership: Creativity and innovation, AU-24, Concepts of Air Force Leadership, pp. 449–461

Kuhn, T. (1970), The Structure of Scientific Revolutions, Vol. 1, 1st ed., The University of Chicago Press, Chicago

Levitt, T. (2012), Quotes on creativity and innovation
http://www.leadershipnow.com/creativityquotes.html - accessed on: February 02, 2012

Lindegaard, S. (2010), The Open Innovation Revolution: Essentials, Roadblocks, and Leadership Skills, 1st ed., John Wiley & Sons, New Jersey

Lisaboncouncil (2012), Innovation
http://www.lisboncouncil.net/initiatives/innovation.html - accessed on: February 09, 2012

Lu, Y. & He, Y. (2010), Study on the mechanism of open innovation promoting innovative performance, IEEE, Vol. 1, pp. 31–35

Manceau, D., Moatti, V. & Fabbri, J. (2012), Open innovation, what's behind the buzzword?
http://institut-innovation-competitivite.eu/en/publication/open-innovation-whats-behind-buzzword/ - accessed on: December 12, 2012

Mavridis, A., Molinari, F., Vontas, A. & Crehan, P. (2009), A practical model for the study of living labs complex environment, IEEE, pp. 563–567

Mayrhofer, W. (2010), Value creation in private equity, Unpublished diploma thesis, Vienna University of Technology

McGuirk, M. (2007), Customer segmentation and predictive modeling
http://www.steelhouse.com/wp-content/uploads/2011/10/Iknowtion.pdf/ , 2007

Melling, C. T. (1993), Invention, innovation and the spirit of enterprise, IEEE, pp. 119–124

Merrifield, B. (2000), Forces of change affecting high technology industries, National Journal, No. 1, pp. 253–256

Mueller, P. (2010), The role of divestitures as part of an active portfolio management in the strategic planning process considering the implications of an economic downturn, Unpublished diploma thesis, Vienna University of Technology

Mustafa, R. (2010), Relationship between knowledge transfer and business models in the framework of business model explicitness, Unpublished diploma thesis, Vienna University of Technology

Nagji, B. & Tuff, G. (2012), Managing your innovation portfolio
http://www.hbr.org/ - accessed on: December 12, 2012

Oeamtc (2013), Oeamtc
http://www.oeamtc.at - accessed on: February 22, 2013

Osterwalder, A. (2004), The businnes model ontology a proposition in design science approach, Published diploma thesis, Universite de Lausanne

Osterwalder, A. & Pigneur, Y. (2010), Business Model Generation: A Handbook for Visionaries, Game Changes, and Challengers, 1st ed., John Wiley and Sons, New Jersey

Panduwawala, L., Venkatesh, S., Parraguez, P. & Zhang, X. (2009), Connect and develop, p&g's big stake in open innovation, Msc in innovation and technology management, University of Bath

Ploeckinger, H. (2013), Zero emission motorcycle (zemc) - "freeride-e" http://www.bmvit.gv.at/ministerium/staatspreis/mobilitaet2011/nominierte/zemc.html/ - accessed on: February 26, 2013

Popovic, V. (2007), Zivitni ciklus proizvoda i proces uvodjenja inovacija, Published diploma thesis, Panevropski Inivezitet Apeiron

QuickMBA (2012a), Quickmba / entrepreneurship / open innovation http://www.quickmba.com/entre/open-innovation/ - accessed on: February 08, 2012

QuickMBA (2012b), Quickmba / strategy / vertical integration http://www.quickmba.com/strategy/vertical-integration/ - accessed on: February 08, 2012

Sage, L. (2000), Winning the Innovation Race: Lessons from the Automotive Industry's Best Companies, 1st ed., John Wiley & Sons, New Jersey

Sandulli, F. D. & Chesbrough, H. (2009), The two sides of open business models, Social Science Electronic Publishing, Vol. 1, No. 25, pp. 1–25

Schauer, B. (2008), R&d portfolio selection considering risk and project interrelations, Unpublished diploma thesis, Vienna University of Technology

Schlick, T. & Hertel, G. (2011), E-Mobility - a promising field for the future, 1st ed., Roland Berger Strategy Consultants, Vienna

Schonberger, R. & Knod, E. (1994), Operations Management, 1st ed., Irwin, Boston

Serrat, O. (2009), Harnessing creativity and innovation in the workplace, Knowledge Solutions, No. 61,

Shapere, D. (1964), The structure of scientific revolutions, The Philosophical Review, Vol. 73, No. 3, pp. 383–394

Shapiro, S. M. (2002), 24/7 Innovation, 1st ed., R. R. Donnelley & Sons Company, New York

Simic, D., Lacher, H. & Baeuml, T. (2011), Development, design and realization of an electric powertrain for a small range bus, VPPC, Vol. 1, No. PID1939655, pp. 1–6

Song, G., Zhang, N. & Meng, Q. (2010), Innovation 2.0 as a paradigm shift: Comparative analysis of three innovation modes, IEEE, pp. 1–5

Technikjunkie (2013), Der technik blog
http://www.technikjunkie.com - accessed on: February 22, 2013

Vanhaverbeke, W., Cloodt, M. & Vrande, V. (2007), Connecting absorptive capacity and open innovation, Social Science Research Network, pp. 1–22

Viskari, S. (2006), Managing technologies in research organization: Framework for research surplus portfolio
http://www.open-innovation.eu/

Vontas, A. & Protogeros, N. (2009), Evaluating living labs core competences and assets, IEEE, pp. 558–562

Wecht, C. (2010), Management of technology and innovation, Profesional MBA Automotive Industry, TU-Vienna, pp. 1–56

Westergren, U. (2010), Open innovation success or failure – the impact of contextual factors, IEEE, pp. 1–10

Zhang, J. & Zhang, Y. (2009), Research on the process model of open innovation based on enterprise sustainable growth, IEEE, pp. 318–322

Zott, C. & Amit, R. (2009), Designing your future business model: An activity system perspective, IESE Business School, Vol. 1, pp. 1–13

List of Tables

List of Figures