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Rolle und Bedeutung von Open Innovation Strategien in der österreichischen Industrie

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Clemens Felder BSc
Matrikelnummer 1026501

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Clemens Felder	Karl-Heinz Leitner

FAKULTÄT FÜR !NFORMATIK
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Role and Importance of Open Innovation in the Austrian Industry

DIPLOMA THESIS

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in

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Clemens Felder BSc
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Supervisor: Priv.-Doz. Dr. Karl-Heinz Leitner

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Clemens Felder

Karl-Heinz Leitner

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Clemens Felder BSc
Bühel 130, 6863 Egg

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Clemens Felder

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Kurzfassung

Im Forschung- und Entwicklungsprozess verwenden immer mehr Unternehmen offene Innovationsmodelle, da die Geschwindigkeit, in der die Unternehmen neue Produkte und Services entwickeln müssen, stetig zunimmt. Auch der wachsende Wettbewerb, welcher durch die Globalisierung steigt, und die hohen Risiken der Entwicklung von neuen Produkten fördern die neuen Innovationsmodelle. Der erste Teil der vorliegenden Arbeit beschäftigt sich mit dem theoretischen Hintergrund von Open Innovation und dessen Implikationen. Die Grundidee dieses neuen Ansatzes ist, dass Unternehmen versuchen, ihre Innovationskompetenz zu erhöhen, indem sie zusätzlich zu ihren internen Abteilungen auch die Umwelt in den Forschungs- und Entwicklungsprozess von neuen Produkten involvieren. Dies geschieht nicht nur durch Handeln mit externen Partnern, sondern auch durch die Schaffung einer aktiven Kommunikation mit der Wertschöpfungskette, um neues Marktpotential zu erkennen.
In der Literatur existieren einzelne Studien über die Auswirkungen in spezifischen Ländern und über die Verwendung von Open Innovation, aber bislang gibt es keine breite Untersuchung der Perspektiven und Potentiale für Österreich, unter Berücksichtigung der heimischen Unternehmens- und Branchenstruktur. Daher wird im Zuge dieser Arbeit eine empirische Untersuchung durchgeführt, welche die Perspektiven und Potentiale der neuen Innovationsstrategien in Österreich evaluiert. Zum Schluss werden statistisch fundierte und geprüfte Aussagen über die Faktoren und Barrieren der Implementierung und Verwendung der neuen und geöffneten Innovationsstrategien angeführt. Daraus resultierende Erkenntnisse sind an die österreichischen Begebenheiten angepasst und können folglich verwendet werden, um etwaige Rahmenbedingungen für die österreichischen Unternehmen zu verbessern und dadurch die Verwendung von Open Innovation zu verstärken.

Abstract

In the research and development process more and more companies are using open innovation models, due to the continuously increasing speed, in which a company has to release new products or services to survive. Furthermore, the high competition, based on the globalisation, and the high risks of developing a new product are some factors, which are promoting these new innovation models. The first part of this thesis deals with the theoretical background of open innovation and its implications. The basic concept is straightforward - namely companies try to involve the outside world, as well as their own internal departments, in the research and development process of their products. This happens not only just by selling and buying from external partners, but also by establishing an active communication with the value network to find new market potential. Complementing their competences and their knowledge is one of the most important issues.
In the literature there are different studies about the implications and on how open innovation is used in different regions, but hitherto there is no broad investigation of the Austrian industry. Therefore an empirical investigation is conducted, which tries to enlighten the perspectives and potentials of the new innovation models, with consideration of the Austrian company- and sector-structure. In the end, the thesis provides a statistically grounded and proofed explanation about the determinants and barriers in matters of the implementation and usage of new and opened up innovation strategies. Based on those results it is possible to identify possibilities to design a framework for improving and leveraging the usage of open innovation strategies in Austrian companies.

Contents

1 Introduction

The empirically observable trend that companies increasingly co-operate with customers, researchers, suppliers and competitors to develop and implement innovations is in the literature referred to as open innovation (Chesbrough, 2003). The role and importance of open innovation proves a very gainful topic because it is a major and current research field, due to the increasing speed, in which a company has to release new products and services to compete successfully. The high competition based on the globalisation and the high risks of developing a new product are some factors, which increase the innovation pressure. To react to this development the companies tried to improve their processes in the last decades by using different open innovation strategies. The principle idea is that a company tries to involve the outside world - as well as their own internal departments - in the research and development process of their products and services. This happens not only just by buying and selling to them but also by establishing an active communication with different partners to find new market potential. Complementing their competences and their knowledge is one of the most important issues, on the one hand by using different external information sources, and on the other hand, to commercialise as many ideas and technologies as possible, that are developed in the scope of the R&D activities. Companies can and should use both, external and internal ideas and paths to the market, when enterprises look to discover and realise any innovative opportunities. Further, the open innovation paradigm assumes that internal ideas may also be taken to markets through external channels, outside the current businesses of the enterprise, to generate value (Rahman and Ramos, 2013). This form of collaboration, however, is not straightforward, because first the companies have to establish some processes to codify their knowledge. Otherwise, it would not be possible to interchange it; they also have to adopt a culture which supports the inside-out and outside-in knowledge transfer.

1.1 Problem Statement

There are different studies about the implications and on how open innovation is used in different countries, but none of them consider the Austrian industry (García-Manjón and Romero-Merino, 2012; Laursen and Salter, 2006; Rahman and Ramos, 2013; van der Meer, 2007; van de Vrande et al., 2009). Those surveys have shown that the global economy is in a shift form industrial product-centered to innovation- and service-centered. The traditional approach is to develop and invest in internal R&D to have new ideas that can be exploited on the market. These improved products are leveraging the companies' success; they are able to gain more profit as their competitors, with the help of intellectual properties that prevent other firms from exploiting it. Those profits can then be reinvested in the closed R&D to push it additionally forward to new products or technologies. Open

innovation eroded the closed system in a way that other partners are involved in the R&D process as well. Such partnerships support the knowledge aggregation because each actor in such a network is able to utilise both, internal and external ideas by applying internal, as well as external, paths to the market. This means that companies with an open approach are able to gain more profit by exploiting their internal ideas through channels, which don't necessarily have to be in their current business approach. The literature has recognised in more detail, that strategies which are focused on the market are more likely to establish process innovations, whereby partnering strategies have product innovations in similar extends. On the other hand joint ventures alliances, hence, more formalised open innovation approaches, have a positive relation with the generation of filled patents (Santamaria et al., 2010). Now the posed question is, if it is possible to see this transition in Austria as well. If it can be observed, there are several additional interesting questions, like why are Austrian companies doing this transformation to using open innovation and which problems are they facing? One of the most interesting issues is the question, if the open innovation approach has any positive and significant impact on the performance of the companies or if this impact could be amplified by the adaption of any environmental conditions.

1.2 Method

Through an online-survey among Austrian industrial companies the research questions are addressed in an empirical way. The survey is developed based on the findings of recent studies. The major motives, obstacles, open innovations approaches, respectively methods, and new innovation models are identified in the literature analysis and considered in the development of the survey. Afterwards, with the help of statistical methods, the outcome of the survey is evaluated and the determinants and barriers for the use of open innovation is identified. Therefore, it is possible to deliver empirical evidence about the role and importance of open innovation in the Austrian industry.

1.3 Research Questions

To address the previously mentioned goal of this paper, we have to define the overall research questions. Those are considering the most important aspects and have different angles, which are reflected in the following statements:

- To what extent are new open innovation models and -strategies already used by Austrian industrial companies?
- What are the main motives and expectations of the companies in the usage of opening up their innovation strategies?
- What are the barriers of which the Austrian industrial companies are suffering from by introducing new open innovation strategies?

- Are there structural differences (e.g. firm size, industry) in relation to the use of new open innovation strategies?

With those specified research questions, which were not considered in any other publication in such an in-depth manner in Austria, it is possible to get detailed insights into the state of the art of open innovation in Austria.
In addition to those specific research questions several hypotheses are formed, which are based on the findings of the literature research. At the end of this paper, the validity of those hypothesis are tested with statistical analyses.

1.4 Structure

An important part is to get familiar with the differences of closed and opened up innovation processes. Therefore, in chapter 2, a brief introduction of the roots of innovation and innovation in the broader sense is given, as well as a short discussion of the closed innovation approach. The theoretical introduction starts with Schumpeter, who has first defined innovation and the different kinds that can occur. Differences between invention, innovation and imitation are given, which lead to the discussion of different traditional innovation strategies. Afterwards, the transition from the closed to the open innovation approach is reflected. The three core concepts of open innovation and also some recent empirical investigations are introduced. New open innovation strategies, which are researched in the literature and also adopted in the industry, are discussed; some examples are user innovation, crowdsourcing and virtual product development in the context of advances manufacturing technologies.

Afterwards, in chapter 3, the methodological approach and the hypotheses are described in details. As part of the empirical study the survey is conducted as a standardised questionnaire and designed to address the hypotheses, which are derived from the research questions. In this chapter the characteristics of the sample are examined and described as well. Furthermore, these characteristics are compared with the real distinguishing features to obtain if it is a representative sample or not. Additionally, an overview of the used and derived variables for the empirical assessment is given. The participants are scrutinised and grouped based on different characteristics, like number of employees, age of the company and industry. In the next part descriptive analyses of the questions are given before the previously defined hypotheses are evaluated with the help of statistical methods that are applied to answer the hypotheses in chapter 4.

The conclusion of the paper, in chapter 5, provides a summary and reflection of the key findings, as well as the indication of future research possibilities.

2 Literature Review and Hypotheses

2.1 Definition of Innovation

Innovation was first defined and discussed by Josef Alois Schumpeter in 1911, who called it a „new combination“. According to him, the economical development is characterised by a permanent disturbance of the equilibrium state. During this time, the mainstream research was about the equilibrium state and how this condition can be achieved. The disturbance can be caused either by a technological change or by a new organisational form of production. The technological change is triggered by the manufacturers, as well as the innovations. The innovation process can be called a „creative destruction“, because it creates new industries or even supplants existing markets. This process can be characterised by sudden and abrupt occurrences of innovations and, therefore, is very hard to formalise. If a corporation implements an innovation, it is able to generate a monopoly; this means it will make huge profits. The competitors or other persons will spot this over average profit, hence, more and more will follow. So the competition gets stronger and most of the profit has to be used to compete. If someone wants to survive they have to develop and implement new innovations. Schumpeter distinguished between five different kinds of „new combinations“ (Schumpeter, 1911).

1. The manufacturing of a new product or a new level of the product quality which the customers did not know yet.
2. The introduction of a new method of production which does not necessarily have to be an invention. It also could be the treatment of a commodity in a commercially manner.
3. The developing of a new market which was not applied with the particular industry, regardless of whether this market already previously existed or not.
4. The exploitation of a new source of raw materials or half-manufactured goods - again regardless of whether this market already previously existed or not.
5. The implementation of a reorganisation, like the abolition of a monopoly position.

This classification based on the innovation type is not the only one - others, which leave out some of the aforementioned types or add new ones, are discussed as well. One of those additional innovation types is the management innovation that improves the leadership of a company. An other important type is the social innovation, a kind of innovation that often occurs with other innovation types, for example with product or process innovations because such an innovation provides a sustainable benefit for their target group. Such a sustainable advancement can be of an advantage for the employees of an organisation or

even the whole society. Another aspect of social innovations is the advancement of the structural- and process organisation of a company, which provides more value for the employees (Murray et al., 2010; Stummer et al., 2010).

For further specification of the term innovation it is possible to analyse the following four distinct dimensions (Hauschildt and Salomo, 2011):

- *Content*: what is new and in which extent does the innovation influences the market? Innovations are often a combination of technical, organisational, business related and social changes.

- *Subjective*: for whom is the innovation new? This dimension is concerned with the interest and acceptance of the customers. Different levels of novelty are known: (1) a world first is a product, service, technology or problem solution that was not used or know hitherto, (2) a new for the market is an innovation that is already used in other markets or sectors and is now applied to a new customer group in a new market, (3) new for the company means that a known innovation or solution is also applied within the company, hence, it is already used in other organisations.

- *Normative*: is this new combination for the firm a success and is it accepted on the market as well as by the participants? A new product or solution has to consider the needs of many stakeholders, whereby, some of those desires are opposed, thus the innovation has to find a trade-off.

- *Process-related*: where does the innovations stars and where does it end? The innovations process starts with an idea or concept until it is successfully introduced to the market. The diffusion aspect is not related to this dimension because otherwise a distinction between innovation- and routine process is not possible.

However, Schumpeter considered the research and development departments of large and influential companies as a source of innovations because due to their influence they are able to rationalise their innovation process. Thus they are able to develop their innovations in an experienced way. In such a traditional approach the internal R&D department develops ideas and they are not crossing the firm's boundaries, therefore, it is called *closed innovation* Due to that the newly developed potentials are modified internally until they can be presented on the market. In such an approach the economical result is only influenced at the end of the innovation process, namely at the market introduction, so until it generates a valuable outcome a long lasting development process is necessary. This method is based on a linear model, which does not have any interfaces and consequently not a lot of communication between different phases. Hence, a weak idea with a huge market potential could be eliminated due to the lack of communication between the idea- and market phase. Therefore it is obvious that an idea - also called invention - is not an innovation, but of course it can be easily used to fill a patent. Schumpeter said once:

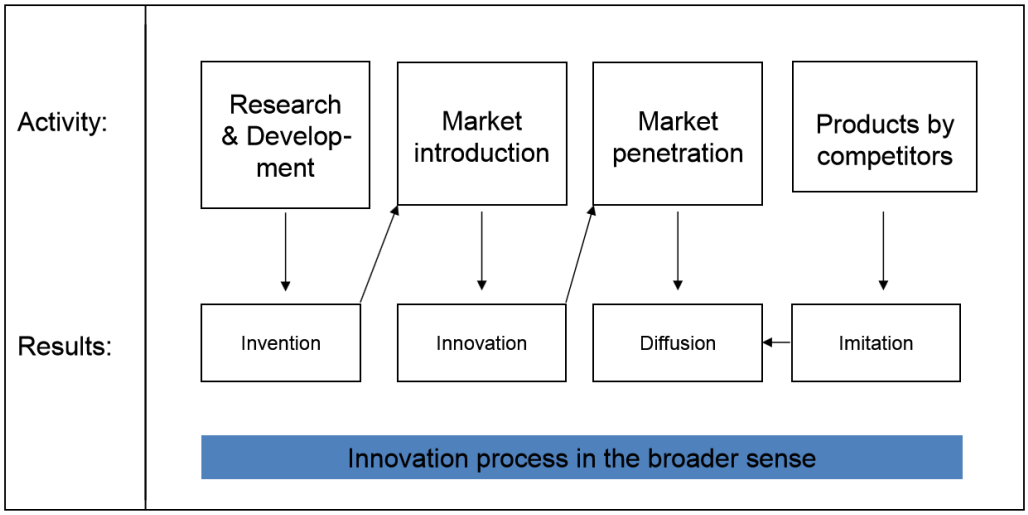
> „Innovation is the process of finding economic applications for inventions.“ (Schumpeter, 1911)

That means that we have to distinguish between invention and innovation, because not just any invention is an innovation, as long as there is no successful economic utilisation. It can also be a new recombination of some existing products or half-/raw materials. An invention could be, as already mentioned, an idea, prototype or concept. Ideas can have different backgrounds; first they can be of an imitative nature. In this case market data already exist and the acceptance of the product is known, but it is a highly competitive market. Second, something already known could be improved - this is called incremental advancement. It adapts or extends existing products or services. The most risky procedure, but also the one with the most potential, is the innovative approach - sometimes also called radical innovation - where the company generates something valuable, which the customer was not able to imagine, so they can have a huge growth potential and a chance to make higher profits. Summarised we could recapitulate, that radical innovations are based on fundamental technological changes, whereby incremental innovations are established through existing competences of the firm. Hence, they lead to a stepwise improvements of existing products (Inauen and Schenker-Wicki, 2012).

Figure 2.1 illustrates how the different concepts of invention, innovation and imitation fit together. The Research and Development (R&D) activities generate the invention. A new product or service is transformed by the marketing to an innovation, by considering market relevant topics. The next step is to increase the market share with specific market penetration strategies, which will often lead to a diffusion of the product strategy. Hence, the product is adapted to a lot of different market segments and, therefore, there will be few slightly different products. If those products are requested by many customers, it does not take long until there are some competitors on the market, which provide an imitation of the product.

There are different opportunities to create innovations either as an entrepreneur or as an existing firm. Both approaches have some advantages and disadvantages. The entrepreneurs approach is more flexible and an ad hoc innovation process is possible, whereby in an existing firm, the R&D department somehow mechanises the innovation process. This paper focuses on the business aspects and not on start-ups. In the literature are different innovation models known to address the objective of a more mechanised innovation process; the most important of those are described in the next section.

Figure 2.1: Invention, Innovation and Imitation



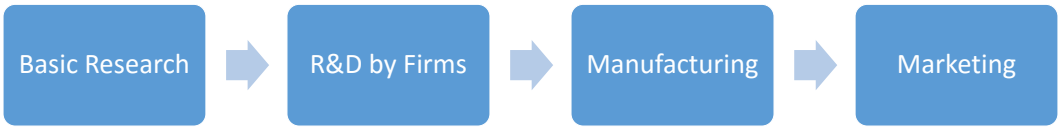
Source: Brockhoff (1997)

2.2 Innovation Process

Innovation is leveraged by the creation of knowledge, usage of existing knowledge and the combination of those knowledge pools to generate a new solution. Thus, an innovation is not a result, but it is a processes that enables the company to solve a problem in the product development by uniting different perspectives, activities and capabilities of a firm. To address various external influences and changes several innovation models are developed, which also have different strategic focuses. In the fifth generation of innovation processes by Rothwell he derived five innovation process generations of an historical overview of the industrial innovation management. Whereby those generations can be interwoven or even several generations can be used at the same time in an enterprise. Each generation is more complex and integrated than the previous and they are developed to react to external changes and to annihilate drawbacks of the earlier generation.

The first generation is the so-called *technology push* model, which depends on the foundations of scientific work and applied research. This innovation model is a linear structure that starts with a new technological progress which is then transformed by engineering-, manufacturing- and marketing activities to a final product that is sold (see Figure 2.2). Therefore, the name can be derived because the new product is based on a new technology that is pushed through the different steps until a final product reaches the market. Due to the fact that the new product relies on a new technology this model fosters the firm's ability to develop radical innovations, but there is no consideration of the market nor are any feedback mechanisms given.

Figure 2.2: First Generation - Technology Push



Source: illustration created by the author based on Rothwell (1994)

The second generation of innovation models is the *market pull*. Again, this model is a linear process, whereby the origin of a new product is on the demand side. Hence, the demand of the customers is picked up by the company and afterwards turned into an invention. This leads to a reaction of the R&D to the needs of the market participants. After the invention passed through the development and manufacturing steps it is sold to the customers (compare Figure 2.3). The market pull model is leveraging the firm's ability to develop incremental innovations because the average customer does not have big visions, but they can easily recognise how to expunge drawbacks or how to improve it, so that it better fits to their needs. In the course of that a shorter time to market is important, because everyone is able to interpret the needs of the market and to develop a suited product that satisfies those needs.

Figure 2.3: Second Generation - Market Pull

Source: illustration created by the author based on Rothwell (1994)

The third generation eliminates several shortcomings of the predecessors by combining the technology push and the market demand in one model, with additionally interaction and feedback loops. Thus, a firm that applies that model is able to perceive new developments in science and technology as well as the needs of the market. In the development process there are always interactions between the multiple internal functions. All those characteristics of the third generation can be found in the *Stage-Gate* model of Cooper (1990). In this model the process is split into concrete steps called stages. Normally each stage is assigned to one group or department of the company. The different stages are separated with gates, because before the next stage is triggered, the current state is assessed in the gate. Hence, it is necessary that certain information and results, that can be created by the internal team, external sources or experts, are available. Each phase should be cross-functional and not limited to one department, meaning the team should consists of members from different divisions. The team generates information that is the result of the current stage and has to meet certain mile stones and routine checks, so the

gate enables the company to ensure quality measurements in the development process and additionally provides a sophisticated control mechanism. This control mechanism allows to assess the current state with predefined criteria to decide either stop or go for the next stage or in case of shortcomings of the project redoes the current stage for revision. Such an early assessment and decision step at each gate enables the firms to identify and eliminate potential problems or failures in an early stage (Cooper, 1990).

The fourth generation tries to address the time problem, due to the fact that the other models are very slow and it took a lot of time from the first idea to the final product. In the previous generation cross functional integration within the firm was introduced, which enables the company to reduce the time by introducing parallel and more integrated development processes and products. If possible relevant functional overlaps between the activities and the departments are used. This is the first model that considers external partners in the innovation process, namely alliances, supplier-, universities linkages and lead customers.

The fifth generation models are considering innovations as a distributed networking process composed of system integration and networking models. Such a distributed networking process is supported by the information and communication technology that provides an efficient and cheap communication between the participants of alliances in terms of suppliers, partners and universities. Also the business processes can be automated, which enables a more flexible and faster development speed. By following the framework of Rothwell researchers have recently identified a new generation of innovation models, that are extending the fifth generation of network models. It is called open innovation, which is extending the internal perspective of the innovation process with external ideas and also additionally external paths to the market (Kotsemir and Meissner, 2013; Nobelius, 2004). We are going to have a closer look on this paradigm in Chapter 2.4. Beside the different innovation models, that the companies can apply, they can also vary their innovation strategy. In terms of this they are able to use different approaches to react or even to actively act on new demands and new products.

2.3 Innovation Strategies

According to James M. Utterback, who introduced the dominant design concept, there are different innovation strategies, which can be performed by a company (Utterback, 1994):

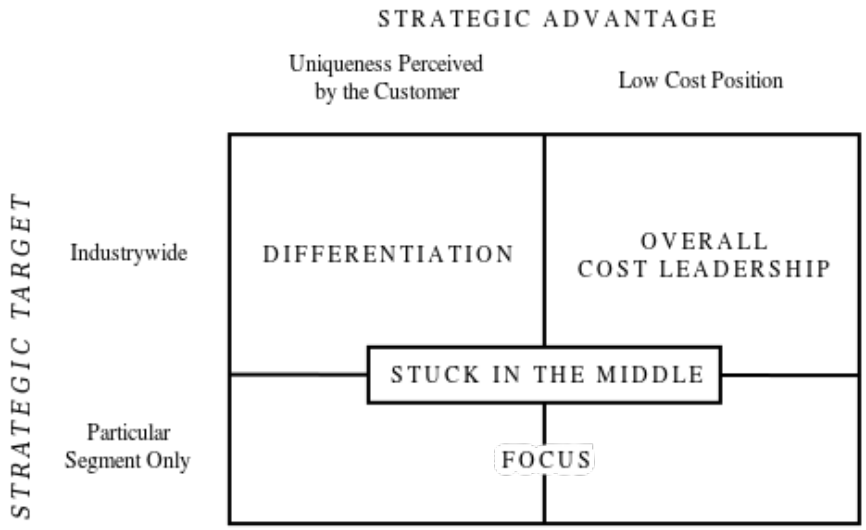
- *Invention leader:* This strategy is R&D intensive and often carried out by small companies with restricted access to capital and little know-how in business development and marketing.

- *Innovation leader:* Brings the invention to the market by considering both, technological and market requirements. A dominant product design establishes.

- *Early follower:* Scans the industry and implements recently introduced products and technologies once a dominant design is reached. Differentiation from competitors by superior marketing - differentiation strategy - or lower costs due to economies of scale and saved R&D expenditures (cost leadership) need to be accomplished in this strategy.
- *Late follower:* A firm using this strategy has capabilities in cheap production of standardised products and enters the mature market with cost leadership strategies.

Michael E. Porter introduced the generic strategies matrix, a concept which illustrates how firms can gain a competitive advantage. It is possible to use three different approaches, but each business should focus on one strategy, because otherwise they would waste important resources. The firm can target either cost leadership, differentiation or niche focus. The dimension of the strategic target can be split up into industry wide or segment only. Furthermore, the strategic advantage, where it is possible to distinguish between being perceived by the customer as unique or as a low cost provider, needs to be considered.

Figure 2.4: Porter's Generic Strategies



Source: Porter (1980)

2.4 The Open Innovation Paradigm

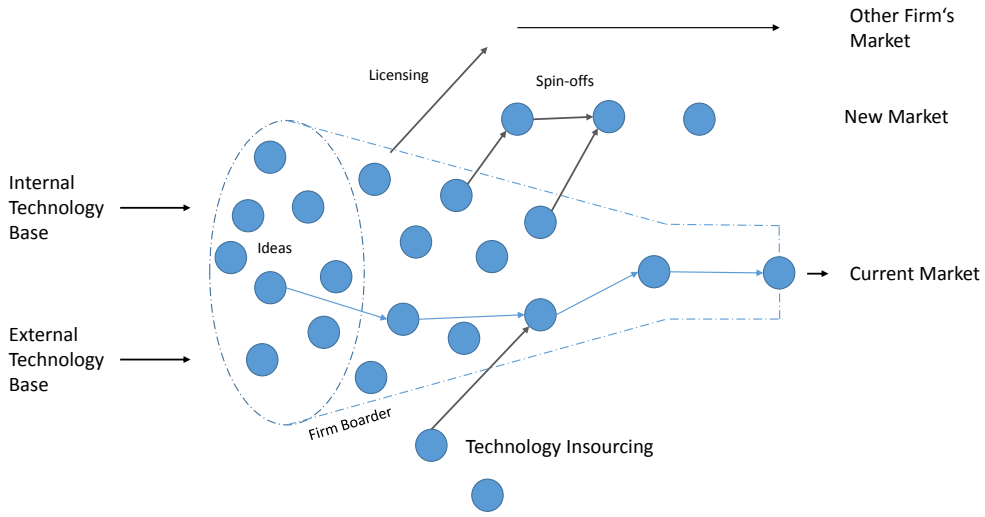
The last chapter showed that it is not easy to be innovative, because it is not possible to entirely mechanise or formalise this process. To be sustainable successfully it is necessary to be innovative. Therefore, most companies have an own R&D department, which is responsible for various innovations, like product, style, manufacturing and design. With new products the company has an advantage over the competitors, hence, they provide the basis for an opportunity to increase the profit by employing a cost-efficient method. This is a long lasting and expensive task. So the companies try to do the R&D in-house and to leak as little as possible of the crucial information to others. The internal R&D is no longer the invaluable strategic asset, because nowadays the companies are not able to control the whole innovation process, due to the fact, that the society has changed and that the knowledge-worker's mobility has increased. Also new financial structures, like venture capital, suppress this paradigm more and more. In addition to these developments the enterprises are facing other obstacles, like the decreasing product lifetime cycle. This means the speed, in which a company has to release new products/services to survive, is increasing continuously, so the innovation cycles are getting shorter and shorter. Since the financial crisis the companies show a propensity to save money; this also results in a decrease of research and development budgets. The high competition based on the globalisation and the high risks of developing a new product are some factors, which increase the innovation pressure. To react to this development the companies tried to improve their processes in the last decades by using a new emerging approach, which was first proposed by Henry Chesbrough in 2003, the *open innovation* paradigm. This approach tries to break up the boarders of the management task of the innovation processes. It is equal with the opening of the company and the combination of internally and externally developed technologies to create business value. Companies commercialise both external and internal ideas/technologies and use both external and internal resources. The open innovation process can be triggered from different points. This can be done from internal or external sources and new technologies can enter the process at each step. There are various additional ways, beside the traditional sale channels, to go to the market, such as out-licensing or a spin-off venture (Fredberg et al., 2008). There are many ways of practicing open innovation, out of which Oliver Gassmann and Ellen Enkel suggest some examples (Gassmann and Enkel, 2006):

- customer and supplier integration,
- listening posts as innovation clusters,
- applying innovation across industries,
- buying intellectual properties,
- investing in global knowledge creations.

Open innovation focuses on the transformation of the solid boundaries of the company to a more permeable border, which enables innovations and knowledge to move more

easily between the internal R&D process and the external environment. The main focus of this exchange process is the activity to search for new ideas, which have a commercial potential (Fredberg et al., 2008). Gassmann and Enkel identified three core processes of the open innovation approach; those processes are listed, and in detail explained, subsequently (Gassmann and Enkel, 2006). In the middle of Figure 2.5 the firm itself, with its different possibilities to exploit the ideas, is shown. The Outside-In process enriches internal knowledge of the firm with external knowledge from customers, suppliers or partners. This means the company uses external ideas to leveraging their success. It also includes the transfer of technologies from other firms and universities into the company, whereby the Inside-Out process is directed to the environment. It is used to commercialise internal ideas faster than it would have been possible in an internal way. This can be done with licensing or by triggering a spin-off. The coupled process is the process of the integration and the externalisation of knowledge to develop shared alliances, joint ventures and innovation networks. All these concepts only have a positive outcome, if there is balance between giving and receiving.

Figure 2.5: Schema Open Innovation



Source: illustration created by the author based on Chesbrough (2003)

2.4.1 Inside-Out Process

The different approaches of out-bounded processes can be summarised as the efficient usage of the internal knowledge, which can be achieved by loosening the firm boarders, so that ideas can spread out of the company. A firm generates a broad spectrum of ideas, not all of which fit the company. In the traditional way those ideas would disappear in the bottom drawer, but with open innovation there are various possibilities to handle these ideas. In this case invention and innovation do not necessarily have to take place where they are exploited and transformed into new products. The outcome possibilities of an Inside-Out Process are (Chesbrough and Brunswicker, 2013):

- *Corporate ventures:* an established and large business participates as a financial partner to a small and pioneering company, in order to obtain access to innovation and to invest in strategic options for the future. This is a financial and as well a strategic partnership.

- *Joint ventures:* joint ventures are established by two or more partners and are legally separated from the founding partners. They are only involved with their capital and they only have a shared financial risk.

- *Intellectual Property out-licensing:* in the out-licensing scenario the company tries to turn an IP, which is less critical to their business, into cash, to recoup investments in its creation.

- *Participating in standardisation:* if you participate by the development of a standard you are able to influence it in a way, that it is good for your product. This means it could be possible that your product turns into a standard. This encourages economies of scale and also differs your product form those of your competitors.

2.4.2 Outside-In Process

Knowledge and ideas are generated on the outside of the company and can then be fetched into the company with the integration of external knowledge and idea sources, like customers and suppliers, as well as specialised external technology providers. The main task of the inbounded process is the utilisation of externally acquired knowledge. As in the Inside-Out Process, the place where the knowledge is generated does not have to be the same as where it is applied. A major obstacle is the not-invented-here syndrome. This means, that the people within the firm do not like ideas, which are not originated inside the firm. To overcome this problem the culture of the company has to be adapted, which sounds easy, but is not. As we can read in various literature, there is even an own research field about this topic: Change Management[1]. Some tools to realise an inbounded approach are listed below (Chesbrough and Brunswicker, 2013):

[1] For further informations on this field of expertise Thomas Lauer's *Change Management: Grundlagen und Erfolgsfaktoren* proves as a good source.

- *Contracted R&D services:* the R&D task is sourced out to an external organisation, which the company has to pay, like in every other out-sourcing contract. This partnership or collaborative way is normally based on a long-term partnership and it is possible to gain specialist expertise from the partner.
- *Supplier innovation award:* For the most companies partnerships with the suppliers have an outstanding significance. With such an award the suppliers have an incentive to continue to occupy a prominent position in the competition with innovations.
- *IP in-licensing:* can be used to reduce R&D spendings, through the buy-in of existing intellectual properties or licenses from third parties. They can even save time because it is not necessary to re-invent something - sometimes referred to as engineering a workaround.
- *Customer & consumer co-creation*: is a collaboration between the company and its consumers, which creates a value by combining and renewing each other's resources and capabilities to create value through new forms of interaction, service and learning mechanisms. It differs from the traditional passive consumer market of the past. The value arises out of the personalised and unique experience for the customer.

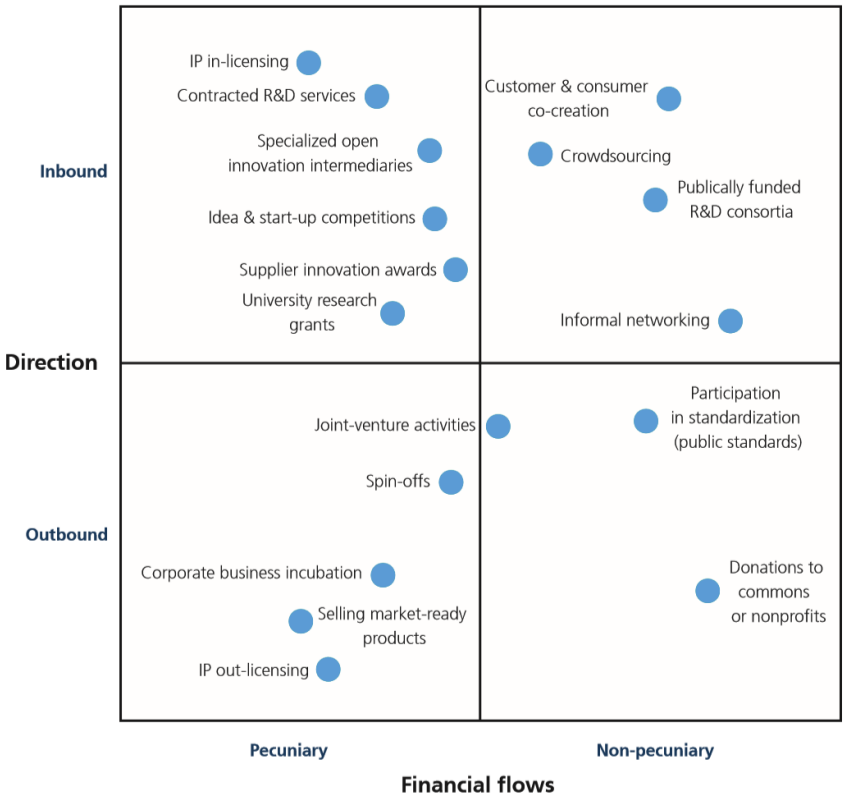
2.4.3 Coupled Process

The Coupled Process, as the notation already suggests, couples the Inside-Out and the Outside-In approach. Most of the companies, which combine those, are targeting to develop a standard or to settle a dominant design for their products. In the Coupled Process the companies are trying to expand their revenue through multiplier effects and also to extend the product with other valuable technologies from others. An important factor for a successful attempt is the right balance of giving and taking. Crucial prerequisites for a collaborative innovation processes are on the one hand, that the company can absorb external knowledge and integrate it into their own knowledge and technology base and on the other hand, that they can externalise their own knowledge, so that their partners can exploit it and benefit from it. The success depends on whether the company finds the right partner and and how they are able to deal with knowledge - can they externalise the knowledge as well as are they able to internalise the external knowledge? Through the Coupled Process a company is able to get access to competences and/or knowledge, which is necessary to gain a competitive advantage in the desired business. As a consequence the success is based on the ability of the company to manage the networks with external partners in all phases along the whole innovation process (Chesbrough and Brunswicker, 2013).

Based on the previously discussed different modes of open innovation, that are dependent on how the knowledge is flowing Chesbrough and Brunswicker (2013) have derived a classification of open innovation. Additionally to the either outside directed or inside directed knowledge they are also considering if these knowledge flows are pecuniary or

non-pecuniary. As the name already suggests, if it is a non-pecuniary financial flow then there is no direct financial reward. If such a financial flow is directed from the outside of the firm towards the inside the company is able to use the freely available ideas. This can be realised for example by crowdsourcing, customer co-creation or informal networking. On the other hand also the firm is able to reveal their ideas for free in public standards or by donations to commons. However, for the pecuniary flows in both directions many methods are known, for more details compare Figure 2.6.

Figure 2.6: Classification of Modes of Open Innovation



Source: Chesbrough and Brunswicker (2013)

An other way to classify open innovation especially for the software industry was proposed by West and Gallagher (2006), whereby the classification is based on the relationship of the R&D contributors. Those four generic open innovation strategies are (West and Gallagher, 2006):

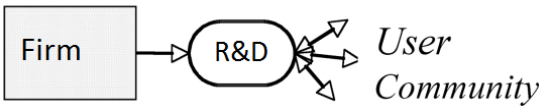
- *Polled R&D*: The shared R&D approach is used to utilize the common benefit of all involved parties, in terms that the contributors are providing their intellectual properties and the partners are able to facilitate them in their related products. Such pooled R&D partnerships are often used to realise synergy effects.

Figure 2.7: Pooled R&D Concept

Source: West and Gallagher (2006)

- *Spinouts*: This method enables the company to exploit existing knowledge or intellectual property which is not creating value and not strategically needed. Compared to abandonment or spin-offs the company is able to further generate value of it by placing it on the outside of the firms, but still promoting and supplying it with company's internal resources and commitment. Therefore, such a spinout can foster the demand for other products that the company is selling, hence, this approach is best suited for technologies with limited value, for example for technologies that are becoming to be a commodity.

Figure 2.8: Spinout Concept



Source: West and Gallagher (2006)

- *Selling complements*: Complements can leverage the demand of a product or service, whereby a complement is not limited to other products. It can also be a service for the buyer or an activity within the own value chain. In other terms a product can be an intellectual property that is given away for free. The company is generating revenue by providing additional services, for example consulting and helping to establish that technology.

- *Donated complements*: This approach is similar to the one mentioned above, but the companies are providing a core product that easily can be extended with complements. Those complements are not provided by the firm itself, but they are created for example by an innovation community to add additional value to the core product.

After the awareness of the different classifications of open innovation methods, in the next section, some selected new innovation models are discussed in detail. In the explanation advantages, disadvantages and hints are given on how the best benefit can be achieved.

2.5 Specific Forms of Open Innovation

The open innovation approaches - Outside-In and Inside-Out - can be achieved through several approaches. Therefore, the focus of this section is to discuss some of those techniques, which are researched in the literature, as well as such which are adopted in the industry. A broad range of open innovation approaches are known and already excerpted in the literature, hence, this paper focuses one some selected forms of open innovation. Those selected approaches are very interesting for the Austrian companies in the near future because in Austria are a lot of companies that are focused on a specific niche and for those companies it is very important to have possibilities to get feedback from customers or even to collaboratively create new products. They are leveraging the rising participation and the expanding networks, so their prime attention is to collect/access the knowledge and the idea of third parties. To get in touch with the customers User Innovation (Bin, 2013; Lüthje et al., 2005; Piller, 2006; Slaughter, 1993) can be used, whereby the identification of Lead Users is also an important approach (Franke et al., 2006; von Hippel, 1986). However, they are taking the advantage of the skills and interests of people who are not within the firm, hence, they are accessing a new source of wisdom. Especially Crowdsourcing (Boudreau and Lakhani, 2013; Gassmann, 2013; Hammon and Hippner, 2012) is focusing on communities outside the firms and Enterprise Webs (McAfee, 2006) are trying to collect the knowledge of employees.

2.5.1 User Innovation

User innovation is a novel form of cooperation between companies and customers, which extends the classical approach about the so-called Lead Users in the industrial goods sector. Some of the central actors of this network are the customers and the users of a product, who are often the same persons. Sometimes the innovation processes are self-initiated by the users and partially brought up to the prototype stage. In this approach the customers are not just initiators of a new product or source of innovation, they are also part of the production process. Their potential is greater than that of a traditional company because they are not restricted by the firm's boundaries and their knowledge is much broader because it does not only result from the small group of members of the product-development team. If this group is expanded to external actors it is possible that ideas, creativity and solutions of the partners can influence the innovation process in a positive manner. The motivation of the users is not the maximisation of the profit or the market leadership, but the pursuit of the best possible product for their own use. The users who are part of this process have understood that this objective is reached best not through a closed system. It can be achieved through an open innovation process. A commitment of one person calls forth reactions and contributions from others, thus, creating more value for all. This approach is supported by the modern information and communication technologies, because they provide a cheap opportunity to interact with a huge amount of customers at the same time, but in an individual way. Furthermore, it is possible to actively involve them in the different phases of the innovation process (Piller, 2006).

In this course, it is interesting to research, why customers want to be part of this innovation process because normally the company is beneficiary of the jointly developed innovation and often covers all property rights. Therefore, the investigation of the user's motives is fascinating and a must-do for the companies, so that they can motivate the users to contribute in innovation activities and to identify which incentives are necessary to empower the motives. There are three types of motives (Piller, 2006):

- *Extrinsic motives* are satisfied through the circumstances of the activity and the following outcome. An extrinsic motive is the expectation to use a product or service innovation by oneself. In addition, the participants can be rewarded by material returns, for instance discounts, payments or licensing.

- *Intrinsic motives* are satisfied by the activity itself. This is often because the task is stimulating, or rather joyful, exploitative and creative. The users should have the feeling that they are equal to the task, as well as consider the task as a challenge. If they receive immediate feedback on their performance the customers get the impression of self-determination, control and competence.

- *Social motives* will emerge, if human actions are influenced by others or if the user is able to influence other people. If a customer engages in innovation activities, which are visible for other market participants, different social psychological effects occur. Especially the user integration in virtual communities opens the possibility to reach a large number of customers with relatively little effort; those communities are able to extend the innovation readiness of the users, whilst the customers support each other in terms of innovation tasks and in executing them together. Customers expect for this interaction acknowledgment or appropriate considerations for their served assistance and contribution. Esteem can also be developed through the tie of social contacts with like-minded peers or through the possibility to influence the environment.

User innovations are - compared to the manufacturer - much more often used by their component suppliers. Those are using the quickly generated, low-cost expertise of the users. Hence, in the end also the manufacturers have an indirect cost and value benefit (Slaughter, 1993). Several empirical investigations have tried to analyse how far user innovations are developed:

Table 2.1: Degree of Engagement in User Innovation

Engagement in innovation	*Bin, 2013*	*Lüthje et al., 2005*	*Franke et al., 2006*
rough idea	13.8%	27%	31.7%
clear design idea	16.9%	-	-
drafts of idea	28.5%	23.4%	14.6%
prototype	32.3%	40.5%	27.6%
commercial product	8.5%	9.1%	26%

Source: illustration created by the author based on Bin (2013)

User Innovation is a good approach to extend the traditional instruments of a company's innovation management, but it is not a substitute for the conventional, corporate-driven innovation process, because due to the above mentioned findings, this technique isn't able to fully substitute the innovation process of a firm. Moreover, it is a complementary tool, which supports the enterprise and reduces the uncertainties in the innovation process (Piller, 2006).

2.5.2 Crowdsourcing

The social networking trend is the foundation of a few new research fields, like Crowdsourcing. This new method can be used in many different areas, but we will focus primary on the innovation process. „Crowd" refers to the bulk of Internet users - this initially indeterminate mass consisting of undefined people solidifies over time; people get to know each other, they work collaboratively together and inspire each other. Therefore the participants can be from different countries, companies, domains and industries. They have their own interests and motivations, which make the crowds harder to control. The participants try to solve a challenge and present their ideas, opinions and suggestions. Then the submissions are commented by other community members, discussed, evaluated and further developed. With this approach it is possible to already actively involve users in the early phase of idea development. Through the contribution of creative innovation mass pulses are triggered in such a diversity, which a company probably is unable to generate internally (Gassmann, 2013). The Crowdsourcing approach requires a lower level of engagement and involvement than user innovation. Crowds are motivated by intrinsic motivations, but to use their power it is necessary to have access to a crowd. It is not easy to establish a big and powerful crowd because of the difficulty of addressing so many people. There are different ways to establish a crowd: a firm can build its own platform and hopefully get a huge audience or somehow use an existing social media channel, where it is easier to reach a lot of people. Nowadays on the market there are a few intermediaries, which provide sophisticated crowdsourcing platforms with integrated management and incentive systems. Those can be used as an approach to access a new knowledge pool or as a marketing tool. Companies can reinvigorate (with incentive

systems, for example) and redeploy crowds across a continual stream of problems. In essence, the crowd has become a fixed institution, available on demand. According to Kevin J. Boudreau and Karim R. Lakhani, there are different possibilities to perform a crowdsourcing activity, which are listed bellow. Each one is best suited to a specific kind of challenge.

- *Crowd contests* are started by publishing a specific problem, which a company suffers from. This happens on an universally accessible platform, where the participants can submit their solutions. Contest can be used for challenges, where the outcome is not fixed and no best-practices are available, for example technical, analytical, and scientific problems or design problems and creative or aesthetic projects. In this cases it leads to the best solutions because the crowd runs a series of independent experiments with various results. Also if the company only uses one solution, they are able to identify the „technical frontier“ based on the different submissions, especially if they are clustered at an extreme. The internal R&D department would not be able to provide such a great variety of information. Since the outcome is not known in advance the company has to define the challenge in a generalised manner because it has to be understood by external people, who do not have a firm-specific knowledge. Furthermore, it should not reveal to much information about the firm and its strategies. The statement of the problem should include several subproblems and the contest has to be structured in a way that enables the company to implement the occurring suggestions.

- *Crowd collaborative communities* is - as the name already suggests - the collaboration of a company with a community, which prevalent is an open source community. Those communities are based on the principle of aggregating a large number of diverse contributions into a value-creating whole. This form of collaboration works best, if the participants can accumulate and recombine ideas and share information freely. Hence, the protection of intellectual property is nearly impossible; this implies that the companies should have a strict separation between proprietary assets and community assets. To benefit from the community assets the company needs to generate profits form complementary businesses.

- *Crowd complementors* is the approach, which uses the crowd as creators of value to transform the product into a platform. This enables the users to generate complementary innovations and to leverage the product to new spheres because they provide many different solutions to various problems. This shows the contrast to the previously mentioned approaches, which provide one or more different solutions to only one specific problem. Beside the additional licensing or transaction revenues from the complementors, this additional value can also leverage the demand of the product, because it is more useful with this new complement innovations. If the demand increases also the supply of complementary innovations is going to increase and it is possible to have positive network effects. The drawback of this approach is that the firm has to provide some access to the functions and informations of the core product. Otherwise the complementors are not able to add additional

functions. Due to this, informations are exposed to unknown people and the firms have to take steps to protect their information.

- *Crowd labor markets* are used to match buyers and sellers of services, an action which could be seen as matching skills to tasks. Normally a firm uses this approach with third party intermediaries. Those labor markets should be used if a company knows what kind of solution it is searching for and consequently also knows what skills an appropriate solver should have. Therefore one of the major tasks of such a platform is to identify a qualified worker, which only can be done with reputation mechanisms and skill evaluations, bidding systems and possibilities to recourse. In the outsourcing process crowd labor markets can be used easily to find suited labor forces. Especially for simple tasks, which a person performs better than a computer, it is easy to identify the right people, due to the fact that there is a specific requirement profile. If the job is done the firms have to evaluate the worker. Summarised, when using crowd labor markets, the enterprises have access to a broader variety and depth of skills, which are easy to obtain on these platforms. There are no real obstacles by practicing crowd labor markets; the only concern is to identify the tasks which can be outsourced. Normally an issue in an outsourcing process is that the partner can not deliver the agreed work or only deliver with a poor quality. Within such platforms this risk can be minimised by the usage of the mentioned evaluation tools (Boudreau and Lakhani, 2013).

Larissa Hammon and Hajo Hippner identified the most important opportunities and challenges of crowdsourcing (see table 2.2).

Table 2.2: Opportunities and Challenges of Crowdsourcing

Opportunities	*Challenges*
Access to immense knowledge-pool	Difficult to calculate project costs
Increase of brand awareness	Exact project definitions
More sophisticated problem solutions	Loss of control (sabotage or boycott)
Cost-cutting potential	Legal framework conditions
Anticipation of consumer needs	Communication feedback loops with the project participants

Source: illustration created by the author based on Hammon and Hippner (2012)

If crowdsourcing is used in the innovation process, the information flow between the customer and the firm is improved. This conducts a better understanding of the customer's desire and a strengthening of the relationship, that leads to a better fit-to-market. Furthermore, also the time-to-market is shortened, due to shorter development time because of a higher modularity and flexibility of the processes. In addition the new-to-market is affected by crowdsourcing as well. As already mentioned, with this approach it is possible to access a huge capability- and knowledge pool. Empirical studies have shown that publicly accessible crowdsourcing competitions bear some risks. Upfront the

quality of the ideas isn't known, since the composition of the crowd is not know - it can happen, that the participants do not have the right professional expertise. Therefore, it is not sure if the companies will be able to use the outcome in their project, hence, the project costs are difficult to calculate. Competitors are able to monitor the freely accessible platform to anticipate in which direction other firms are innovating and therefore to establish a counter strategy. In crowdsourcing activities intellectual properties are an important issue because it is more complicated to handle them, compared to a closed innovation approach, due to the fact that not too much of the corporate intern know-how should drain-away to the public. For this reason companies try to gain all rights of the generated ideas on a crowdsourcing platform through contractual licensing agreements or terms and conditions. A crucial part is also the establishment of an incentive system, based on one or more incentive motives, which were already described in the chapter of user innovation (2.5.1). To sum things up, crowdsourcing could be used as a tool to solve some organisational deficits with the wisdom of the crowd (Šundić, 2011).

2.5.3 Innovation Communities

An innovation community is a collective of like-minded actors, who get together in virtue of a specific innovation task and promote said task (Gerybadze, 2003). Eric von Hippel defines innovation communities as:

> „[...] meaning nodes consisting of individuals or firm interconnected by information transfer links [...]“ (von Hippel, 2005)

The information transfer link is not specified, each communication possibility is feasible. The main purpose of such an innovation community is to aggregate informations to a specific category. It is possible for the contributor, as well as for everyone else, to access the provided information. Furthermore these communities usually provide some additional functionality to support the participants and also some mechanism for the participants to help each other because they act in a collaborative manner. They also provide important services to customers - often they help others by applying the innovation. Realising an innovation community nowadays is very easy, due to the modern information and communication technology. With those platforms the users are able to reveal their innovative ideas freely - they can be reviewed, discussed and voted on by the users. Innovation communities are complementing and extending the firm's innovation process towards a better decision-making because more information from the customers is available. They do not only have positive effects, they also generate high risks: the company is not able to control what the users are posting. It could be possible that the users want to harm the firm with negative comments. Before a community is able to be productive the firm has to make a huge effort to establish a community and develop a community feeling between the participants. As we can see, the company has to put a lot of resources into the establishment of such a platform. Therefore it is possible that a conflict between the targets of the community and the targets of the company itself occurs.

This also includes how a firm can choose between the suggestions of the community and the internal ideas, which means that they have to find balance between organisational intern interests and the interests of the community. The company should not perceive the innovation community as an external resource, but as an internal innovation resource, where different ideas are competing against each other to be seized by the company. If a community is getting more successful, its power over the firm's process is rising as well. There is no statistical difference between supported or unsupported ideas, which fit the firm's product/capability portfolio - so they use community innovations not only to strengthen their assets (Gangi and Wasko, 2009).

The *open source* approach is a specific form of an innovation community and also can be part of an open innovation strategy. It originates from the software development field and is only open source if specific software licenses are used. Normally distributed persons are contributing to the project, whereby everyone is able to participate because all artifacts are revealed and publicly available. Most of the licenses are again forcing the contributors to reveal their changes, thus bears additional advantages for everyone, because everyone can benefit form the improved version. The motivational factors to participate in open source projects are categorised in empirical studies in three different classes (Lakhani and von Hippel, 2003; West and Gallagher, 2006):

- *direct utility* for the participant self or the employer,
- *intrinsic benefit* from the gained experience or personal fulfillment,
- *signaling* the skills to peers or potential employers.

Companies are using combinations of those categories to gain an advantage of open source, whereby the main advantage is the shared right to use the technology and a collaborative development by using donated labor (West and Gallagher, 2006). Open source is not only limited to software, nowadays it represents freely available knowledge and information in general.

2.5.4 Enterprise Webs

Enterprise Webs can be seen as the utilisation of social platforms and other information technology tools within the companies or with partners and even with customers. This approach can be used for various activities like development of ideas, problem solving and communicating. However, it can be seen as an internal opening in preparation of an extended external opening in terms of open innovation. It leverages the way to collaborate, share and organise information between employees because current communication practices can be categorised in two distinct methods. First, the *channels* - example given e-mail and instant messaging - can be used by everyone to share and distribute digital information, but only a restricted circle of people has access to the shared data. The second group, the *platforms.* are working the other way round as the channels since the

information is generated by a smaller group of users. That information can be accessed by a lot of people. Knowledge Management systems have tried to combine both approaches by extracting knowledge, best practices and relevant experience from all employees of a firm and publishing those informations in a company-wide accessible database. This approach was not used widely until digital platforms occurred on the Internet and supported the generation, sharing and refining of information. Those interactive platforms are called Web 2.0 and they widely oust the Knowledge Management systems inside the firms. If some of those Web 2.0 tools are adopted in a company to capture the practices and outputs of the knowledge workers, the tools are also referred to as Enterprise 2.0. According to Andrew P. McAfee the Enterprise 2.0 technology paradigm consists of six components (McAfee, 2006):

- *Search* is a fundamental function of any information platform because it is crucial to find the desired information. This can be achieved through different approaches, for instance navigation aids or keyword search.

- *Links* are changing over time and representing the opinions of the people. Therefore they structure the information, which means they are building a structure and reflecting the importance. In traditional intranets only a small group of employees are allowed to build links.

- *Authoring* means, that everyone can contribute something, it does not have to be a whole article, also knowledge, insights, experiences, comments, improvements and links are important contributions. Blogs are supporting individual authorship and are cumulative, while wikis are enabling group authorship and are an iterative process. The authoring paradigm shifts the intranet platform form a creation of a few to a continuously updated and interlinked work of many.

- *Tags* are simple one word descriptions, which are attached to the informations for a better categorisation of the content. Therefore, the knowledge worker's information structures and relationships are reflected and they can keep track of useful information sources; it dos not matter if it is an internal or an external source. Furthermore it is possible to recognise which other employees are using the same tags and which sources they have visited, so that in the end some patterns and processes can emerge.

- *Extensions* are like tags, but they are automatically categorised by a pattern matching algorithm. They are used in recommendations, for instance if you liked object A, you probably also like object B.

- *Signals* are informing an interested person if a new and relevant information occurs somewhere. The signals often consist of a headline, referring to the full information. Aggregators are browsing the interesting information and, if new information is published, they order and then display the signals. With such a tool the employee does not have to browse the sites anymore, it is possible to look up in the aggregator-tool if there is something new.

To achieve a wide acceptance of the Enterprise 2.0 technologies they have to be easy to use with no or only little training. They should not dictate the employees how to work or structure the information, instead the structure is emerging after they were being used. Hence, autonomous and individual peers are building a distributed platform with changing structure (McAfee, 2006).

2.6 Open Innovation and Manufacturing

In addition the manufacturing process of the companies is affected by new innovation models, which, however, are not yet widely adopted in an industry sector or in a specific area. The selected models are considering the current trend of increasing automation and connectivity between everything and everyone. The boarders of customers and manufacturers are blurred because everyone can influence the outcome of the production. Based on the emerging trend of computer integrated manufacturing processes (Sendler, 2013; Gilmore and Pine II, 1997) the production of personal customised products can be achieved. Those products also have huge affects on the innovation process, which can be supported through virtual product development to enable everyone to take part in the development process of new products. Additionally, the personal fabrication (Gershenfeld, 2012; Mota, 2011) has the potential to change our daily life, due to the fact that with 3D-printers products can be produced with marginal costs of nearly zero.

2.6.1 Open Innovation and Advanced Manufacturing Technologies

Hitherto the past industrial revolutions were triggered by technologies and innovations in the manufacturing process of products, which started with the loom, continued with the production lines until the industrial automation with the help of computers. The next step provides a better individualisation in terms of supporting a stronger consideration of customer requirements and better and more direct involvement of customers. We will face this development in the near future and it does not only affect the mechanical production process, but it will also revolutionise production-chain-design, process-planning and the production, as well as the supply chain of mechanical and non-mechanical parts. Components and embedded software will form a single entity and provide different advantages over the whole product life cycle: personalised functions are provided for the customer, the supply chain gets more flexible and transparent, the production makes a step toward the personalised mass production with economical costs and the development department is able to identify the user behaviour and the product requirements in more detail. This evolution originates out of different, already existing, trends. The local and temporal flexibilisation of the usage of information technologies provide enhanced value and usage possibilities. New forms of communications are rising, where people form communities and can openly formulate their wishes, desires and meanings and, furthermore, discuss and interact with each other. Everyone is able to scan this communities and to

rate the found information, wherefore it is possible to generate, save and publish all information in the public. Because of that it is important to be able to interpret and understand how the information is correlated and in the end to conclude which impact this has (Nambisan, 2002). Physical objects are connected and are able to communicate autonomous. This is referred to as the Internet of Things, which also leverages this vision. Through that an object can interact with another object and therefore provide some additional functionalities, enabling new innovations, product functionalities and efficiency in the value-added process, hence, it provides a basis for entirely new business models. The main element is the „Smart object“ - such an autonomous, physical digital object consists of the interplay of mechanics, electronics and software. They are able to process, store and interpret the information, which is created by themselves and in their external neighbouring world. In addition they can cooperate with each other and exchange informations with other devices/machines and human users. The goal is that such a smart object contains all production informations, which the machine can elect and therefore perform the right production step. It also should be possible that the object can determine its way through the manufacturing plant with those interactions and the information. Such a manufacturing plant is called „smart factory“. All these concepts are necessary to run a production line, which is able to produce lots with the size of one with sustainable economical costs (Sendler, 2013).

The *mass customization* method consists of the two contradictory concepts, namely of mass and single piece production. Tseng and Jiao defined mass customization in the following way:

> „producing goods and services to meed individual customer's needs with near mass production efficiency“ (Tseng and Jiao, 2007)

From this we can recognise that mass customization is a paradigm shift in the manufacturing, like the open innovation approach in the R&D. The company has to have the capability to recognise the customer needs and then offer products, which satisfy precisely those needs. To aim for mass production efficiency the firm can use the approaches which are described in the previous section, for instance a smart factory. Furthermore, the employees have to deal with unique tasks, because everything is forged to an individual customer. To achieve such a unique product it is necessary that the customer can explain his problems. This is possible with a choice system supporting the customers by identifying their problems and minimising the choice complexity as well as the maximisation of the enjoyment of the search process. James H. Gilmore and B. Joseph Pine II identified four appropriate mass customization approaches (Gilmore and Pine II, 1997):

- *Collaborative customization* is used to identify the customer needs in a direct interaction between the customer and the customizer, starting right at the design stage. The outcome is a customised product, which fulfills those needs. This approach is used, if the customers are not able to articulate what they want.

- *Adaptive customization* allows customers to adapt a standardised product according to their needs. This is applicable if the customers' preferences differ and the technology allows them to customise themselves.

- *Cosmetic customization* is an approach where a standardised product is sold to all customer segments, but the representation is customised. This works best, if the customers are using the product in the same way, but have different preferences on how the product design should be.

- *Transparent customization* is a process where the products are customised to the customers' needs, whereby the customers do not state their needs explicitly. This is only possible if the firm has the capabilities to predict or to observe those needs and inconspicuously customises the product.

Traditional offerings are only satisfying average requirements - the company's offering is not exactly what the customer wants. To minimise this gap the companies have to chose the appropriate mass customization approach to adapt their products only where it is necessary. A firm can implement a combination of them (Neacsu, 2014).

2.6.2 Personal Fabrication

Personal Fabrication is also called democratisation of manufacturing and can be the next step in the manufacturing process, following after the last century of mass production, whereby we are now still in the mass production phase. The next step is leveraged by the broad access from individuals to sophisticated production tools and the knowledge to manufacture objects for different purposes. A personal fabricator could support this dream and makes it possible to design and produce tangible objects by individuals wherever and whenever they are needed. Such material objects are created from digital designs. A computer-aided design model is loaded into the fabricator, which then builds the physical instance from stock material. Furthermore, it will be possible to self-reproduce a personal fabricator, meaning the production of other machines through a first machine. Neil Gershenfeld said that this technology has an even greater impact on our daily live than personal computers because the PCs form only the bits in a digital world, whereas the fabricators are personalising the physical world of atoms. Therefore, it is possible to produce several or just single parts at the same cost as series of identical items in mass manufacturing tools, because they do not require any tooling. Digital fabrication will have an important impact on the emergence of lightweight factories and mass customization, which is a combination of mass production with individual customizations. Based on the reduction of the complexity, availability and costs of 3D-printers, CNC-machines, laser cutters, etc. the distribution of digital fabrication technologies is boosting. This development is also facilitating individuals to act as creators and to produce goods beside the centralised manufacturing model. Those arising kinds of new production possibilities can be identified as new factories (Mota, 2011):

- *Online Fabrication Services* are used by different customer segments - for example a customer, who is searching for a specific custom product or an artist, who wants to produce a small scale production of a designed product. Everyone can upload a digital design, which is turned into a physical object by the online service and shipped to the customer. Others are providing a community marketplace where individuals can publish and sell their designs or a crowdsource approach where the buyers are asking the community to design and create a product, which is forged to their desire. There are also some freely licensed designs in public accessible databases. Most of those online fabrication services offer a broad variety of different techniques for instance 3D-printing, laser cutting and electronic parts. Furthermore, they are also offering different kinds of materials, hence, they are on the path to become a multifunctional public factory.

- *Distributed Manufacturing Networks* connect designers with manufacturing tool owners. Both included parties have a benefit - the tool owners have an additional revenue stream and the creators have produced their designs locally. The creators are able to find shops and equipment operators nearby, where they can request a specific job. After the owners have bid on the request the customer can chose the one, which should produce the product. Already, there are some companies which are trying to build up a global manufacturing system consisting of 3D-printers.

- *Local Production Shops* have essential fabrication tools, with which those individuals can create their own products. A local production shop emerges directly out of a local community and is independent from other production shops. This means every shop can have a different equipment and most of them are providing additional services: workshops for the tools, peer learning and collaborative problem solving.

- *Personal 3D-printers* are emerging out of professional 3D-printers. They are smaller and cheaper, so that they can be afforded by an individual customer and fit in personal spaces. Furthermore, they can be used without specialised technical skills; following the ascent of PCs personal 3D-printers are evolving into a technology which everyone can operate and use at home. However, some challenges remain, such as the combination of different materials, fumes and other pollutions and the lack of speed.

As we can see, digital fabrication is not only a vision, but a revolution, which is already on its way. The central question is, how our lifes are going to change, if anyone can produce anything and anywhere he wants (Mota, 2011). Of course, the nowadays available digital fabrication tools are not in their final form. Personal fabrication seems to be a real disruptive technology and the far-reaching implications are very difficult to foresee: Are those new production technologies more sustainable or are they producing more waste than the traditional mass manufacturing process? How can the individuals store the various raw materials and how can be secured that the safety-, environmental- and quality-regulations are met (Gershenfeld, 2012)? To respond to such new approaches in terms of open innovation and new manufacturing techniques a dramatic change of the

companies is often required, therefore, in the next chapter there is a discussion about how business models can react to those changes.

2.7 Business Model Innovation and Open Innovation

The innovation strategy's objectives of a firm are focused on distinguishing the improvement and efficiency enhancement in a positive manner from their competitors. As we have discussed previously, this is realised by innovative products, improved services or optimised processes and is nowadays more or less state of the art. The competitor will also perform similar accommodations, therefore, it is only a temporary solution to elude the increasing competition. An opportunity to gain a competitive advantage is to include the business model into the innovation strategy because if the same technology is brought to the market through two different business models it will lead to two different economical outcomes. Therefore, the business model aspect is important, especially due to the fact that most of the business models are historically emerged and not constructed by the firm's decisions. A business model consists of three main components: a value proposition, an added value model and a revenue model. The value proposition describes the benefit of the customers or the partners of the company, if they are trading. Different steps of the added value and the most important partners, as well as crucial activities to perform the business, are clarified in the added value part of the business plan. Hence, this value part shows different economical agents and their roles and how they are generating benefits. In the revenue model all monetary flows from and to various sources have to be listed to reflect future earnings and thereby also the value and the sustainability of the business model. Those components are tightly linked; if one is changed it affects other parts as well. Based on the three basic elements we can distinguish between three different business model innovation categories (Stähler, 2001):

- *Value innovations* are the adaption of the benefit of a specific customer segment, which can not be satisfied by already available products. The new value innovation can address this poorly state or even create a new benefit, which customers were not able to think of. Hence, such innovations are able to generate new markets without direct competitors.

- *Architectural innovations* leverage an economical advantage in the field of internal and external activities. This includes also the adaption of the boundaries between the firm and the external partners, as well as new distribution and communication channels and determines if the customer inherits certain activities of the company.

- *Revenue model innovations* can be done in different ways. Either the revenue stream or the composition of miscellaneous sources is changed or the change effects the revenue type - an example would be if a company stops to sell a production machine to the customer, but rather marshals the machine for the customer and

sells the output, hence, the revenue is generated by a service instead of a physical product.

A company with an established business and therefore also an established business model is locked in this business model because the current state of having a source of income will not support the process of defining and finding a new one. Furthermore, the old business model can be more efficient than the new one because all activities and processes are optimised. To change a business model is not easy - there are some tools to support the development and definition of a new model. However, an at least important task is the adaption of the organisational processes. The best way to achieve this is to have a fluent transition from the old business model to the new one, where the old one supports the new model, until it is analysed, adapted and continuously improved and ready to renew growth and profits (Chesbrough, 2010a; Sosna et al., 2010; Teece, 2010).

More and more companies have recognised the trend towards a more service-driven economy, which supports the companies by providing a real value to the customer and, therefore, preventing them to switch to a competitor. Through the service interactions with the customers the firms gain a direct insight to the customer's challenges. There are differences between service innovation and product innovation due to the fact that the customers interact with the employees, so they are also part of the innovation. Services often need a physical presence for direct interaction somewhere near the customers. Services are intangible and are not able to carry a brand. Business services are in various fields of the economy, for instance design, R&D services, marketing, legal services and consulting. A lot of them are construed to discover external knowledge and to utilise internally generated knowledge. The service approach is not only limited to a subgroup of the economy, but can also be used by all industries. Furthermore the product-based businesses are adapting services to create additional value for the customers and also to increase the customer retention. The revenues of product sales are falling steadily, hence, a lot of companies are arguing that innovating in services is the solution for growth. If a company sells a product they only get paid once, but if they change the manufacturing- and product-oriented approach to a service approach they are able to generate a more continuous money flow. Due to that, they are getting paid for using the product and the large fixed cost for the customer is transformed into a variable cost instead. Furthermore, the objective of the customer is aligned to that of the company, since both want to minimise the downtime of the product. Therefore, the company provides some maintenance and repair services for the product. To be sustainable in the future the companies have to think outside their boundaries and beyond their products, but like commodity businesses, also the service businesses are not spared of stagnation. To recover from this they are often creating platforms out of the product. Such an approach needs a new access toward customers, business models and the capacity to open up the innovation process. Businesses with open service innovations are adding value by leveraging human capital and tend to be interactive with their collaborators and innovation networks in an unstructured way. This exchange is based on trust and moral principals instead of formal contracts. The most significant information to support the establishment of an

open service innovation model comes form the market-based partners. Market-based partners are customers and suppliers, which are providing a better understanding of the market requirements for innovations. Of course also science-based partners can provide some advantages, like collaborations with research institutes, which support a better understanding of the used technology or an improvement of the capabilities across all functional domains (Chesbrough, 2010b; Mina et al., 2014).

Normally service offerings are improved incrementally and only a few firms are able to create service innovations and thereby developing a new market. Market-creating service innovations have an immensely bigger potential than imitative or even incrementally improved service offerings and are a strategic asset. Service innovations can differ along two dimensions: First the access to the core benefit can be changed - which would be a new delivery benefit - or a new benefit can be offered. Secondly, it can be distinguished between producing and consuming a service simultaneously or separately. Berry et al. identified nine drivers which lead to a market-creating service innovation, if all nine are considered in a holistic approach.

- *Scalable business model*: Services are more manpower intensive and, therefore, the labour is the primary cost as well as the customers' value creator. Hence, the long-term profitability depends on them and this business model is much more complex to scale because there are no production economies or distribution benefits.

- *Comprehensive customer-experience management*: If a service is offered simultaneously more customer interactions are occurring. Therefore, all these intersections are shaping the customers' perception about quality and value. The experiences are based in three different forms, (1) functional: regards the technical quality of the offering, (2) mechanical: represents non living elements, such as design and overall appearance and (3) human: arises out of the behaviour and appearance of the employees. All those forms have to be consistent to offer a valuable and customer-approved service.

- *Investment in employee performance*: The customers' perception about the capabilities of the employees has a huge effect on the customers' satisfaction and switching behaviour. Therefore, the employees should be able to do their activities on a constantly high level. This can be achieved by training and education, performance based incentives and internal branding.

- *Continuous operational innovation*: A service business consumes a lot of operations, if those are not continuously improved the competitors are going to catch up. If they are adapted in a strategic manner, it is possible that new market segments are entered.

- *Brand differentiation*: Although it is not possible to brand a physical product it's necessary to establish a brand for the service itself, because a strong and trusted brand reduces the perceived risk and elicit emotions. Furthermore, it helps to

tie the customer to the service - if the customer is not obligated to purchase the product beforehand he could switch anytime.

- *Innovation champion*: A champion can evoke the required resources and support the process from the idea until the transformation into a new market.

The authors also mentioned *superior customer benefit*, *affordability* and *continuous innovation*, which are used on a more general basis and therefore are going to be discuss only briefly. New services are only sustainable if they provide a clear and better solution to a problem. If that problem is much-needed the customers are trying the product or service and hopefully use it regularly from now on. Such innovative services are often saving time and effort for the customers. It is obvious that the best service does not have any benefit, if the customers are not able to pay for it - therefore, the cost structure of the company is crucial. Consecutive innovations can not be neglected since the whole environment is in a continuous change and the firms have to react to those changes. In consequence it is critical to establish a service friendly culture because this is not as easy to imitate, as an infrastructure or technology (Berry et al., 2006; Chesbrough, 2011).

2.8 Empirical Studies about Open Innovation

In this chapter we are going to discuss some recent empirical investigations and their major conclusions. The surveys, which were published in the early live of open innovation, have a specific focus on how a company can benefit from this new trend and on the question if they are using this new approach. Later, this focus was shifted to a particular peculiarity of open innovation, like Inside-Out or Outside-In. As well as that, a diversification of the company types can be observed. This means most of them consider various aspect of the open innovation approach and the transformation from a closed to an open paradigm. The selected empirical studies for a deeper breakdown are discussing open innovation in a general manner and are not primarily focusing on a specific approach on open innovation like crowdsourcing, innovation communities or mass customization. Those are selected because of the intended broad investigation of open innovation in Austria. The different studies state in unison that the companies can benefit in various ways from opening up their innovation process. In table 2.3 we can see some of the capital importance investigations for this work. Due to those findings we can develop our own study for a broad analysis on open innovation for Austria. In the following we are going to discuss those researches in a brief manner.

Table 2.3: Selected Empirical Studies on Open Innovation.

Study	*Topic*	*Sample*	*Key results*
Van der Meer, 2007	Open Innovation - The Dutch Treat	814 companies in all sectors and industry in the Netherlands with more than 50 employees	Dutch firms have successfully adopted open innovation, but at the same time they are facing the problem of handling the business model in a flexible way
Lichtenthaler, 2008	Open innovation in practice	155 medium-sized and large technology-oriented firms, which were the largest firms in Germany, Switzerland and Austria based on revenues	There is a trend toward more open innovation and the companies are tending to combine Inside-Out and Outside-In approaches
Van de Vrande et al., 2009	Open innovation in SMEs	605 small- and medium-sized enterprises from the Netherlands	Medium-sized enterprises are more engaged in open innovation than the smaller ones
Lazzarotti et al., 2010	Open Innovation Models Adopted in Practice	99 random companies form the Northern Italian region Lombardia	Clusters of adopters: open and closed innovators, integrated and specialised collaborators
Enkel, 2011	Open Innovation. Wie machen es die Besten?	159 German, Swiss and Austrian firms	The open innovation activities and sources have to be aligned with the corporate strategy
Davide et al., 2011	The Open Innovation Journey	10 early adopters of open innovation in mature industries in Italy	The Outside-In approach is more used than the counterpart
Rahman and Ramos, 2013	Challenges in Adopting Open Innovation Strategies in SMEs	22 SMEs in Portugal	The SMEs are suffering a lack of skilled manpower
Chesbrough and Brunswicker, 2013	Managing Open Innovation in large firms	125 companies from Europe & USA with more than US$ 250 million revenue and more than 1000 employees	Outside-In activities are more commonly adapted than Inside-Out practices

Source: illustration created by the author

The Study of van der Meer (2007)
The questionnaire *Open Innovation - The Dutch Treat* was designed by Han van der Meer and filled by 814 companies. We can find the main focus of the questions in the following list (van der Meer, 2007):

- Which factors are hampering innovation in Dutch companies?
- To what extent do Dutch companies plead to open behaviour?
- To what extent do Dutch companies exhibit open behaviour?

The study shows, that about three-fourths of the innovation projects are not successful or only partly, due to the reasons of too little commitment, too little time, too few resources and wrong innovation strategies, but also because of economical reasons - a long payback period, high innovation costs or legislation are some of the impediments in the innovation process. The main challenge of open innovation in Dutch companies is the dominance of the existing business model, which is not codified, but exists implicitly in the daily routines. Hence the companies are not able to adapt their business models in a flexible and open way. Although the firms are interested in commercialising their knowledge, they have troubles with the extraction and also with the installation of such structures, which are providing the ability to externalise the knowledge. The Dutch firms are still trying to sell their obsolete ideas and knowledge to others and have recognised the opportunities to generate short term cash out of exporting structures, such as start-ups, spin-offs or corporate venture capital. Open innovation projects are influenced by collaborations between different firms in a positive and more successful manner (van der Meer, 2007).

The Study of Lichtenthaler (2008)
Open Innovation in Practice had a sample of 155 firms, which are all technology-oriented and the largest, based on their revenue in their country. Those companies are from Germany, Switzerland and Austria. The author clustered the firms based on the extend of external technology acquisition and the extend of external technology exploitation, due to the fact, that the opening up of the innovation process can be aligned to those two types, this equates to the firm's strategic approach on open innovation. The following clusters have emerged (Lichtenthaler, 2008):

- *Closed innovators* are still following a traditional Closed Innovation strategy with nearly no external technology acquisition and external technology exploitation. Therefore they are developing their technologies in-house and the exploitation is also inside the firm's boundaries.
- *Absorbing innovators* are utilising external technology in a great manner, but external technology commercialisation is not a big issue. This means they have opened up their innovation process only in one direction, to acquiring knowledge form external sources, but they are additionally not using the opportunity to commercialise their technological knowledge to the same extend as other companies in the sample.

- *Desorbing innovators* have, just like the cluster above, partly opened up their innovation process, but in an distinct direction. Only some knowledge from the outside is utilised, however the internal technology assets and knowledge is commercialised intensively, for instance by external sources or licensing agreements.

- *Balanced innovators* use both approaches of technology transactions in a noticeable extend. Their approach is not restricted to one direction, hence, they are using both types of technology transactions. The firms in this category have opened up their innovation process and they are basically using the paradigm of open innovation.

- *Open Innovators* are - as the name already suggests - using a very open approach in both dimensions, thus, they adopted the open innovation approach thoroughly. They acquire external knowledge and technology, whereby they coincidently try to fully capitalise their internal technology by commercialising their technological knowledge.

This study is one of the first large-scale empirical works that describes the state of open innovation based on the two main types of technology transactions - Inside-Out and Outside-In. In this sample the firms, which had an open innovation approach, had a competitive advantage because they had some important strategic innovations. Therefore, external technology acquisition and external technology exploitation will be a must-have rather than a nice-to-have, otherwise it would not be possible to keep up with the competitors (Lichtenthaler, 2008).

The Study of van de Vrande et al. (2009)
With the subtitle „Trends, motives and management challenges“ the paper investigates how open innovation practices are applied by small and medium-sized enterprises (SMEs) in the Netherlands. Furthermore, the motives and the challenges, which the sample of 605 companies face, are examined. They distinguished the open innovation practices between technology exploitation and technology exploration - this is another terminology for the Inside-Out and the Outside-In approach. Venturing - starting up a new organisation out of the internal knowledge - and the process of selling or offering royalty agreements to other organisations, in order to utilise the internal intellectual property in a more sophisticated manner, are practices which can be aggregated to the term technology exploitation. The evaluated technology exploration techniques are the direct involvement of customers in the innovation processes, for example by active market research to spot their needs, or by developing new products, which are based on their preferences, or modifications of similar products. Also partners of the external network can be used to collaborate with and to support the innovation processes with external knowledge or human capital. An other approach is the external participation, where a firm invests in a new or established enterprise to gain access to their knowledge or to leverage synergies. Instead of buying a whole organisation it is also possible to outsource some of the R&D activities; this can be done by buying external R&D services from other organisations, such as universities, public research organisations or specialised suppliers.

Inward intellectual property licensing is buying or using intellectual property, for instance patents, copyrights or trade marks, from other organisations to benefit from this external knowledge.

The prime finding is, that the usage of those practices, commonly known as the open innovation approach, has in average increased significantly in the years between 2002 and 2009. R&D outsourcing is practiced by half of the sample, but the most prevalent methods are the customer involvement, external networking and employee involvement. Whereby the outward and inward licensing of intellectual property, venturing and external participations are only used by a few companies. The most important motives why firms should apply open innovation are the market-related motives because they have to keep track with the market developments and also with the customer demand. The best way to achieve this is to engage in ventures or participate in other firms and of course to involve the customer in the innovation process. An other finding is that all innovation practices have the same underlying assumption, namely to react on environmental changes. Therefore, the companies' motives to engage in open innovation are to acquire missing knowledge, gain access to resources, but also to distribute the risks and to reduce costs. The hampering factor of time and resources scarcity affects all practices, but it is only sparsely indicated. If a firm is jointly developing a new product they frequently report that the partners often are not able to meet required quality or exceed deadlines and that, if they are involved with customers, there are a lot of difficulties with property rights or that the customer demands are too specific. Therefore, the authors have concluded that every single open innovation practice creates its own specific problems (van de Vrande et al., 2009).

The Study of Lazzarotti et al. (2010)
The *Open Innovation Models Adopted in Practice* is an empirical study focused on a sample of 99 companies, which applied for public fundings in Lombardia, a Northern Italian region. The Public funding is awarded for innovative activities within different manufacturing sectors. In the paper a new perspective of analysing the opening-up of the innovation process is introduced. The authors established two variables to measure the openness - the number and type of partners and the number and type of phases of the innovation funnel. The firm-specific variables are the following:

1. Objectives of collaborations classified in:
    - aims to extend skills, competences and creativity
    - aims to share risks and costs
2. Approach on innovation: technological aggressiveness with emphasis on radical innovation
3. Organisational and managerial actions for open innovation

Based on this variables the following clusters occurred (Lazzarotti et al., 2010):

- Open innovators, who collaborate with a wide set of partners in many phases of the innovation process
- Specialised collaborators, who open only a small part of the innovation process to a wide variety of partners
- Integrated collaborators, who collaborate only with a limited set of partners along the whole innovation funnel
- Closed innovators, who open a very small part of the innovation funnel to a very limited set of partners

The study shows that there is something like a continuum in the openness of companies. Furthermore it concludes that the specialised and the integrated collaborators can be seen as „intermediate“ models, but those options are valuable for companies, which do not have a highly aggressive approach and which do not want to invest too much in opening up the innovation process. As a consequence this means, that these companies can not expect as much benefit from open innovation as the open innovators. However, they also want to use the opportunity of the external sources of knowledge, but in a smaller extent (Lazzarotti et al., 2010).

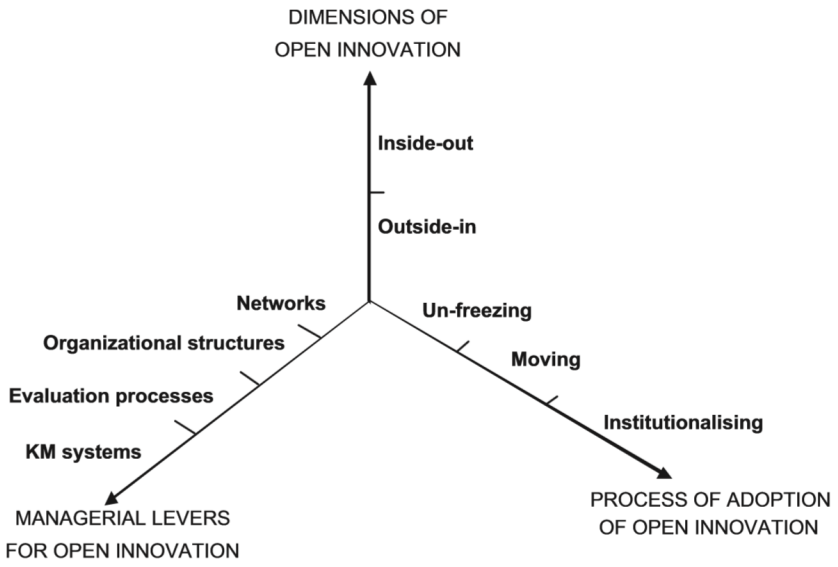
The Study of Enkel (2011)
In a study of the Zeppelin University 159 businesses reported that about 70% of them are integrating customers and suppliers in terms of gathering customer and supplier ideas. This also means that the technological know-how of the suppliers has influence on the development of new product ideas and that customers act as prototype testers. Those activities lead often to an incremental enhancement of existing products and processes. The usage of Lead Users - these are users, who perceive a desideratum before all other customer groups - is prevalent. If they help to develop a new product it can conduct to a radical innovation, but it is very difficult to identify them. However, about 50% of the companies have indicated that they are using Lead Users. Also joint developments with customers and suppliers through the entire development process of a product or a service are specified as the most important activity by 73.6% of the companies surveyed. Like in the previous surveys this study by the Zeppelin University has found out that nowadays in most of the enterprises open innovation is a reality and that the main focus is the integration of external knowledge and joint developments. At most 20% follow the Inside-Out process, e.g the multiplication of own knowledge and competences to new markets or systematic out-licensing of patents. Only 44% of the international centered companies focus their attention on the commercialisation of their skills by other companies such as joint ventures or networks. The internet-based possibilities like solution platforms or crowdsourcing are used by scant companies. A cause for this could be the greater trust in known experts rather than in the ideas and solutions of an anonymous user base or the lack of knowledge about the costs and advantages. Therefore, the companies are loosing the potential of the „wisdom of crowds“ and they do not receive any ideas and suggestions from experts out of their suspected solution contributing industries. Such

cross-industry innovations have a huge potential and are supporting the development of radical innovation through the integration of technologies, knowledge or experts from other industries. The two most important motives for the companies that are practicing the activities of open innovation are either efficiency enhancement or growth through innovations. The efficiency enhancement particularly can be achieved with a shortening of the time from the product concept to the market, but also through cost saving and synergy effects. Growing through innovations happens mainly with conquering new markets and access to resources and knowledge. Both motive categories are evenly distributed, which suggest that it is possible to reach both with open innovation (Enkel, 2011).

The Study of Davide et al. (2011)

In Figure 2.9 we can see the dimensions of the theoretical framework which was designed by Davide Chiaroni, Vittorio Chiesa and Federice Frattini to explain the move form a closed to an open innovation paradigm by the mature industries in Italy. Furthermore, they especially focused on a leading cement manufacturer. It is a combination of different fields, first the open innovation approach is split up in two basic dimension - Outside-In and Inside-Out. The adaption process of open innovation is defined as an organisational change process, which can have three different steps towards a more opened up paradigm, namely un-freezing, moving and institutionalising. The third dimension consists of the managerial levers for open innovation.

Figure 2.9: Theoretical Framework



Source: Davide et al. (2011)

Those managerial levers can leverage the implementation of open innovation, the most important for this are (Davide et al., 2011):

- *Networks* are important because if a company is practicing open innovation it implies that the use of inter-organisational relationships is crucial to take external ideas from different source into the company and to expand internal ideas on the outside of the current business model. A firm should be able to manage different network groups, due to different purposes - on the one hand the Inside-Out and on the other the Outside-In process.
- *Organisational structures* have to be aligned to the application of externally acquired knowledge and technology but the right structure is also needed to develop internal ideas on external paths to the market.
- *Evaluation processes* have to be adapted because those which are developed for the traditional closed approach will not fit open innovation. Therefore, it is required to introduce new metrics, which cover more external sources and exploitation paths of innovations.
- *Knowledge management systems* are a critical factor for the introduction of an opened up innovation paradigm. The leveraging and exploitation of knowledge inside and outside of the firm is only possible if the company is able to trigger the diffusion, sharing and transfer of knowledge within the firm as well as between external partners. Such a system also includes an intellectual property management system.

The authors concluded that the implementing of open innovation is a challenge and requires a few changes in organisation and management system. In this study it was also shown that the firms first introduce an Outside-In approach and afterwards start with the Outside-In process. They try to access external resources to minimise the risks by investing technologies that are already sustainable in other markets. Furthermore, they focused strongly on the change management process of un-freezing, moving and institutionalising, where first it is necessary to establish the awareness. Then a champion has to promote the transition process and in the end the new process has to be used in the daily business, which is called institutionalising (Davide et al., 2011).

The Study of Rahman and Ramos (2013)
Also Hakikur Rahman and Isabel Ramos investigated small and medium scale enterprises because most of the other surveys only looked in detail on large companies - the behaviour of SMEs was not well-known. The responding 22 SMEs are located in Portugal and the main goal of this research was to find a focus area to empower SMEs through adaptation of open innovation strategies. To achieve this goal they tried to identify technology commercialisation barriers from which the companies are suffering, and categorise them. The emerged categories are (Rahman and Ramos, 2013):

- Human aspects

- General constraints
- Policy constraints
- Competition

The *human aspects* are crucial because companies can gain competitive advantage only by effectively managing daily business and at the same time creating innovations for tomorrow. To survive in the future the enterprises have to have a sustained management of innovations (Ashurst et al., 2012). Furthermore, the open innovation business models have to be updated regularly to fit into the dynamic and new realities. The study stated nine variables, whereby the major two challenges in this area, in terms of human aspects, are high wage level and scarcity of skilled manpower.

Specific challenges associated to SMEs are embraced in the *general category*. It includes misaligned consistency in the information about open innovation strategies. This leads to an unawareness among SMEs about the actual benefit of open innovation. One of the though obstacles is the incompetence in handling intricate knowledge resources which are needed to use the opened approach in the information era in a proper way. The author's defining of challenges, in terms of general constraints of open innovation, is about - just as with the human aspects - the lack of skilled manpower. But also due to the prevailing economic crisis the purchasing power of the customer on the demand side is low and problems in accessing supplying finance are an important issue (Rahman and Ramos, 2013).

The *policy challenges* have to deal with the managers who are often owners of the SME as well. These persons are different form the managers in large firms. The innovation policy has an important role in the affairs between neighborhood SMEs; those SMEs often cooperate in the sense of open innovation, just like Lead Users. This paradigm assumes that enterprises can and should use both external and internal ideas and paths to the market. Hence, it also assumes that internal ideas are taken to the market through external channels to new markets, so the open innovation model does not upset the traditional policymaking to legitimise policy interventions which are relevant for open innovation, such as spillovers, system failures and market failures. The difficulties for SMEs are the high costs to fund open innovation projects and activities which often exceed the financial capacity. Government regulations are major obstacles as well (Rahman and Ramos, 2013).

The last category is the *competition*, which investigates the factors that enable the enterprise to find premium acceptance in the market. At the moment globalisation and information and communication technologies evolve more and more, therefore, the companies have become much more competitive than before. Furthermore, the enterprises have to know the global market to be successful in the local market. Nowadays innovation is essential to keep up in the market, where transformation, globalisation and competition dominates. The most important activity to overcome the barriers, which are related to competition, is product differentiation. Small and medium enterprises also try to

establish a niche market which can be local or international. Furthermore, they try to shape strategic partnerships to tackle the challenges (Rahman and Ramos, 2013).

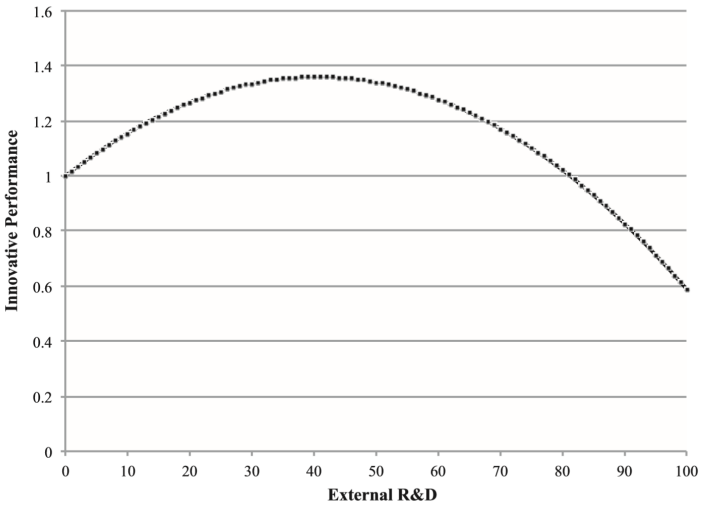
The Study of Chesbrough and Brunswicker (2013)
With *Managing Open Innovation in Large Firms* Henry Chesbrough and Sabine Brunswicker made, in 2013, the first large scale, quantitative survey, which is especially tailored to understand the adoption of open innovation in large enterprises. Furthermore, it investigates the inbound techniques as well as the outbound practices and the implication of monetary and non-monetary incentives on those approaches. They also measured the key performance indicators, which the companies are using to track open innovation. The most important key findings are (Chesbrough and Brunswicker, 2013):

- 78% of the firms in the sample are practicing open innovation activities
- No firm is abandoning open innovation
- In 71% of the cases the support from the top management for open innovation is increasing
- 82% of the companies are reporting that the practicing of open innovation today is more intensive as three years ago
- Outside-In methods of open innovation are more commonly applied than Inside-Out methods
- Customer co-creation, informal networking and university grants are the three most widespread Outside-In activities
- Joint ventures, selling market-ready products and standardisation are the three most widespread Inside-Out activities
- Customers, universities and suppliers are the three most common open innovation partners
- Companies tend to receive "freely revealed" information more likely than they are providing such information
- Open innovation is not much formalised and cultural norms are as important for open innovation as formal practices
- The biggest challenge is the change process from closed to open innovation

In the results we can see that open innovation is recognised by all firms but not all of them are practicing it. In addition, the top management has recognised the rise of open innovation and, therefore, it is strongly supporting it. The firms prefer the inflow of knowledge into their innovation portfolio, whereby the outbound activities play a minor part. They also exploit their ideas through new paths to the market. The major point why firms engage in open innovation is that they want to build new partnerships and explore new technological trends.

The Study of Berchicci (2013)
The data for the paper *Towards an open R&D system* origins from the Surveys of Italian Manufacturing Firms. Luca Berchicci introduced different variables to measure the openness of the R&D process. The first variable measures in percent in which extents the firms are engaged in external R&D activities. It reflects the ratio between in-house and outsourced projects. The second one tries to express the R&D capacity; it is calculated by dividing the number of employees working in the R&D department by the total number of employees in the company. The results have shown that firms with a larger R&D department are performing their R&D activities principally by themselves. However, the openness provides benefits and also costs. With a moderate level of external activities the firm is able to capture and utilise the knowledge flow and with this ability it is possible to improve the innovative performance. The findings suggest that the existence of a stock of knowledge strongly influences the firm's innovative output, as well as the engagement in outsourced R&D activities in a positive manner, but only until a certain point - beyond this the innovative performance decreases because the firms have to handle a great number of partners.

Figure 2.10: Relationship Between External R&D and Innovative Power



Source: Berchicci (2013)

The effective organisation of the process is an important challenge for their future activities because with the increase of the external sources also the searching, selection and coordination costs are increasing and this consumes a lot of organisational time. Those partnerships have to be formed and afterwards monitored, especially if there is a shared knowledge base and a common understanding of the tasks which are needed to be developed. It exhibits that the internal R&D capacity is necessary to balance the

external and the internal activities for a greater innovative outcome. The benefits and also the costs are varying between the different enterprises and, therefore, are influenced by the firm's ability to build its own stock of knowledge. Therefore, it is possible to summarise that the external R&D is complementary to the internal R&D, but only up to a specific point - afterwards it has a substitution effect (Berchicci, 2013).

The Study of Fitjar and Rodríguez-Pose (2013)
This paper from Rune Dahl Fitjar and Andrés Rodríguez-Pose examines the sources of firm product and process innovations in Norway and it analyses the role and source of knowledge based on the Science, Technology and Innovation (STI) and the Doing, Using and Interacting (DUI) mode. The STI view is that innovations are the result of investments in R&D, science, technology and the interaction knowledge producing centers, mainly research companies, universities, knowledge brokers and consultancies. Those institutions are generating a codified and explicit knowledge which can be adapted by a firm to develop a new product or service. The ability to adopt this knowledge is affected by human resources and on the level of training of employees. Whereby the DUI view is about the capacity of the employees and also the managers to develop solutions for existing problems and to react to changes and challenges in the market, which are dictated by suppliers, customers and competitors. It is not about improving the formal qualifications of the employees or to deploy resources into the R&D. Therefore, an innovation is the result of a combination of learning-by-doing and using the DUI mode. Such a process needs different informal interactions between the participants, regardless of whether they are inside or outside of the firm. This kind of relationship is normally within the supply chain and therefore it is likely that the partnership generates specialised innovations, whereby the DUI-mode, which is often outside of the supply chain, will leverage more diverse new ideas. Also in the Norwegian industry the firms main external partners are suppliers and customers. The DUI collaboration within the supply-chain has a positive and significant impact on innovation but there are huge differences between regional and non-regional partners. Normally, in the literature regional networks are more efficient, however in Norway non-regional suppliers and customers are strongly and significantly related with product and process innovations. An engagement with external agents is levering newer products than it would, if the firms would only relay on their own resources for innovations. Both STI- and DUI-modes of interactions are supporting an innovative atmosphere but in different extents (Fitjar and Rodríguez-Pose, 2013).

2.9 Hypotheses

Based on the literature review we are able to derive some hypotheses which we want to verify with the empirical investigation. Therefore, we should recapitulate the main research questions of the paper.

- To what extent are new open innovation models and -strategies already used by Austrian industrial companies?
- What are the main motives and expectations of the companies in the usage of opening up their innovation strategies?
- What are the barriers of which the Austrian industrial companies are suffering from by introducing new open innovation strategies?
- Are there structural differences (e.g. firm size, industry) in relation to the use of new open innovation strategies?

Those research questions will be addressed by a specially designed standardised empirical study. In addition we will test a number of hypotheses.

In chapter 2.8 we have seen that there is a huge and observable trend in many firms to implement open innovation approaches. Due to that open innovation projects are influenced by collaboration between different and also external partners in a positive and more successful manner (van der Meer, 2007). Another aspect is that external technology acquisation and external technology exploitation are must-haves rather than nice-to-haves because only in this way it is possible to keep up with the competitors (Lichtenthaler, 2008). So it is of importance which significance the new open innovation models have in Austria. In other countries most of the open innovation approaches were first used in high-technology industries. In a more mature state of those new innovation methods also companies in other industries than the high-technology were starting to implement some of those. The new innovation methods bear a huge support for the internal R&D department, but some of the industries beyond the high-technology are not adopting the outbound-oriented concepts in great extents (Chesbrough and Crowther, 2006). However, a cause could be that SMEs are sometimes lacking the ability to handle the intricate knowledge resources of the information era and the unawareness of the actual benefit of open innovation due to scant human resources (Rahman and Ramos, 2013). Therefore, we can formulate the first hypothesis about the high-tech and low-tech sectors.

Hypothesis 1 *Open innovation strategies are more often adopted in the Austrian high-tech sector than in the low-tech sector.*

Keeping on the forefront with market developments and constantly perceiving the customer demand are important catalysts to adapt an open innovation approach (van de Vrande et al., 2009), enabling enterprises to gain a competitive advantage and to defend or even extend their market position. Gassmann and Enkel wrote that open innovation has

become more and more important, due to the fact that the product life cycles are getting shorter and, therefore, the innovation cycles have to be shorter too. This means the cycle has to be completed in faster iterations each time. Furthermore, the development costs are increasing enormously (Gassmann and Enkel, 2004), whereby in another study, this motivational factor was identified as a second driver after the company's speed to market by the development of new products (Chesbrough and Crowther, 2006). Such speed increments can be achieved with open innovation practices because the internal R&D is supported with external knowledge and technology. Therefore, the companies are able to rely on already existing or partly developed solutions.

Hypothesis 2 *Reducing development time is the prime motivation for Austrian companies to use open innovation strategies in their development activities.*

The OECD Oslo Manual identified categories of hampering factors regarding the innovation process. Those factors have a negative impact on the innovation result as well as on the process. It even could be that due to the barriers the innovation activities are not initiated. The most important categories are the knowledge factors, institutional factors, cost factors and market factors (OECD Oslo Manual, 2005). SMEs as well as large firms are facing funding difficulties due to high innovation and commercialisation costs (Lee et al., 2010). This problem is a result of the prevailing economical crisis (Rahman and Ramos, 2013) and also intensified by it.

Hypothesis 3 *Expected high costs related to the implementation of open innovation strategies are considered as the main barrier by Austrian companies to adapt open innovation strategies.*

Research has shown that large and multinational enterprises are widely using the open innovation paradigm. More recent studies have concluded that small and medium-sized enterprises are practicing open innovation activities as well (Gassmann and Enkel, 2004; Lee et al., 2010; van de Vrande et al., 2009). Additionally, it is observable that their open innovation effort is increasing because this is relevant and present in every day business life. Large firms are more often commercialising their technology in an external way, whereby smaller and medium sized companies are more focusing on their own technology than they are exploiting it internally (Lichtenthaler, 2008), because they often do not have the capability to establish such a system and maintain the partnerships to utilize their technology externally. With the increasing number of employees the enterprises are more likely to implement open innovation and they are performing better in all degrees of openness (van de Vrande et al., 2009). Such an advantage results often of a more diverse organisation that can use several approaches. Therefore, each department is able to use the best suited method and additionally the company is capable of establishing a competence center. Due to this reason it would be interesting if there is a difference between SMEs and large companies in the Austrian industry.

Hypothesis 4 *Open innovation strategies are equally adopted by small and large sized enterprises.*

Open innovation is not an outsourcing process of the R&D activities. But there is an observable trend to spend more in internal R&D in companies that are using an open innovation process. This means the levering of external activities can be seen as a complement rather than as a substitute in the performance of the internal R&D department (Chesbrough and Crowther, 2006).

Hypothesis 5 *Austrian companies with a high R&D-rate are more engaged in open innovation strategies.*

Different researchers have identified that most of the companies using open innovation are focused on the Outside-In approach. This means that they are collecting knowledge from the company's environment, which then is leveraged by the internal R&D to add further value, for example to their products or services. But they do no offer/publish their internal knowledge, as well as they do not exploit new paths to markets or even new markets themselves, which both would be possible to be developed with the external knowledge/technology. Summarised we could say that the external technology commercialisation is not fully leveraged but it would have a great value if the firms were able to implement the second approach successfully as well (Gassmann and Enkel, 2006; Lichtenthaler and Ernst, 2007). We expect that Austrian companies are similar to those in other countries; therefore, we can formulate the following hypothesis.

Hypothesis 6 *Austrian industrial companies tend to use the Outside-In approach of open innovation more frequently than the Inside-Out approach.*

If the companies are not adopting an open innovation approach they are too focused on their internal excellence and, therefore, they are missing opportunities from the outside of the firm. First, external technology acquisition is used to gain access to external technologies, which can support or complement the already existing, hence, it enhances the internal knowledge base. With this new available knowledge the firm is able to extend its capabilities and/or to improve its products to provide additional value to the customers. Second, the external technology exploitation supports a sustainable growth by exploiting their assets by a third party. Therefore, the companies are protectively extending their internal knowledge with external sources to gain a competitive advantage which leads to a better performance in the end (Grant and Baden-Fuller, 2004; Hung and Chou, 2013; Laursen and Salter, 2006; Lichtenthaler, 2009). According to this we can conclude the following hypothesis.

Hypothesis 7 *The intensity of adopting open innovation strategies is positively associated with the performance of the company.*

Incremental innovations are important for the companies but at some point for those innovations the market and the demand will be saturated. This means that the companies need some radical innovations at that point. Inauen and Schenker-Wicki (2012) investigated how openness influences the degree of novelty. They found a statistically positive correlation between the openness of the Inside-Out process and the probability of

a higher radical innovation performance (Inauen and Schenker-Wicki, 2012). The radical innovation competencies can be enhanced by open innovation methods, because if they are using an more open approach they are able to use recency from externals as well as from internal departments. Not only the identification of novelties are leveraged, also the commercialisation phase is supported by open innovation, meaning that missing competencies can be reduced very fast with the help of market and technology partners. In the end the lifecycle of radical innovations can be shortened (O'Connor, 2006). Therefore, we conduct the following hypothesis about open innovation and radical innovations.

Hypothesis 8 *Companies using open innovation strategies are tending to develop more radical innovations than those, who do not use open innovation strategies at all.*

3 Methodology

The methodology, in relation to conducting the empirical study, consists of different steps. First, based on the research questions some hypotheses are derived. Those hypotheses are more specific and, therefore, have a deeper insight than the research questions and can be verified. For the verification process of the hypotheses, where a hypothesis is either supported or rejected, we also need some data to analyse and to perform the test. Data about how the state of the art, according to the adaption of open innovation, is across the whole Austrian industry, is acquired by an empirical survey, which is based on similar, previous literature, which we have discussed in the previous section. However, so far this literature has not yet considered the Austrian industry in much detail. The empirical survey will be a standardised survey, which ensures that the questions are always provided in the same order and with the exact same wording. Hence, also a benchmark and comparisons between the answers are possible. The conducted survey provides an empirical data basis to address the research questions through the hypotheses which are analysed with statistical tools. The statistical analysis tries to reveal and screen phenomenas in terms of correlations and numerical characteristics in the data to provide an objective view on the observed reality. The major aim of the quantitative research is the verification of hypotheses according to existing theories. In this method the population is known and a basis to deduct likelihood assertions of different variables. Furthermore, there is a strict distinction between the data ascertainment and the data evaluation. The sample size has to be a representative selection, as well as an appropriate number (Müller, 2008).

3.1 Design of the Survey

The survey is designed to address the above mentioned questions with respect to the recently published literature on open innovation. The main topics of the questionnaire are first the obstacles, which the companies are facing by the improvement and development of new products and services, second the Inside-Out approach and how the companies are realising this strategy and third the questioning of the Outside-In method. Additionally, it is interesting why the companies are opening up the innovation process and what the barriers at doing so are and if the participating firms can think of any solutions to those barriers. Some questions are dealing with the degree of novelty and the firm's performance, like the OECD Oslo Manual (2005) questions. Most of the questions are providing an answer possibility on a scale from not relevant (1) to very relevant (5). Due to that scale it is possible to perform statistically significant tests. The standardised empirical survey is conducted as an online-survey on the platform *LimeService*[1] where

[1] For more details see: `https://www.limeservice.com`.

the companies got an invitation to participate. Through this invitation it is possible to secure that each company only participates once, otherwise the outcome would be biased. Since we try to investigate the Austrian industry and the official language of Austria is German, the questionnaire is also written in German. The questionnaire consists of several parts. First the challenges that the companies are associating and experiencing with the adoption of open innovation. The second part aims to obtain the diffusion of different internal as well as external sources that are inquired in an own section. Nowadays lots of firms are seeking and implementing new commercialisation strategies, thus this aspect is also a major part in the questionnaire. For an empirical quantification of the motives and barriers of the new open innovation strategies those interesting aspects are addressed in an additional part. For the evaluation several performance issues were polled. In appendix A the standardised questionnaire can be found for further investigations.

To come up with a sample of the Austria industry various companies were addressed. Various sources were used to acquire the contact details of different firms - for example the *Plattform für Innovationsmanagement*[2], participation lists of conferences and an already existing list, which was used in an earlier study to assess the effects and implications of the *Staatspreis Innovation* on companies (Leitner et al., 2014). Due to the used sources most of the companies are innovation oriented, which means that they are already interested in this topic or even exercise it and additionally they are located in the manufacturing industry. Furthermore, the companies are contacted regardless of the size, which means that in the sample large as well as small firms are occurring. In addition the enterprises are from all branches and thus this study is not limited to a specific branch because all branches are addressed. Those company-lists were expanded with the contact details of a specific employee[3] - mainly persons who are in the innovation field, for instance head of research and development, innovation manager,... Those contact persons were identified with the help of different sources, for example corporate websites, social network platforms and commercial register. Thus, companies which have hardly any or no innovation activities were not contacted. Therefore, the sample has a disposedness towards more innovating firms and it has to be interpreted with caution.

Altogether, 928 Austrian companies from all regions and industries were invited via email in the end of October 2014. The only restriction that was considered was that the company's size - the interest only lay with firms with approximately at least ten employees. If there was no response a reminder email was sent after some time to motivate them to take part. In December we still were not satisfied with the response rate and so we started to call some of the contact persons, who had not yet filled out the survey. One month later we had 95 responses, which is equivalent to a return rate of 10,24%. We closed the online-survey after about three months in the beginning of January. In the following we are going to analyse the resulting sample.

[2] `http://www.pfi.or.at`

[3] Each company was represented by a single employee, who has filled out the questionnaire. Therefore the specific background of those people can have an influence on their answers.

3.2 Statistical Methods

To analyse the data and test the hypotheses the following statistical methods are used. Moreover, those are briefly described in terms of the purpose of the method and the preconditions which have to be fulfilled. Generally the significance level can be chosen subjectively because the significance level is used to determine if the null hypothesis is rejected. If the significance level is chosen lower more of the data has to be different from the null hypothesis. According to Backhaus et al. (2011) commonly used levels are either $\alpha = 5\%$ or $\alpha = 1\%$, this implies that p=0.05 or p=0.01, in which 0.05 is designated as significant and 0.01 as very significant. Furthermore, the values which are smaller than 0.1 are marginal significant. For the analysis of data and test of hypotheses the following methods are used:

Correlation Analysis

By the calculation of the correlation the undirected relationship of two variables can be examined. Those variables have to be interval scales to gain a statistically valid information. The correlation analysis is used if no statement about the assumed direction of the relation can be made. The non-directional connection is therefore accepted because none of the variables can be determined as an independent or dependent variable. Since there are two variables it is also called a bivariate relationship. A correlation can be tested either one or two sided; if the relationship is assumed as non-directed the two sided analysis should be used. For the determination of the strength of the relationship a correlation coefficient by Pearson and Bravais is calculated (Field, 2009).

Variance Analysis

The variance analysis identifies the effect of a single nominal factor on an interval variable. This is done by comparing the mean values of the resulting groups of the dependent variable by separating them into the different categories of the independent variable. The dependent variable should not only be on an interval-scale but it also should be normally distributed. Requirements of the variance analysis are that the random sample is independent and that the measurements in each group are normal distributed. The variances of the underlying data have to be homoscedasticity, otherwise the normal variance analysis can not be executed, due to the assumption of homoscedasticity. Therefore, a generalised test should be used, which does not rely on the assumption of homoscedasticity. If homoscedasticity is violated it is called heteroscedasticity, which means that the error values are differing across the independent variable. The Levene test is able to proof if this prerequisite is violated by assessing the equality of variances based on the mean. Another approach is the Brown–Forsythe test, which uses the median instead of the mean (Field, 2009).

Chi-squared

With a χ^2-test frequencies analysis can be performed with any scale level of the variables. This test has different application areas, which can be distinguished to one- and two-dimensional chi-squared tests. In the first, as the name already suggests, only one variable is necessary. It is possible to do an examination if the data is normal distributed, for example for the variance analysis or for the expected frequency of the distribution. On the other hand the two dimensional test is an one dimensional test, which is extended with an additional categorical peculiarity, whose result can be analysed in a cross table. Furthermore, a test on independence of two characteristics can be investigated, enabling a statement as to whether the two observed features are stochastically related in any form (Rasch et al., 2006).

Regression

For the identification of systematical relations and their either positive or negative impacts we need to apply a regression analysis. Three different questions can be addressed with the help of a regression analysis, namely the cause analysis, which identifies how strong the influence of the independent variable on the dependent variable is. The impact prediction shows how the dependent variables change if the independent variable alters and the last one is the time series analysis, where the change of the dependent variable over time and thus ceteris paribus in the future can be seen (Backhaus et al., 2011). Such an analysis is possible if all dependent variables have a metrical scale and the independent variables are either continuous or categorical. Furthermore, also some model-premises have to be satisfied; the following issues are violating the premises (Berchicci, 2013):

(a) non-linearity,

(b) heteroscedasticity and

(c) autocorrelation.

Above we already have discussed heteroscedasticity and non-linearity is obvious. The residuals are autocorrelated, if the residuals are so highly correlated among each other, that independence of errors appears. This can be tested with a Durbin-Watson statistic, which can have values between 0 and 4, whereby zero is an entirely positive autocorrelation, two is no autocorrelation at all and four is an entirely negative autocorrelation (Berchicci, 2013).

Logit-regression

In contrast to the above stated regression analysis the logistic regression does not need any distribution assumptions and as the name already insists, it is based on a logistic dependency and not a linear relationship between the independent variables and

the dependent variables. The regression equation determines the relative probabilities with which a certain event occurs, with respect to one or more independent variables, whereby those variables can have any scale level but the dependent variables have to be from the nominal type. In each group there should be at least 25 observations (Backhaus et al., 2011).

3.3 Description of the Variables

Several variables are derived from the questionnaire to analyse the hypotheses. The most important variable, *Extent of open innovation*, is dealing with the innovation approach which measures the level of openness of the firm. In the literature there are different possibilities to measure the open innovation strategy of a company. On the one hand it is possible to use a breadth-ness approach, in that case the firms are getting a higher valuation, if they are using several distinct approaches because of that it is called breadth-ness approach. On the other hand the depth-ness approach considers a company as open if it is using one or more specific open innovation activities in a comprehensive manner (Greco et al., 2015). In this paper the first approach, namely the breadth-ness approach, is used to gain a holistic view through the different kinds of open innovation activities. Hence, companies with a more diversified approach are rated more opened-up. To achieve a holistic view on the phenomenon of open innovation the two main dimensions of the opening up of the innovation process are integrated into the open innovation variable, whereby those different dimensions are separated questions in the questionnaire. Also at the extraction of a single variable out of the answer possibilities there are different options used in the literature. First, it is done by calculating an overall mean of the factors to measure the level of openness within the organisation (Lazzarotti et al., 2010). Another common approach is to calculate the sum to consider multiple variables within one factor (Lichtenthaler, 2008). In this paper both measures are used and they lead to the exact same results, due to the fact that they only differ in the absolute scale, hence they both have an interval scale with a different factor.

Furthermore, also the variables *Extent of Outside-In* as well as the variable *Extent of Inside-Out* are derived in the same way, in terms of breadth-ness and in calculating the mean of the factors to measure the different approaches. The considered factors for the Outside-In approach can be seen in the appendix at question two. The Inside-Out factors are listed in question four, but not all of those are used, namely the adoption of the business model is not included in the calculation. Due to the underlying Likert-questionnaire, with the answer options from one to five, also the already described condensed variables are within the same interval. The *Employees* variable reflects the number of employees of the company. It is a metric scale and the value often corresponds to the state of last year.

Different categorical variables (see Table 3.1) are used to analyse the sample and to compare the sub-groups. The variable *Number of employees* depends on the number of employees and it has three distinct categories. Variable *Age* is obvious - as the name

already indicates it reflects the age and the establishment date of the firms. The sectors are categorised based on the NACE definition of the OECD and used in the statistical analysis as the variable *Industry*.

Also the *R&D-rate* is self-describing, whereby this value is directly questioned. This mean that the participants directly entered their values. For the *Barriers* and the *Motives* several possibilities were stated and to each single one the participants were able to express their consents on a five point Likert-scale. In the end, the answers to the variables *Barriers* and *Motives* are aggregated with the mean. Further, also the *Performance* variable is an aggregated value of the *Sales*, *Profits* and *Change of employees* that are questioned directly.

The eight categorical variables at the end of the Table 3.1 are dummy-variables to indicated whether the participant is part of this subgroup or not. If we consider the *Open innovation* variable, it is stated that the company is either using it or do not us it. The categorical variables of *Open innovation*, *Outside-In* and *Inside-Out*, are derived based on the corresponding extent variable (extent of open innovation, extent of Outside-In and extent of Inside-Out). The categorical variable is true (1) if the extent variable indicates an above average usage of these methods. *Radical innovations* were inquired directly in question eight.

Table 3.1: Overview of the Variables

Variable	*Type*	*Values*
Extent of open innovation	interval	Value on a scale from 1 (low) to 5 (high)
Extent of Outside-In	interval	Value on a scale from 1 (low) to 5 (high)
Extent of Inside-Out	interval	Value on a scale from 1 (low) to 5 (high)
Employees	interval	Absolute amount of employees between 10 and 16000
Number of employees	categorical	1 = 10 until 49 employees 2 = 50 until 499 employees 3 = 500 and more employees
Age	categorical	1 = old 2 = medium-old 3 = medium-young 4 = young

Table 3.1 – continued from previous page		
Variable	*Type*	*Values*
Industry	categorical	1 = High-technology 2 = Medium-high technology 3 = Medium-low and low-technology 4 = Production-related services
R&D-rate	interval	Ratio of the R&D expenditures on a scale from 0 to 100
Barriers	interval	Value on a scale from 1 (low) to 5 (high)
Motives	interval	Value on a scale from 1 (low) to 5 (high)
Performance	interval	Value on a scale from 1 (low) to 5 (high)
Sales	interval	Value on a scale from 1 (low) to 5 (high)
Profits	interval	Value on a scale from 1 (low) to 5 (high)
Change of employees number	interval	Value on a scale from 1 (low) to 5 (high)
Open innovation	categorical	1 = Open 0 = All others
Outside-In	categorical	1 = Using Outside-In methods 0 = All others
Inside-Out	categorical	1 = Using Inside-Out methods 0 = All others
Radical innovations	categorical	1 = Developed recently radical innovations 0 = No recent radical innovation
High-technology	categorical	1 = High-tech 0 = All others
Medium-high technology	categorical	1 = Medium-high-tech 0 = All others
Medium-low and low-technology	categorical	1 = Medium-low and low-tech 0 = All others

Table 3.1 – continued from previous page		
Variable	*Type*	*Values*
Production-related services	categorical	1 = Production-related services 0 = All others

Source: illustration created by the author

3.4 Characteristics of the Sample

As already mentioned 95 companies have filled out the questionnaire. This means that we finally have a sample of Austrian companies. To ensure that it is really a representative sample of the Austrian companies landscape we classify based on different criteria. We have three criteria, namely size, industry and age.
The size criteria is based on how many employees the company employed in 2014. There we have three distinct categories, which are adapted to the Austrian characteristics:

- 10 until 49 employees
- 50 until 499 employees
- 500 and more employees

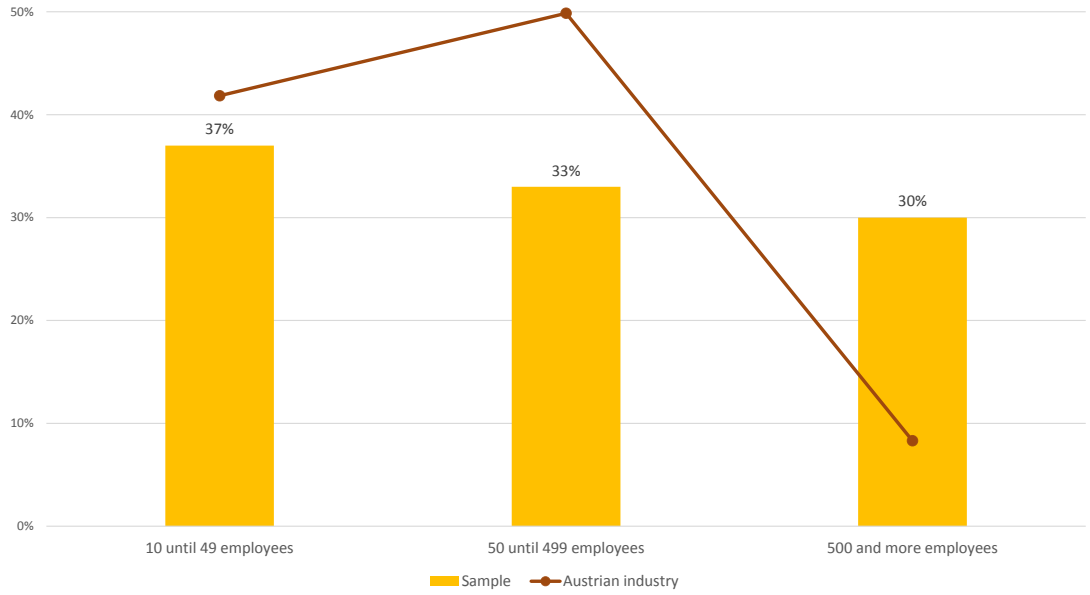
The industry classification is derived form the Statistical Classification of Economic Activities in the European Community - also referred to as NACE - from the Organisation for Economic Co-operation and Development (OECD). We are using the current revision status NACE rev. 2, where the manufacturing industry can be aggregated according to technological intensity into manufacturing industries and production-related services. Whereat manufacturing industries are moreover subdivided into *high-technology*, *medium-high-technology*, *medium-low-technology* and *low-technology*. The production-related services are often knowledge intense and split in two distinct sectors, namely *knowledge-intensive services (KIS)* and *less knowledge-intensive services (LKIS)* (OECD, 2009).

3.4.1 Analysis of the Company Sizes

In Figure 3.1 we can see that we have more small and medium sized participants than large enterprises, but it is still nearly an equal distribution between the different categories. This means that we have participants of all sizes, based on the employees, and we are able to use this classification in the statistical analysis. Hence, we are able to perform evaluations, if we can identify differences between those classes. The Austrian industry consist of around 8,000 companies in the field of industrial production and industry-oriented services. The variety of companies reach from small and medium enterprises to international groups, operating with headquarters in Austria. In their recent report

the WKO[4] investigated the size of the companies, based on how many employees they have. It revealed that the small and medium sized enterprises are a major pillar in the Austrian economy because together they constitute 92% of all industrial companies in Austria (compare Figure 3.1). All together it is obvious that the first category, 10 until 49 employees, is very similar to the real occurrence of this company-size. Contrary, in the 50 until 499 employees size-class there are lesser participants if we compare it to the reality and in the area of large enterprises are to much participants because in the Austrian sector of industry 8% of the firms are larger than 500 employees (WKO, 2015). This means that the medium sized firms are under-represented and the large companies are over-represented. Hence, to sum it up, the results should be interpreted carefully because of this differences.

Figure 3.1: Comparison of the Distribution of the Employment Size



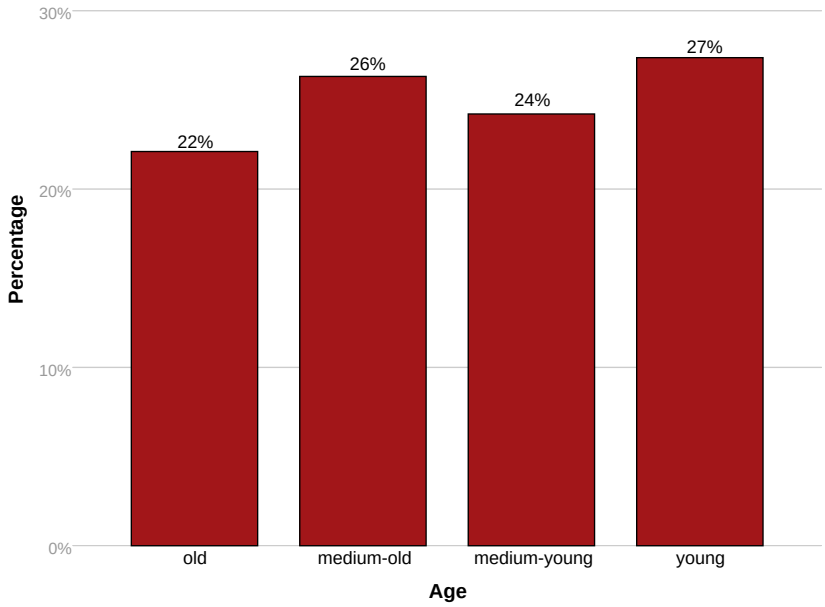
Source: illustration created by the author

[4] Wirtschaftskammer Österreich

3.4.2 Analysis of the Company Age

The participants have a broad range of establishment years; the first was founded in 1831 and the most recent in 2013. The overall average is 1965 with a standard deviation of 43.84 years. For the later analysis we categorised the participants based on their age, whereby we created four classes for this purpose. The companies which were founded after 2000 are classified as *young*, those between 2000 and 1985 are *medium-young*. *Old* are the enterprises with an establishment year before 1950 and if they are founded between 1985 and 1950 we call them *medium-old*. The establishment classification (see Figure 3.2) is well suited for a statistical analysis, due to the fact that there are enough companies in each class.

Figure 3.2: Age Classes Distribution

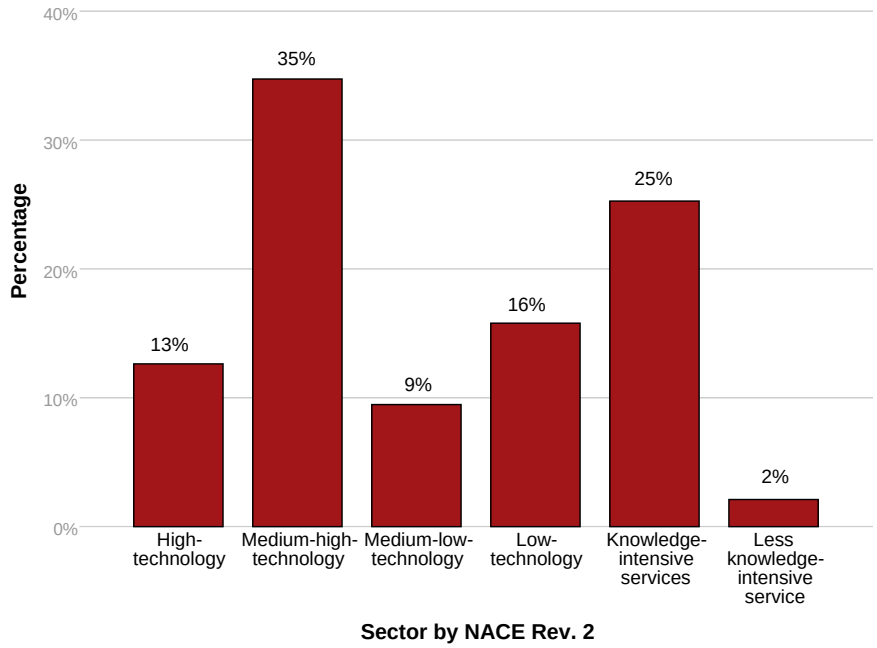


Source: illustration created by the author

3.4.3 Analysis of the Industries

Now we are going to analyse the companies based on their industries, for this purpose we have organised them in categories, as already mentioned in the introduction, based on the NACE definition of the OECD (2009). This definition provides a very fine level of granularity, but on the other hand it also provides a possibility on how to aggregate the manufacturing industry according to their technological intensity. Additional in this classification the production-related services are distinguished into their knowledge intensity. In Figure 3.3 we have the branch distribution, where we can see that we have an excessive inequality between the different categories. With this inequality it is not possible to state statistically founded statements.

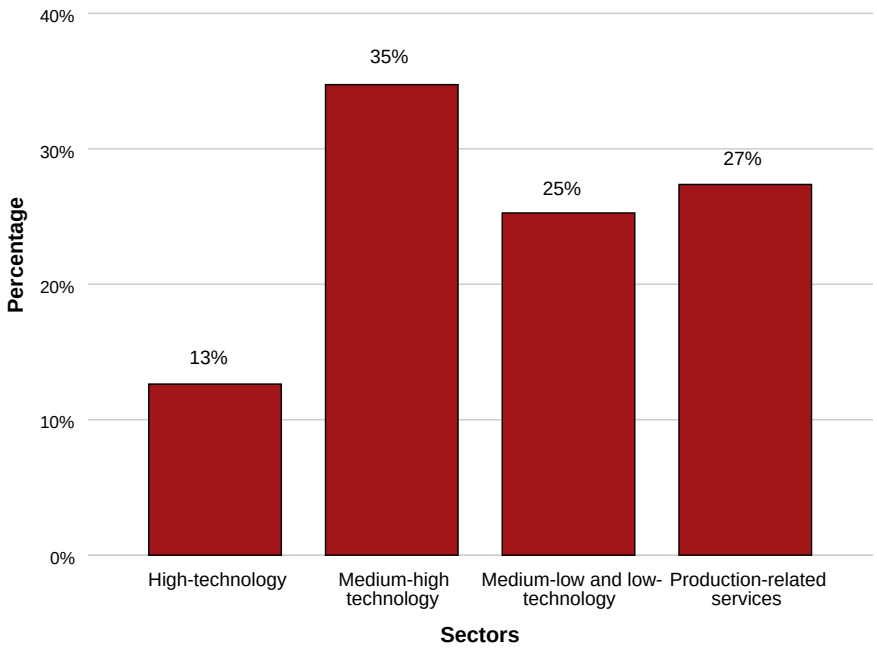
Figure 3.3: Distribution of the Industries



Source: illustration created by the author

For a better statistical comparability of the categories Medium-low and Low-technology are aggregated as well as the Knowledge-intensive and Less Knowledge-intensive classes. Through this the distribution of the branches looks as it is shown in Figure 3.4. In the High-technology category are 13% of the participants. In comparison with the other classes in the Medium-high technology are most of the questioned companies, namely 35%. In the aggregated class Medium-low and Low-technology 25% and in the Production-related service category 27% of the surveyed companies are situated.

Figure 3.4: Distribution of the Industries for Analysis



Source: illustration created by the author

3.5 Non-response analysis

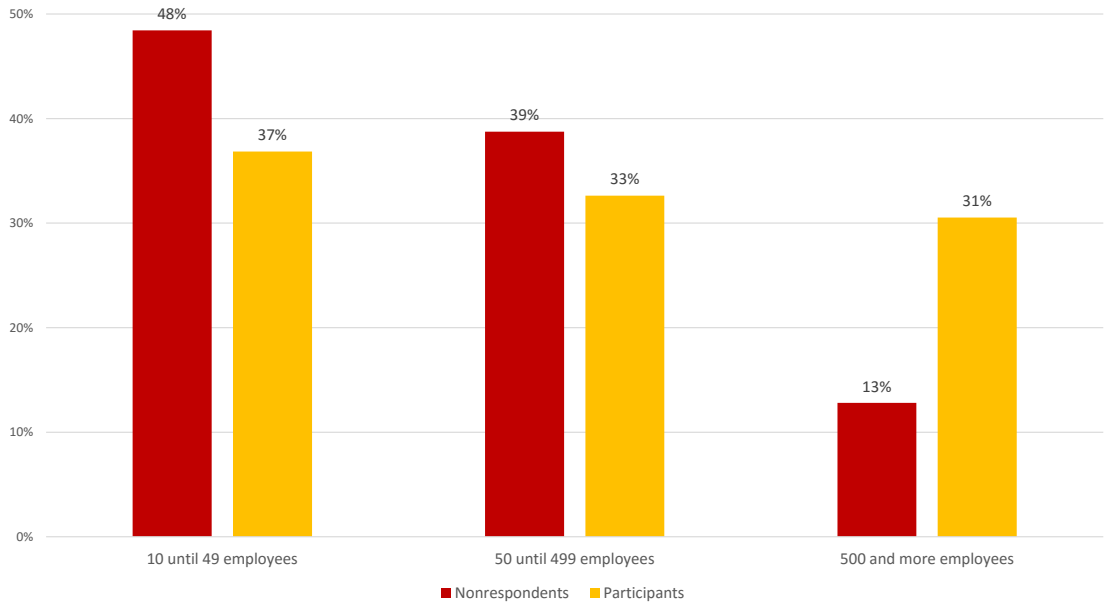
In this section the nonresponse issue is addressed because it is possible that the respondents may not represent the actuality of the whole sample or population. Therefore, it is of interest if the 95 participants are representing the 928 companies that were invited to the standardised questionnaire. Why did these reply, whereas the others did not? Is it possible to derive or find some differences between the distinct groups? Did only large enterprises with a huge manpower response - given that they have special public relation departments? To address the threat to external validity, different main strategies are discussed in the literature (Lindner et al., 2001; Miller and Smith, 1983).

The first used method to investigate the nonresponse is a comparison of the early to late respondents. This can be done with the extrapolation method, which means that late responds are more similar to nonrespondents than early responses (Armstrong and Overton, 1977). Although there is no formal definition of a late respondent Armstrong and Overton proposed that late respondents are participants that took part after the last stimulus. The late responses should be at least 30 participants to have statistical power and to be meaningful - if after the last stimulus the number is too small it is possible to combine the last two stimuli. Considering our sample 35 late respondents have successfully finished the questionnaire after the last reminder. Those are compared to 31 early

responses that are directly stated after the initial invitation. The comparison is made between the early and late participants on the primary variables and a t-test reveals, that in the most important variables no statistical difference between the two groups is present.

The second strategy is to compare specific characteristics of the respondents' to the nonrespondents' characteristics. If the nonrespondents do not statistically differ, then it is possible to generalise the results to the sample and population. For this sample the characteristics that can be compared are industry and the size of the companies in terms of employees. The characteristic size was already previously compared to the Austrian industry, which is the whole population; now additionally a comparison between the participants and the nonrespondents is conducted. This analysis is checked with a chi-squared test, which this test is significant and, therefore, means that the respondents and the nonrespondents with respect to the company's size differ (compare Figure 3.5).

Figure 3.5: Comparison of the Size of Nonrespondents & Respondents



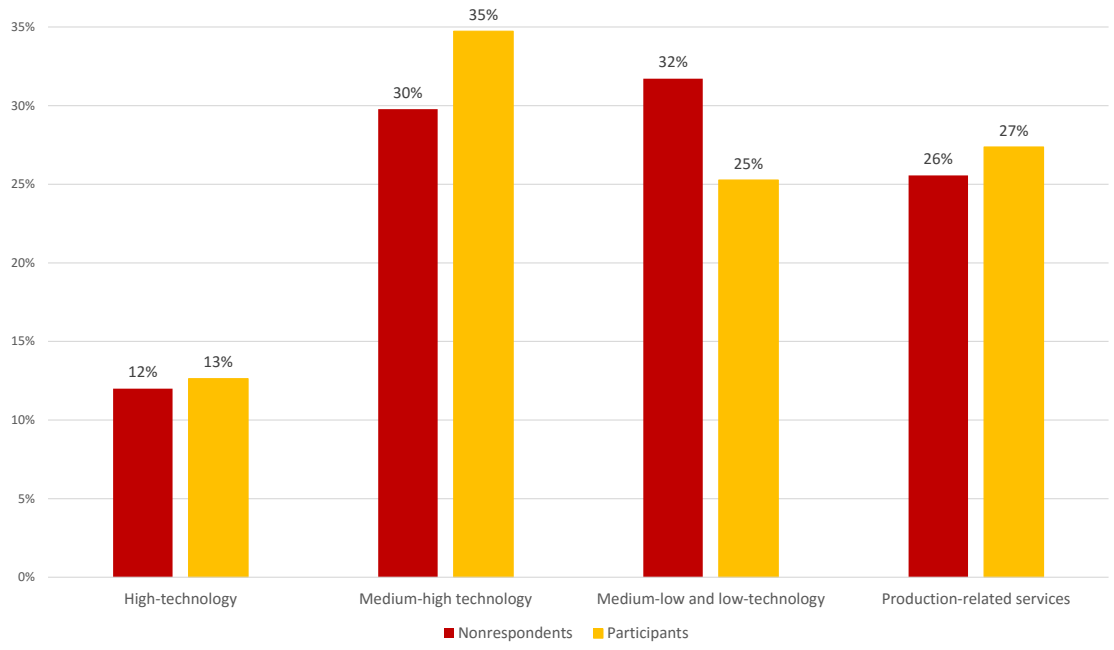
Source: illustration created by the author

The prior figure showed the differences of the respondents and the nonrespondents, whereby it is obvious that the small sized enterprises have the biggest share of addressed companies but on the other hand the amount of answers in this cluster is only slightly above average. The opposite extreme can be observed with the large enterprises because only 13% of the addressed companies are large ones but in the respondents this category captured 31% of the participants. Different factors are leveraging this inequality -

firstly, smaller firms have often a scare budget as well as manpower, therefore, they may focus on their business activities instead of participating in surveys. Secondly, the large companies have established public relation and marketing departments to engage with the society and in other activities. In the course of this survey the special interest for large companies was their curiosity about open innovation, especially on how they can further improve their innovation processes. However, small companies often do not have a codified innovation process, but still are often innovation oriented because they are based on a new product or because they are integrating the innovativeness into their daily business activities.

In Figure 3.6 the distribution of the nonrespondents and the respondents are compared considering their industry. We can see that the share of High-technology- and Production-related service participants are nearly the same in both categories, whereby in the Medium-high technology the respondents rate is higher than the nonrespondents rate and in the Medium-low and low-technology category it is the other way around, meaning that in this category the share of participants is smaller than the share of the nonrespondents.

Figure 3.6: Comparison of the Industry of Nonrespondents & Respondents



Source: illustration created by the author

To investigate the differences and to test if they are statistically significant a chi-squared test was used to compare the distribution of the participants with the nonrespondents distribution. Hence, in the test the known distribution of the participants is used as the observed N and the distribution of the nonrespondents is the basis for the expected N. All in all the chi-squared test results in a value of 7.719 and a p-value of 0.052, thus it is not significant and the null hypothesis can not be rejected. The drawn conclusion is that the observed frequencies of the participants in the industries as well as the expected frequencies of the nonrespondents are not statistically different. The result of this chi-squared test can be found in another representation in Table 3.2. The additional performed variance analysis had a not significant test of homogeneity of variances with a p-value of 0.572. The variance itself is not statistically significant (p-value of 0.835) as well. Therefore, this result is aligned with the chi-squared test, thus the attribute forms a basis for generalisation, because the respondents are not different from the nonrespondents. Nevertheless, according to the previously described size characteristic no generalisation is possible.

Table 3.2: Chi-squared Test Nonrespondents & Respondents by Industry

	Industry
Chi-square	7.719
df	3
Asymp. Sig.	0.052

Source: illustration created by the author

4 Empirical Results of the Survey

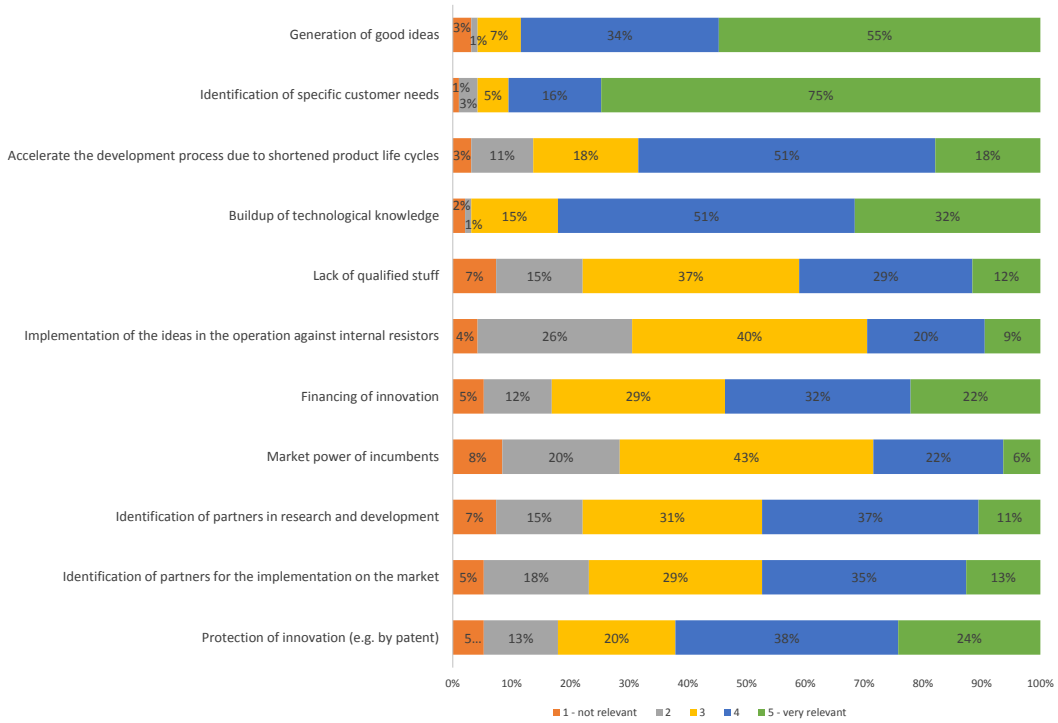
Now that we have investigated the basic structure of the sample, it is possible to first conduct a descriptive analysis and later on a more sophisticated one. Hence, the descriptive analysis reveals what is more important for the Austrian companies and what does not really matter. Afterwards the implications and relations between the different answer opinions are identified as well as the different characteristics of the companies, which are already identified in the previous chapter. The hypotheses are checked subsequently after the descriptive part in ascending order. In section 4.8 the correlations and interaction effects between the characteristics and the answers are investigated, so that we can also test the more complex relations. All investigations were supported by tools; the descriptive as well as the statistical analysis is conducted with IBM SPSS Statistics[1] and Microsoft Excel.

4.1 General Innovation Challenges

The first survey question addressed the general challenges which the companies are facing in their innovation process. They do not necessarily have a direct relation to an open innovation strategy. Most of the companies considered the identification of specific customer needs as a main challenge. 91% say that this is relevant or rather very relevant (four or five on a five point likert scale), 5% are indifferent (three out of five point scale) and only 4% stated that this is not relevant (two or one on a five point scale). There are no significant differences between the various industries. However, the identification of customer needs is at the medium-low and low-technology sector not as important as at the others. Nevertheless, compared with other obstacles it is still considered as the most important challenge. Also compared to the size of the companies there are no real differences but still with an increased size also the identification of the customer behavior is increasing. Hence, smaller firms are more flexible and have a better ability to dwell on the customers and to recognise specific customer needs. Further relevant challenges are internal problems like generating good ideas and to build up a technological knowledge (see Figure 4.1). Improvement of the understanding of the customers can be achieved through open innovation, therefore, it is to be kept in mind for later analysis. On the other end of the scale, the not relevant challenges for the participants were the market power of incumbents and the implementation of the ideas in the operation against internal resistors.

[1] Detailed information about SPSS can be found at: `www.ibm.com/software/at/analytics/spss/`.

Figure 4.1: General Challenges for the Innovation Process



Note: How relevant are the following challenges for your company in your optimisation and development of new products and services? N=95.
Source: illustration created by the author

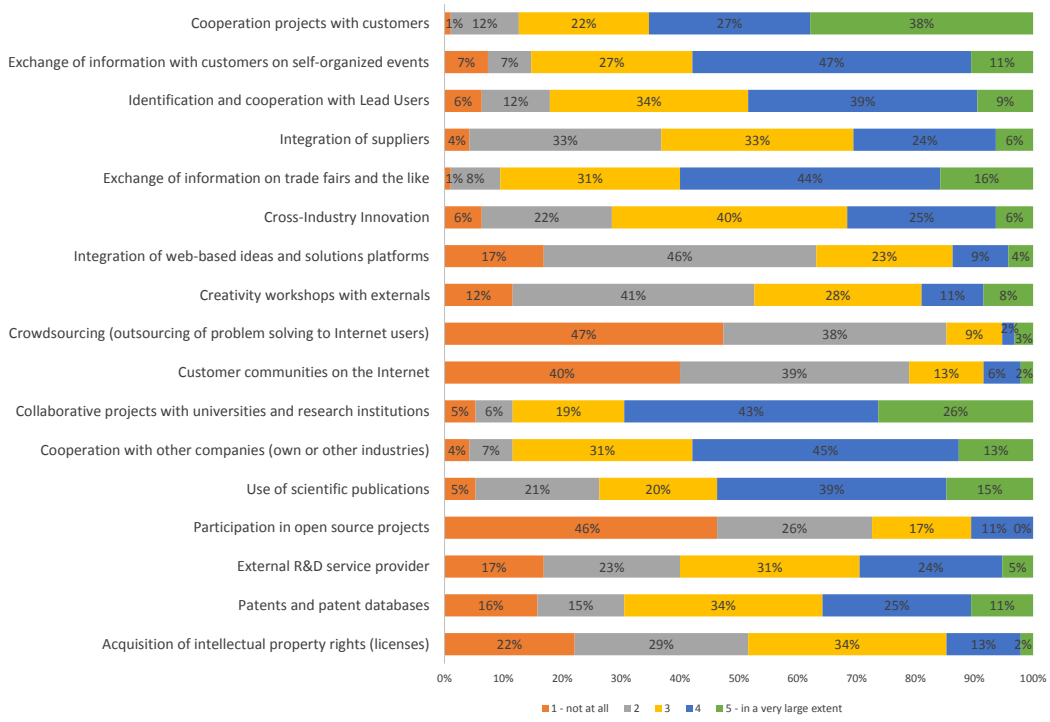
Hölzl and Janger (2014) investigated the innovation barriers at firm level in a cross country study in Europe. According to them, financial and skill barriers are most often indicated and are followed by technology and market barriers. This is somehow in line with the findings of this study, because the relevant barrier generation of good ideas can be seen as a part of the skill barrier and obviously building up technological knowledge is within the technology barriers and the identification of specific customer need is a mix of market barriers and also a skill issue. Furthermore, Hölzl and Janger (2014) reported that small enterprises are more likely to perceive innovation barriers as more important than large companies, thus the size of the company has a negative effect on the perception of innovation barriers. In the Austrian sample those insights can be assessed as not true, due to the results of a chi-squared test and a variance analysis, which showed that the companies, independently of their size, are considering the innovation barriers as relevant in the same extent.

4.2 Use of External Sources

The main external sources of the Austrian companies to get access to external knowledge are cooperation projects with customers and also with universities and research institutions, in which the mean on a scale from one to five for the customer projects is 3.89, respectively 3.79 for university and research institution projects. Here the approach of the companies to address the general problems, especially the obstacle to identify the needs of the customers, is revealed - they try to get a deeper understanding of their customers by operating cooperation projects with them. Therefore, the customers are involved in their projects and can provide valuable feedback and stimuli. To gain additional stimuli the Austrian companies are also collaborating with universities and research institutions to be on the knowledge frontier. Due to this they can create and/or anticipate new trends and developments on which they can pro-actively respond. By the early recognition they are enabled to create new customer desires for which they have the perfect suited solution and are able to build up a technological knowledge at an early stage. On the other hand Figure 4.2 demonstrates that customer communities on the Internet, participation in open source projects and crowdsourcing are not very important for the companies at the moment. This could be because of the novelty of those techniques and because only a few companies, which are mainly large enterprises, have already established such systems. Most of the firms that are using customer communities are reporting a benefit which exceeds the overhead in managing and setting-up such a system. Therefore, it is very likely that in the near future more and more companies are going to establish their own community. Some surveyed companies also responded, that they additionally are using Internet recherches for specialised suppliers and service providers, books and conference participations.

The study of Enkel (2011) revealed similar usages of external sources for the Outside-In process of open innovation. This study also used a five point likert scale, on which the integration of customers and suppliers achieved an average usage of 3.9, whereby 70% of the companies were using this approach in greater extents, also the lead user integration had an above average usage with a value of 3.2 and for 45.9% of the companies this approach was very important. Additionally also Chesbrough and Brunswicker (2013) identified that customer and consumer co-creation is the most important Outside-In practice for the companies. On the other hand those studies are in line with the previous findings, that crowdsourcing and innovation communities do not have such a high pervasion as the aforementioned methods. Expressed in numbers this means, that 19% of the companies have an increased usage of crowdsourcing and innovation communities. The average of this practice on a seven point likert scale is 2.64 (Chesbrough and Brunswicker, 2013).

Figure 4.2: External Sources for the Innovation Process

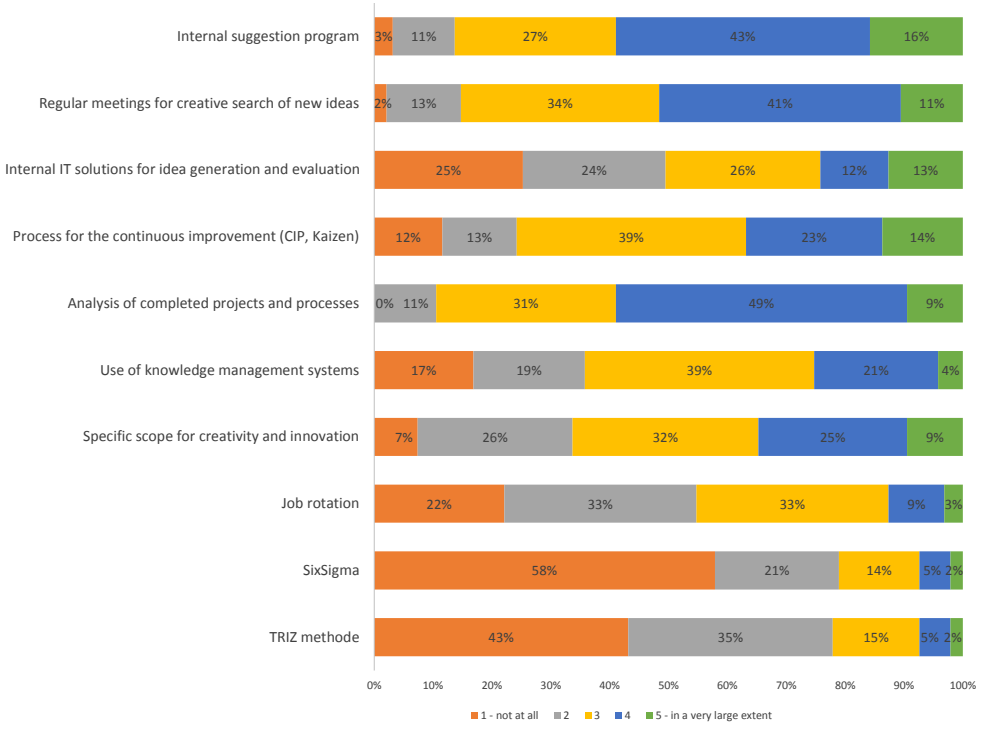


Note: Which of the following activities do you use to access external sources of knowledge? To what extent do you make use of them? N=95.
Source: illustration created by the author

4.3 Use of Internal Sources

For a better understanding of the origins that are leveraging the Inside-Out approach, we have also questioned the participants which internal sources they are using. Analysis of completed projects and processes, internal suggestion program and regular meetings for creative search of new ideas are the most used internal sources to gather informations. More than 50% of the firms have declared that this sources are used in a large extent or in a very large extent for their knowledge gathering.
Whereby also more than 50% have answered that they are not at all or not really using job rotation, the TRIZ method or SixSigma to acquire and hold the internal knowledge (see Figure 4.3). The pervasiveness of regular meetings for creative search of new ideas and the internal suggestion programs indicate that in most of the Austrian companies an

Figure 4.3: Internal Sources for Knowledge Acquisition



Note: Which of the following activities do you use to access internal sources of knowledge? To what extent do you make use of them? N=95.
Source: illustration created by the author

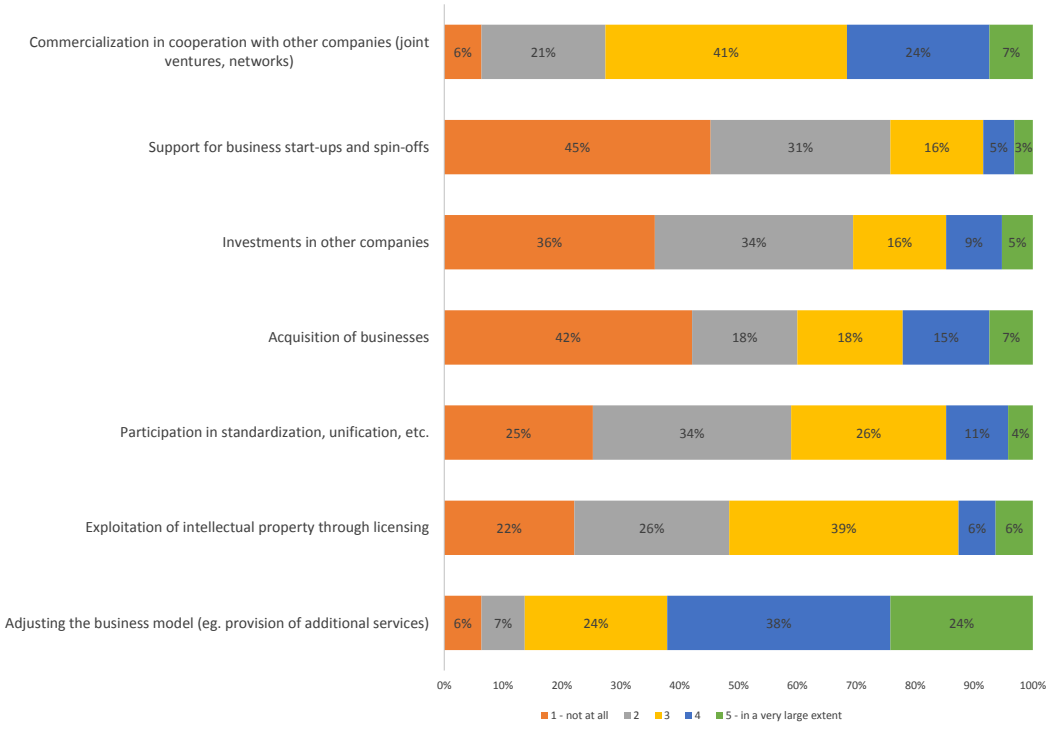
innovation friendly culture is already part of the daily business. This innovation friendly culture promotes the generation of innovations by providing the possibilities for everyone to participate in the development of new or improved products and services. Furthermore, the firms have recognised that their internal knowledge sources are very valuable. This means that their employees, which they are able to gain access to without a big deal, are a very important source of improvements and new ideas. By the utilisation of this source the organisations are able to improve their innovativeness. All other answer options are more or less recognised as neutral, which means three on a scale from one to five. Some participants also mentioned other sources like six thinking hats and exchange of experiences.

4.4 New Commercialisation Strategies

Another survey question addressed the new possibilities and paths for commercialisation. The adjustment of the business model is recognised as the most promising possibility. 62% are using this method (five or four points on a five point likert scale), 13% do not use it at all (one or two points on a five point scale) and 24% are indifferent (three out of five points). The purpose to adapt the business model is to create a competitive and profitable company in the long term because without a suitable business model the firms are not able to deliver or to capture the value from their innovations. Such a reorientation of an organisation makes it more efficient and has positive impacts on the cost structures. There are radical and incremental adjustments of the existing business model. An incremental change is a slight improvement and the value capture is similar as before. In contrast to that a radical adjustment of the business model is often triggered by a radical innovation and, therefore, often provides new approaches on how the firm is going to the market and creates customer value. This provides differentiable competitive advantage. Furthermore, also commercialisation in cooperation with other companies is considered relevant - this fits to the observed external sources (Figure 4.2), where we have seen that collaborative and cooperation projects with external partners, for example other companies, universities or research institutions are commonly used. A joint venture would also be a commercialisation in cooperation. The main motives to get engaged in a joint venture are the usage and access to the knowledge of the partner enterprise and the possibility to share the business risks. The combination of the strength of the partner and also the own strength of the firm leverage the realisation of synergy effects in a joint venture. The least popular untraditional strategies of commercialisation are investments in other companies and support for business start-ups and spin-offs. They are not used by a broad range of Austrian companies.

In other studies the adjustment of the business model is not identified as such an important method for the companies (Chesbrough and Brunswicker, 2013; Enkel, 2011), because 19.6% of the companies are using it and the average usage is only 2.2 out of five; but the commercialization with other companies especially in form of joint ventures was considered as relevant, too. Joint ventures have an average value of 3.2 and 46% of the companies are increasingly relying on it. In general the aforementioned studies, as well as the present study, show that in average the Outside-In methods are more important than the Inside-Out practices due to the fact that the Outside-In methods have an overall average score of 2.93 and the Inside-Out of 2.55.

Figure 4.4: Non Traditional Commercialisation Strategies



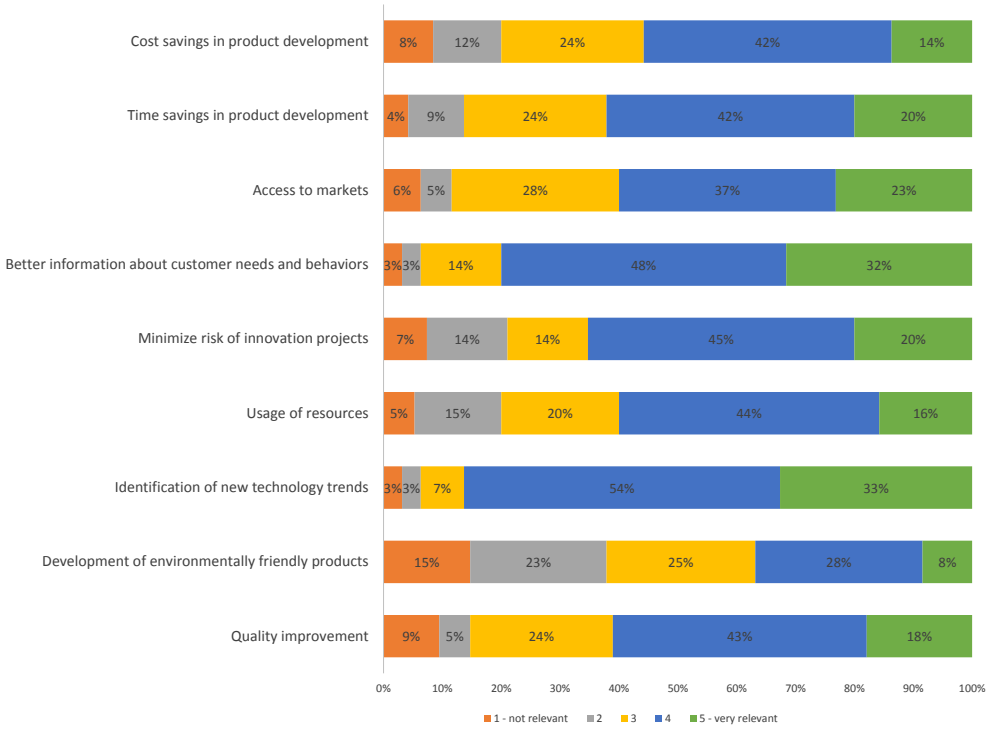
Note: Which of the following activities do you use for the commercialisation of your own ideas beside the classical ones? To what extent do you make use of them? N=95.
Source: illustration created by the author

4.5 Motives

With this question we have a direct relation to open innovation due to the closer look on the motives of why companies are willing to open up their innovation process. The motives can be distinguished in two distinct categories, namely efficiency oriented and innovation oriented. Hence, time saving is efficiency oriented and the identification of new technology trends is innovation oriented. The resource oriented motives are playing a less important role in the opening up of the innovation processes than the innovation oriented and are, therefore, the prime causes. This can be seen in Figure 4.5 because the identification of new technology trends is for 87% of the companies relevant (four or more points on a five point scale). But also the better information about customer needs and behavior lies not far behind (80%). This directly corresponds to the general challenges of innovation, which were asked in question one (Figure 4.1). It relates not only to those but also to the external sources; therefore, we can see that the companies

know about their problem in the development of their products. They are aware that they can address their major problems with the opening up of their innovation process, hence, they try to adjust in the right manner and are conscious about the solution. Previously, we have already discussed how to better understand the customer needs and behaviors, however, with an opening up towards the customers and more involvement of them in the development process they are more engaged and support the company by the development of the right products for the customers. Also the resource oriented motives are relevant, although they are not as relevant as those which were discussed already. Most of them can be addressed within a joint venture because this minimises/shares the risks with the partners, utilises the resources in a more efficient way and provides a more advanced access to the market.

Figure 4.5: Motives for the Opening of the Innovation Process



Note: What are the main motives for the opening of the innovation process for your company? N=95.
Source: illustration created by the author

Different motivational factors for the introduction of open innovation are discussed in the literature, on the one hand Enkel (2011) identified that efficiency oriented catalysts are distributed in almost the same manner as the innovation oriented motives and thus show that open innovation can support both aspects. On the other hand the findings of van de Vrande et al. (2009) are even more similar to those that are described above the figure, because the most important motives are market-related issues, which are enabling the companies to stay on the forefront of market developments and to address the customer demand and in the end the new innovation methods are hopefully providing an increased market share and better financial results.

4.6 Barriers

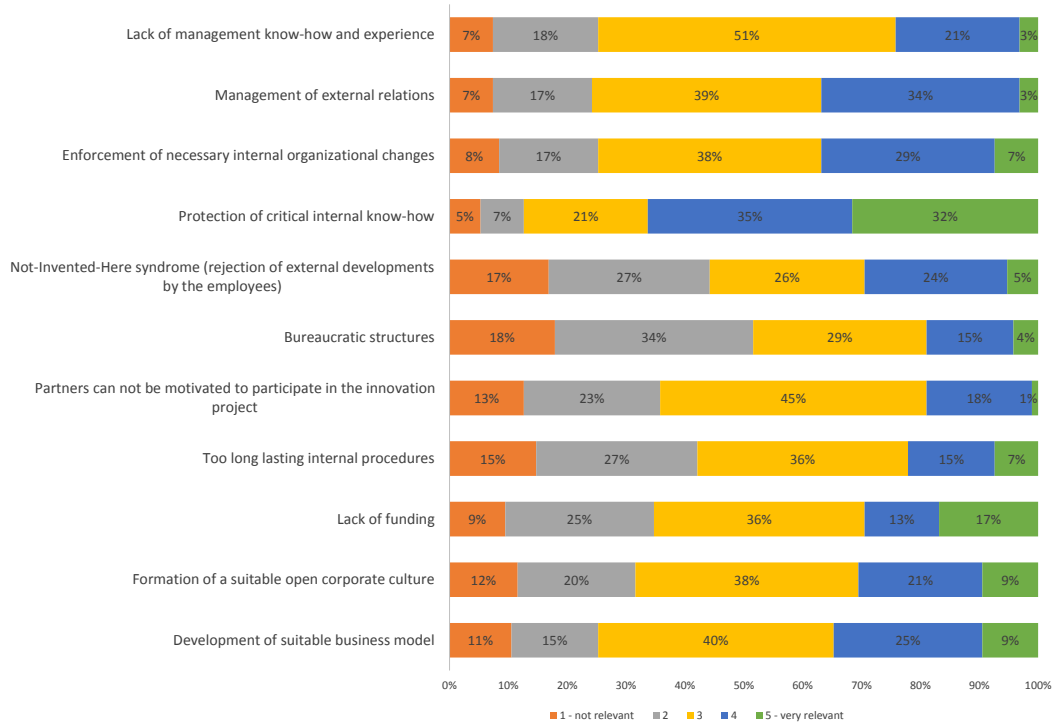
Companies, which are opening up their innovation process or at least thinking about it, are concerned that through this step critical internal know-how could drain out. 67% said that this is a relevant or a very relevant barrier (four or more points on a five point scale) for them, 21% are indifferent (three points on a five point scale) and 12% state that the protection of critical internal know-how is not a relevant barrier (two or less points on a five point scale). Know-how is often tacit knowledge, which is the opposite of explicit knowledge, so it is often closely held information which can be unpatented inventions, skills or expertise. The know-how is often not protected by any legal documents due to which it is often a secret matter and normally provides some competitive advantages.

To overcome the inefficient formal protections the companies should use more alternative methods. If they are opening up the innovation process and are too keen in ownership, they are losing partners as well as the opportunities to successfully utilise new products and services (Dahlander and Gann, 2010; Laursen and Salter, 2006). More barriers for the introduction of new innovation models can be found in Figure 4.6.

If a distinction between companies' sizes is made, some statistically significant differences are revealed. Firstly, large enterprises with more than 500 employees have problems in forming a corresponding open corporate culture and also long lasting internal procedures have a significantly higher mean value. Secondly, small companies indicated that the lack of financial resources is their main barrier at opening up their innovation process.

Similar results have also been identified by Chesbrough and Brunswicker (2013), whereby their most important challenge of engaging in open innovation is the managing of organisational changes with an average value of 5.26 out of 7 points and the handling of intellectual property protection is a huge problem. Both of those major challenges are also considered relevant by the Austrian companies; contrary also the barriers that are not that often mentioned but are still relevant for some companies are analogical to those, that other inquiries have found. This means that time and resources are not the most important barriers to implement open innovation strategies (van de Vrande et al., 2009).

Figure 4.6: Barriers at the Implementation of Open Innovation

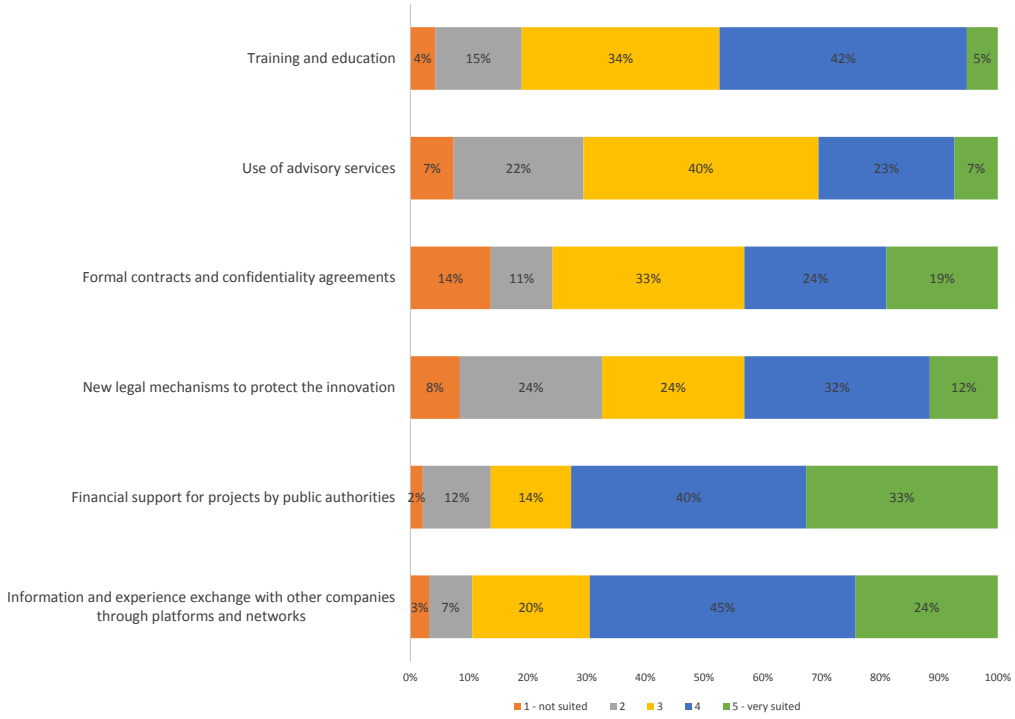


Note: How important are the following barriers at the implementation of open innovation strategies in your company? n=95.
Source: illustration created by the author

4.7 Overcoming Barriers for Open Innovation

One question was in charge of interrogating if there are any possibilities or solutions to overcome the barriers, which we have discussed in the previous section above and of which the companies are suffering at the implementation of open innovation. 73% of the companies were in unison that financial support for projects by public authorities could help overcome the barriers. For 69% the solution to this problem would be information and experience exchange with other companies through platforms and networks. This solution has a clear link to the most referred barrier, namely the protection of critical internal know-how. Due to the information and experience exchange the companies are able to learn from each other and can identify benchmarks. Furthermore, they are able to excerpt their weakness as well as their strength and gain information how they are retaining their know-how. The other support possibility, which is the financial support by public authorities, does not have a direct relation to the previously mentioned general

Figure 4.7: Overcoming the Open Innovation Barriers



Note: How suitable are the following possibilities to overcome the aforementioned barriers? n=95.
Source: illustration created by the author

obstacles, but is especially relevant for the small and medium sized enterprises as above mentioned, because they are hindered from establishing an open innovation process by the lack of funding. Such a support would enable the small and medium sized enterprises to engage with new innovation models. Furthermore, it could encourage the Austrian companies in general to get more involved in a more opened up innovation, since the firms would be able to take some risks because they would be partly absorbed by the support. Therefore, this solution provides some incentives for the firms to transform their innovation process towards an approach, which considers the open innovation strategy in greater extents.

4.8 Testing of the Hypotheses

To achieve a comprehensive view on the phenomenon of open innovation the two main dimensions of the opening up of the innovation process are integrated into the open innovation variable. It is done by calculating an overall mean of the factors to measure the level of openness within the organisation (Lazzarotti et al., 2010). An other common approach is to calculate the sum to consider multiple variables within one factor (Lichtenthaler, 2008). Both measures lead to the exact same results, due to the fact that they only differ in the absolute scale, hence, they both have an interval scale with a different factor (see also Chapter 3.3).

Hypothesis 1 *Open innovation strategies are more often adopted in the Austrian high-tech sector than in the low-tech sector.*

To perform a one-way variance analysis, as already mentioned, we first have to meet some prerequisites. The first requirement is that each group has a normal distribution. This means, in our sample, the groups are the different sectors which are normally distributed. Furthermore, we have to evaluate if heteroscedasticity is present; this is evaluated with the Levene test. The p-value of this test is 0.049, meaning it is significant (<0.05). Therefore, we have to apply a variance analysis with robust tests of equality of means or even use a Kruskal-Wallis test. This test is an alternative to the variance analysis if the homoscedasticity precondition is violated. On the one hand the robust test of Brown-Forsythe has a significance of 0.458 and on the other hand also the parameter-free Kruskal-Wallis test results in a p-value of 0.366. Both do not really differ from the basic variance analysis of the extend of open innovation in the different sectors. In all three tests the p-value is not statistically significant.

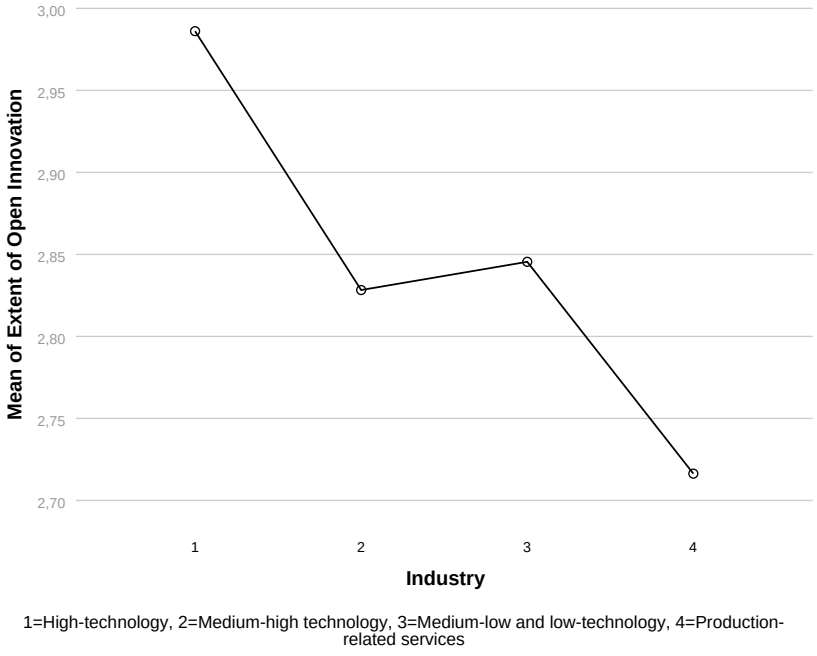
This hypothesis has to be refuted because there is no statistical significant difference between the high-tech sector and the low-tech sector. In other words we can conclude that, regardless of the sector, open innovation is in the same extent applied in Austria. For some additional insights a post-hoc method is applied - those methods are revealing if some means of either pairwise or subgroup comparison differ significantly form each other. Here the Scheffé's method is used, which considers the estimates of all groups of the factor level means and doesn't only - like the Turkey-test does - perform a pairwise consideration. A multiple comparison by the different sectors is performed with the Scheffé-test and clearly states that not only overall but also between each of the industries there is no significant difference. Those results can be found in Table 4.1. The different mean values from the table are also visually represented in Figure 4.8.

Table 4.1: Extent of Open Innovation Approaches by Different Industries

Sector	*Mean*
High-technology	2.99
Medium-high technology	2.83
Medium-low and low-technology	2.85
Production-related services	2.72
Total	2.82
F-value = 0.854 (sig.-level = 0.468)	

Source: illustration created by the author

Figure 4.8: Extent of Open Innovation by Sectors



Source: illustration created by the author

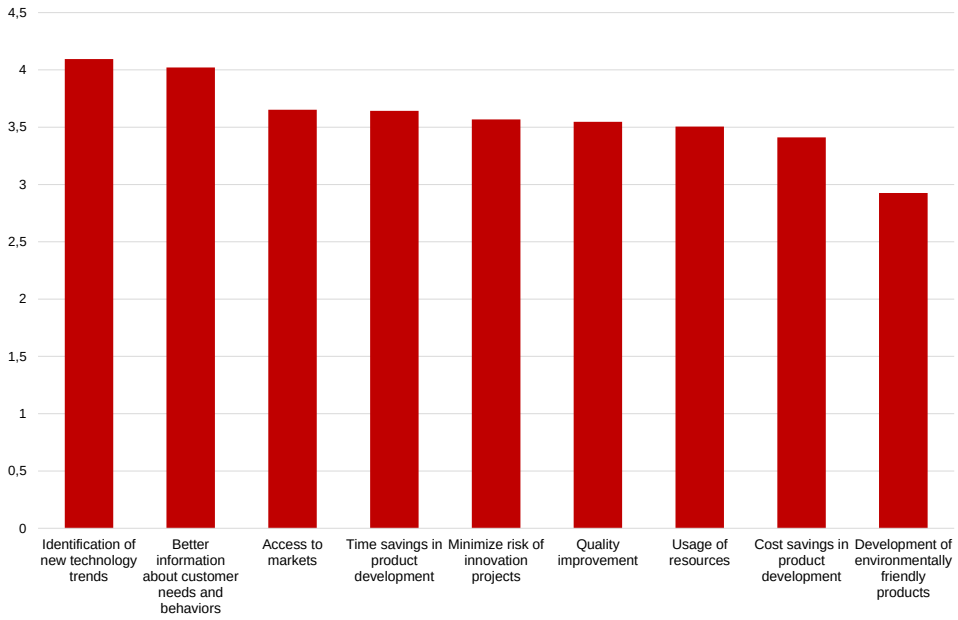
Hypothesis 2 *Reducing development time is the prime motivation for Austrian companies to use open innovation strategies in their development activities.*

Hypothesis 2 states that reducing development time is the prime motivation for Austrian companies to use open innovation in their development activities. Figures 4.9 represent the means of the different motivational factors. It is obvious that most of those motivations are relevant for the companies; except the motivation for the development of environmentally friendly products. The most important motivations to use open innovation are improved identification of new technology trends, with a mean of 4.09, and better information about customer needs and behaviour, with a mean of 4.02; access to markets has a mean value of 3.65 and time savings in product development has achieved a mean of 3.64 on a scale from one to five. Based on these results the next hypothesis can be answered.

This hypothesis has to be rejected because in the Austrian industry the prime motivations to use open innovation are innovation oriented and not that much resource oriented as expected. Although the time saving aspect is rather on the forefront with a mean value of 3.6. So this finding is very similar to those which Enkel (2011) identified in Germany and those of van de Vrande et al. (2009), which have identified that the firms prime motivations are to keep track with the market developments and the customer demand, making the organisation able to eventually increase their growth by increased market share or better financial results.

An additionally performed Kolmogorov-Smirnov test (KS) on the mean values which assumes a uniform distribution, results in a p-value of 0.379. Due to the fact that the KS-test investigates a deviation from a uniform distribution and because our p-value is not within the significance level ($p>0.05$) it is possible to conclude that the mean values do not statistically differ from a uniform distribution and, therefore, the values are not really differing. Considering this result of the KS-test it can be assumed that Hypothesis 2 does neither have to be statistically accepted nor rejected, although the mean analysis insists on this.

Figure 4.9: Comparison of the Mean Values of the Motivation Factors



Source: illustration created by the author

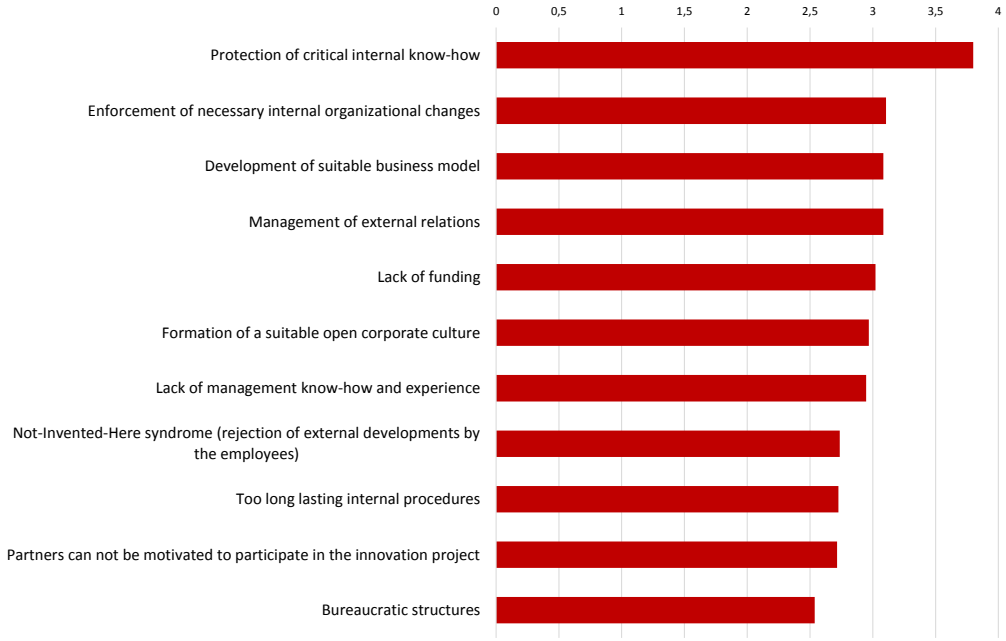
Hypothesis 3 *Expected high costs related to the implementation of open innovation strategies are considered as the main barrier by Austrian companies to adapt open innovation strategies.*

In Figure 4.10 the mean values of the barriers, related to the implementation of open innovation strategies, are shown. The protection of critical internal know-how is by far the most important barrier, with a mean value of 3.8 on a scale from one to five. Other problems, which are hindering the firms at the implementation of open innovation, are the enforcement of internal organisational changes (mean is 3.1) and the development of a suitable business model ex aequo with management of external relations, with a mean value of 3.08.

The assumption that the expected high costs related to the implementation of open innovation strategies are considered as the main barrier by Austrian companies can not be proofed because in the evaluation it is visible that the knowledge barrier is much more relevant. The Kolmogorov-Smirnov test of the mean values of the barriers indicates a statistical significance, with a p-value of 0.019, meaning that the variable is not uniformly distributed. The funding issue can be found somewhere in the middle and based on the test it is statistically less important than the most denoted barrier, namely the protection

of critical internal know-how and, therefore, Hypothesis 3 can not be confirmed.

Figure 4.10: Comparison of the Mean Values of the Barriers



Source: illustration created by the author

Hypothesis 4 *Open innovation strategies are equally adopted by small and large sized enterprises.*

The verification of the fourth hypothesis is again done with a variance analysis. The Levene test with the p-value of 0.896 states that homoscedasticity is given and the variance analysis can be performed. It shows that there are no variance disparities in the different size-clusters of the companies. The variance analysis points out that no differences between the various size-categories are given; the result is: $F(2,92)=0.611$, $p=0.545$.

This hypothesis can be accepted, due to the lack of statistical significant difference between small and large sized enterprises. Hence, all Austrian companies are adopting open innovation in the same scope, irrespective of their size. In the Scheffé-test a multiple comparison of the extent of open innovation, clustered by the number of employees, reveals no statistically significance between any of the compared combinations. Each size-group is compared with the other two. This corresponds to the Table 4.2, where the

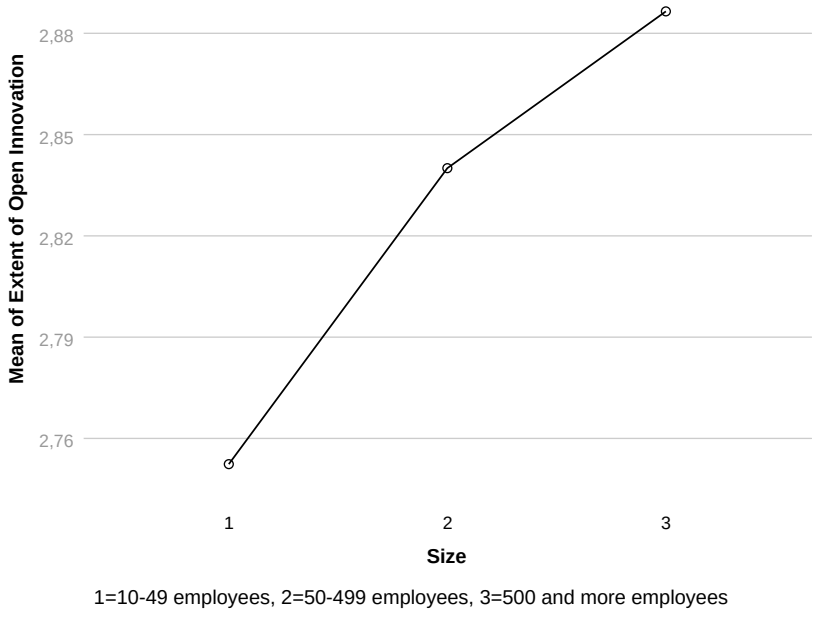
means of the different size categories are given. The slight differences between the means of the different categories can be seen in Figure 4.11.

Table 4.2: Extent of Open Innovation in Relation to the Number of Employees

Number of employees	*Mean*
10-49 employees	2.75
50-499 employees	2.84
500 and more employees	2.89
Total	2.83
F-value = 0.611 (sig.-level = 0.545)	

Source: illustration created by the author

Figure 4.11: Means of the Extent of Open Innovation by the Number of Employees



Source: illustration created by the author

Hypothesis 5 *Austrian companies with a high R&D-rate are more engaged in open innovation strategies.*

To identify the implication of the R&D-rate in the extent of open innovation a regression analysis with the sector and the number of employees is conducted. In this regression model as well as in some of the following models a linear regression is used, although some of the factors are based on the likert scale and therefore an ordinal regression should be used. However, in the literature likert measures are normally treated as normal metric values. In addition the results of the linear models were compared to the ordinal models, which showed, that there are no significant discrepancies and so it is possible to use the linear regression models without doubts. Whether non-linearity is given can be easily seen in a digram; in our data linearity is given. Heteroscedasticity was already described above and is not present in the model. The given data has a Durbin-Watson value of 1.802 - as this value is almost two, we can assume that we do not have any autocorrelation.

However, all three prerequisites are satisfied, so we can perform the regression analysis, in which the R=0.293 and R^2=0.086. The influence of the R&D-rate on the open innovation variable is only 0.004 and the significance is 0.078. This means that we have to reject the null hypothesis which states that there is no systematic correlation between the dependent and the independent variables.

The openness in terms of open innovation is marginal significant, dependent on the R&D-rate. All Austrian companies are depending of their R&D-rate, applying open innovation in their product and service development. Due to the β-value of 0.004 the R&D-rate's impact on the extent of open innovation is positive. This means the higher the R&D-rate is, the higher the usage of open innovation is. Nonetheless, there is no statistical significance of the control variables because the independent factors of the industry have a p-value between 0.931 and 0.131 and the size in terms of employees has a p-value of 0.108 (compare Table 4.3).

Table 4.3: Determinants of the Extent of Open Innovation

Dependent variable	Extent of open innovation		
	B-value	*t*	*Sig.*
R&D-rate	0.004	1.784	0.078
High-technology	0.111	0.672	0.503
Medium-low and low-technology	0.011	0.087	0.931
Production-related services	-0.212	-1.522	0.131
Employees	3.24E-5	1.623	0.108
F-value = 1.672 (sig.-level = 0.150)[a]			
R^2-value = 0.086			

[a] Bedeian and Mossholder, 1994 showed that a statistically significant overall model is not necessary to interpret a significant element within the model
Source: illustration created by the author

Hypothesis 6 *Austrian industrial companies tend to use the Outside-In approach of open innovation more frequently than the Inside-Out approach.*

For the determination of whether Outside-In or Inside-Out is more common in Austria a cross-tabulation comparison and a chi-squared test is needed, which help to determine this hypotheses. The null hypothesis of this test states that both approaches have the same pervasion in Austria, meaning that they are used equally. Due to obvious reasons we do not have to consider the part of the cross table where the companies are using both the Outside-In and Inside-Out approach. The interesting part is that when the firms are using one of the two approaches it is, based on this real occurrence, possible to compare it with the estimated respectively predicted distribution of our null hypothesis. The critical value of a chi-squared distribution with one degree of freedom is 3.841; based on the cross-table we obtain a value of 1.00 and, therefore, the null hypothesis can not be rejected. Summed up, based on the occurrence of both approaches there is no statistical evidence that the two approaches are used in different extents. Additionally a comparison of the extent of Outside-In and Inside-Out is performed. For such an analysis of the distributions a t-test is needed. This test shows that the Outside-In approach has a higher mean with a value of 2.87 compared to the Inside-Out approach with a mean of 2.46. The Levene test of variancehomogenity is highly statistical with a p-value smaller than 0.01, therefore, the variancehomogenity can not be assumed and a Welch-test instead of the t-test is used. This test leads to a highly significant result because the significance (2-tailed) value is 0.000, thus this value is less than 0.01. Due to this, the usage of the Outside-In approach finds a more general approval than the Inside-Out approach. Hence, the Austrian industrial companies are using the Outside-In methods of open innovation in significantly greater extents than the Inside-Out methods.

Furthermore, the sample showed that about 26% of the Austrian companies are using the Outside-In approach, which enables them to collect knowledge and technology form the outside of the firm's boundaries. In the survey we considered some important Outside-In related practices, namely customer and supplier involvement, cross industry innovation, crowdsourcing and customer communities and external R&D.

On the other hand the Inside-Out approach is used by 21% of the Austria firms, enabling the companies to better utilise their internal knowledge by using new paths to the market. The fostering of business start-ups and spin-offs, licensing and internal support and management of idea generation are methods for this practice. This result does not consider the Coupled Process as an independent, which, when existing, is contained in both approaches because it is defined as the combination of an Outside-In and an Inside-Out approach. However, the Outside-In approach is used slightly more often in Austria and the analysis has shown that the extent of Outside-In is statistically significant higher than the extent of Inside-Out, therefore, this hypothesis is true.

Several large and international firms are using the Outside-In approach more often than the Inside-Out. Some source of this unequal usage could be that Outside-In activities do not bear such a great risk of losing the possibility to utilise the created solutions or the draining-out of important internal knowledge (Schroll and Mild, 2011; Chesbrough and Crowther, 2006). Some of those barriers are already identified previously in this paper (see chapter 4.6) and thus, due to the awareness, the companies are able to steer against those obstacles in the future and utilise the whole bandwidth of open innovation by adopting all approaches.

Hypothesis 7 *The intensity of adopting open innovation strategies is positively associated with the performance of the company.*

For the assessing of the companies' performances in diverse industries, Kariv (2008) suggested to analyse their sales over time on a five point scale. This approach is also used in this paper, however the performance variable is additionally extended with the development of the profits and employees. In Table 4.4 a correlations matrix can be found. Some important variables are listed and their influences are stated, whereby the correlation does not state which variable influences the others. The variable extent of the used open innovation strategies has a significant correlation with the performance of the companies as well as the growth in terms of the growing number of employees and also the ability to develop more radical innovations.

Table 4.4: Correlations

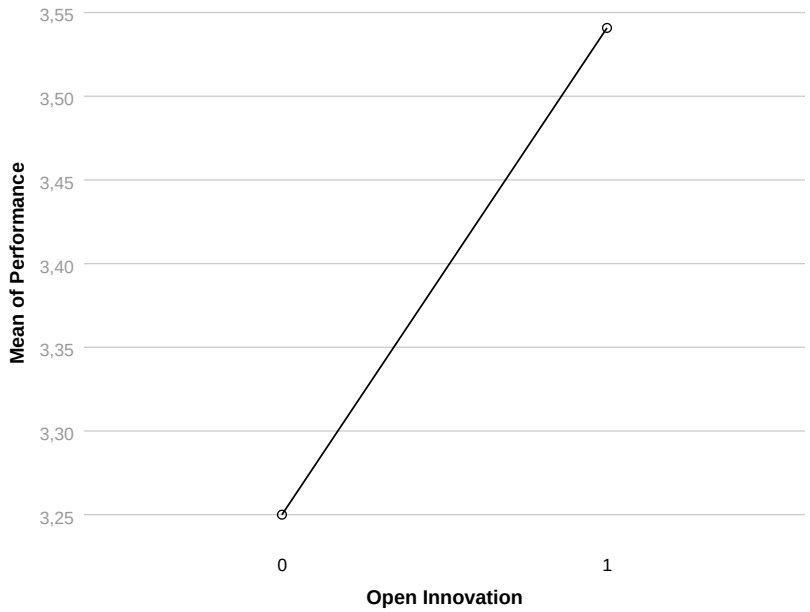
	Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Extent of Open Innovation (1)	2.82	0.49							
Performance (2)	3.4	0.58	0.24[b]						
Industry (3)	2.67	1.01	0.15	-0.06					
Number of employees (4)	1.94	0.82	0.11	-0.01	-0.20[b]				
Sales (5)	3.42	0.66	0.09	0.69[c]	-0.05	0.09			
Profits (6)	3.28	0.71	0.18[a]	0.84[c]	-0.12	0.09	0.56[c]		
Change of Employee Numbers (7)	3.52	0.68	0.23[b]	0.83[c]	0.03	-0.11	0.60[c]	0.40[c]	
Radical Innovations (8)	0.34	0.48	0.27[c]	0.03	-0.10	-0.05	0.15	-0.04	0.08

[a] correlation is marginal significant at the 0.1 level (2-tailed)
[b] correlation is significant at the 0.05 level (2-tailed)
[c] correlation is highly significant at the 0.01 level (2-tailed)
Source: illustration created by the author

The Levene test for the performance variable resulted in the value of 0.295 (no heteroscedasticity) and, therefore, the variable can be used in the variance analysis. In the statistical analysis of the performance, which is grouped by the dummy variable open innovation, we uncover a statistical significant difference of p=0.014 between the two distinct groups. The ANOVA bears the result of F(1,93)=6.264, through which we can answer this hypothesis. Due to the variance analysis the companies who are using an open innovation strategy are also achieving a higher performance in terms of higher growth rates in employees and profit. This can be explained through the increased access to a resource pool, which is beyond the companies' boundaries. The resource pool can be used to leverage the internal research and development process and, therefore, achieve a higher performance (Sisodiya et al., 2013).

In addition we also investigated whether there are disparities in the impact on the performance between Inside-Out and Outside-In innovation strategies. Hence, in the following several regression models are shown to understand the influences and impacts. In general the model has a dependent variable and four independent variables. The extent of Inside-Out and Outside-In enables us to identify the impact of the two approaches on the performance of the Austrian companies. Moreover, also two control variables are included in the model, namely the industry and the number of employees of the firm. A high correlation between the explanatory and the dependent variables is desired in a regression model, but also a high correlation between the explanatory variables can be observed occasionally. This phenomenon is called multicollinearity and is given in a multiple regression model if at least two predictors variables are highly correlated

Figure 4.12: Comparison Performance Means



Source: illustration created by the author

in terms of a high linear dependency. This has a huge impact on the standard error and possibly increases a lot, whereby the solutions are getting instable. The variance inflation factor (VIF) is 1 in case of independence and is increasing with higher linear dependency. In the literature is an ongoing discussion about the threshold of this indicator. Some researches are arguing that all values above 10 are to high (Backhaus et al., 2011), whereby others are identifying 5 as the limit (Urban and Mayerl, 2006). Due to the fact that in this regression model the highest VIF-value is 1.347 it is not affected by the discussion. As it is close to 1 there is no statistical significance of collinearity.

Table 4.5 bears the results on how the different open innovation approaches are influencing the companies' performance in general. For this the general variable performance was used. Furthermore, we can see that the influence of the Outside-In approach is marginal significant, with a p=0.078 and the β=0.238, but the Inside-Out effect, with a p=0.808, is not significant as well as the industries and the size of the company, with p=0.359, 0.390, 0.271 respectively p=0.857. Due to that information the Inside-Out activities do not have a significant impact on the performance of the companies. However, if a company is using the Outside-In approach in a higher extent their performance is increasing as well.
It is not only interesting how the general performance is influenced by the different open innovation approaches but also the effects on major economical indicators of the companies are of especial importance. The following tables (Table 4.7 and Table 4.6) are showing the results of the regression analyses. It is obvious that none of the different

Table 4.5: Impacts on the Companies' Performance

Dependent variable	Performance		
	B-value	*t*	*Sig.*
Extent of Inside-Out	0.021	0.244	0.808
Extent of Outside-In	0.238	1.786	0.078
High-technology	-0.179	-0.923	0.359
Medium-low and low-technology	0.134	0.864	0.390
Production-related services	-0.167	-1.107	0.271
Employees	-4.36E-6	-0.180	0.857
F-value = 1.630 (sig.-level = 0.148)[a]			
R^2-value = 0.100			

[a] Bedeian and Mossholder, 1994 showed that a statistically significant overall model is not necessary to interpret a significant element within the model
Source: illustration created by the author

dimensions of open innovation have a significant impact on the sales, nor on the change of the employee number. But the Outside-In strategy has a significant positive influence on the profits of the companies (p=0.040). Therefore, we can see that the extent of Outside-In activities increases the profits in a positive way (B-value=0.333). Hence, the profits in the Austrian companies are getting larger if the Outside-In approach is used more.

Table 4.6: Impacts on Sales and Profits

Dependent variable	Sales			Profits		
	B-value	*t*	*Sig.*	*B-value*	*t*	*Sig.*
Extent of Inside-Out	0.115	1.174	0.243	-0.099	-0.976	0.332
Extent of Outside-In	-0.080	-0.516	0.607	0.333	2.080	0.040
High-technology	-0.151	-0.669	0.505	-0.086	-0.371	0.712
Medium-low and low-technology	0.141	0.781	0.437	0.156	0.836	0.405
Production-related services	-0.178	-1.015	0.313	-0.296	-1.637	0.105
Employees	2.08E-5	0.740	0.461	2.31E-5	0.797	0.428
F-value	0.920 (sig.-level = 0.484)			2.172 (sig.-level = 0.053)		
R^2-value	0.059			0.129		

Source: illustration created by the author

In addition a comparison of the different innovation strategies is performed, whereby a company is considered as open, if they are indicating by at least nine methods of the twenty-four, of which it was questioned, if they are relevant or very relevant. Based on this classification it is possible to derive, that 44% of the companies are using open innovation in their innovation process. If this group of companies is compared to those

Table 4.7: Impacts on the Change of Employees

Dependent variable	Change of employees number		
	B-value	*t*	*Sig.*
Extent of Inside-Out	0.140	1.393	0.167
Extent of Outside-In	0.143	0.904	0.369
High-technology	-0.271	-1.176	0.243
Medium-low and low-technology	0.112	0.608	0.545
Production-related services	-0.038	-0.209	0.835
Employees	-3.18E-5	-1.106	0.272
F-value	1.135 (sig.-level = 0.349)		
R^2-value	0.072		

Source: illustration created by the author

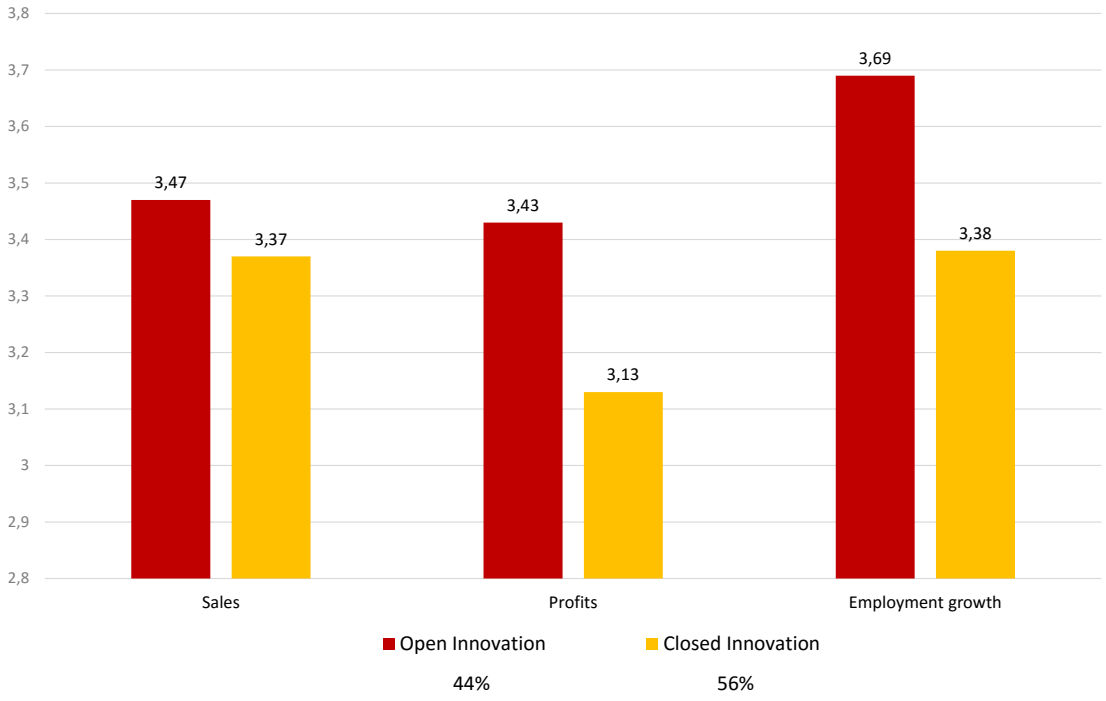
that are using the traditional approach differences in the average value of sales, profits and employment growth can be found. On the left hand in Figure 4.13 it is shown, that companies that are using open innovation are achieving in average 3.47 on a five point likert scale. Compared to that, firms that do not open up their innovation process have a value of 3.37, whereby five is a strong increase and one is a strong decrease. If the enterprises are using open innovation they can in general increase their sales, however, the difference to the other category is not significant. In contrast, the differences of the profit between open innovation and Closed Innovation is significant, due to a variance analysis with the result F(1,93)=4.337, p=0.040, hence companies with an open innovation strategy generate more profits than closed companies. Moreover, companies that are using open innovation have a significant higher employment growth than those with a traditional innovation approach, which is revealed in the variance analysis with the result of F(1,93)=5.157 and a p-value of 0.025.

Hypothesis 8 *Companies using open innovation strategies are tending to develop more radical innovations than those, who do not use open innovation strategies at all.*

To either proof or refute the eighth and last hypothesis another regression analysis was performed but this time a logistic regression was necessary because the dependent variable is a dichotomy variable. The aim is to identify whether the openness of a company affects the company's ability to develop more radical product innovations instead of slight product improvements. Slight product improvements are called incremental innovations. They are exploiting existing technologies and try to improve the competitiveness within the current market or industry of the enterprise. On the other hand the radical innovations are based on new technologies and lead often to a dramatic change of the current market. Those innovations have a higher uncertainty and higher risks than the incremental ones.

In this regression analysis we can see that the coefficient open innovation is, with

Figure 4.13: Comparison of the Innovation Strategies



Source: illustration created by the author

a p=0.020, statistically significant and therefore companies, who are adopting open innovation, are more likely to develop radical innovations. The additionally added sectors, used as control variables, have shown that neither high-technology (p-value=0.329) nor medium-high technology (p-value=0.601) nor medium-low technology (p-value=0.322) or the number of employees (p-value=0.728) has a significant influence on the extent of open innovation (see Table 4.8).
Considering that the extent of openness is a significant factor for the capability to develop radical innovation it is also of importance if there is a difference between the different core open innovation approaches. Therefore, additionally the influence of the Outside-In- and Inside-Out approach on the firm's ability to generate radical innovations is excerpt. The existence of radical innovations is a binary variable and thus a binary logistic regression is carried out where the results are shown in Table 4.9. This analysis reveals that the Inside-Out approach has a significant impact (p=0.01) on the firm's ability to develop radical innovations. Whereby on the other hand the extent of Outside-In has no significant impact, like all the control variables. This result is robust, because it does not change if size and sector dummies are introduced.

Table 4.8: Impacts on the Firm's Ability to Develop More Radical Innovations

Dependent variable	Radical innovations		
	B-value	*Wald*	*Sig.*
Extent of open innovation	1.217	5.396	0.020
High-technology	0.730	0.951	0.329
Medium-high technology	-0.307	0.273	0.601
Medium-low and low-technology	-0.660	0.980	0.322
Employees	0.000	0.121	0.728
Likelihood = 110.725			
$\chi^2 = 10.669$ (sig.-level = 0.058)			
Pseudo R^2 (Nagelkerke) = 0.147			

Source: illustration created by the author

Table 4.9: The Impact of Open Innovation Strategies on the Firm's Ability to Develop More Radical Innovations

Dependent variable	Radical innovations		
	B-value	*Wald*	*Sig.*
Extent of Outside-In	0.055	0.009	0.923
Extent of Inside-Out	0.962	6.562	0.010
High-technology	0.627	0.664	0.415
Medium-high technology	-0.370	0.376	0.540
Medium-low and low-technology	-0.560	0.665	0.415
Employees	0.000	0.000	0.993
Likelihood = 107.046			
$\chi^2 = 14.349$ (sig.-level = 0.026)			
Pseudo R^2 (Nagelkerke) = 0.230			

Source: illustration created by the author

Inauen and Schenker-Wicki (2012) has investigated how the closed innovation approach influences the probability of creating radical innovations compared to the open innovation approach, especially the Inside-Out method. In this empirical study the conclusion was that closed companies are more likely to develop incremental innovations, whereby those that are using the Inside-Out approach are exhibiting more radical innovations. Incremental innovations are often coming along with closed innovation systems because they are normally focused on improving their own products. Such an improvement proceeds step by step and complete new product developments are unusual and hardly ever executed due to the high uncertainty. However, on the other hand an Inside-Out approach provides several methods to support new ideas right from the initiation even if they do not fit into the current business of the company. This is possible by exploiting ideas, technologies and innovations on the outside of the firm's boundaries, in terms

of finishing the development on the outside and bringing it on the market. Whereas the most relevant of the considered Inside-Out methods are joint ventures, spin-offs, licensing and adaption of the business model. If an Austrian company tries to foster radical innovations an Inside-Out approach is recommended because the previous analysis has revealed that the extent of of Inside-Out has a positive significant impact on the firm's ability to develop more radical innovations. Hence, to leverage the opportunities of disruptive innovations new solutions have to be used, for example the idea can be improved in a spin-off where the development process is not limited by existing structures or if some necessary competences are absent a joint-venture with a third party is a good strategy. Although by an internal development and finalisation it is possible to license it to someone else or to establish it on the market, in which case it is often necessary to adapt the business model, due to the significant new- and otherness.

4.9 Overview of the Hypotheses

The Austrian firms benefit immensely by using new innovation models, although they fear that they reveal important internal know-how to others. This drawback is compensated by a better understanding of the customer‘s desire and behaviour, as well as the identification of new technology trends, whereby the time- and cost-saving in the innovation process is not their major motivation for an opening up of this process. In Austria the adoption of open innovation is independent of the sector or the company‘s size but companies with a higher R&D-rate are using it slightly more often. However, in all sectors and sizes the enterprises are implementing new and opened-up innovation processes because it bears several positive outcomes for the Austrian firms. With the help of open innovation Austrian companies can achieve higher revenues and profits as well as more capability to develop radical innovations.

Table 4.10: Overview of the Hypotheses

H1	Open innovation strategies are more often adopted in the Austrian high-tech sector than in the low-tech sector.	not supported
H2	Reducing development time is the prime motivation for Austrian companies to use open innovation strategies in their development activities.	not supported
H3	Expected high costs related to the implementation of open innovation strategies are considered as the main barrier by Austrian companies to adapt open innovation strategies.	not supported
H4	Open innovation strategies are equally adopted by small and large sized enterprises.	supported
H5	Austrian companies with a high R&D-rate are more engaged in open innovation strategies.	supported
H6	Austrian industrial companies tend to use the Outside-In approach of open innovation more frequently than the Inside-Out approach.	supported
H7	The intensity of adopting open innovation strategies is positively associated with the performance of the company.	partly supported
H8	Companies using open innovation strategies are tending to develop more radical innovations than those, who do not use open innovation strategies at all.	supported

Source: illustration created by the author

5 Summary & Conclusion

Within the scope of this paper the general issues were the pervasion of the new open innovation models and -strategies, as well as on the one hand the main motives and expectation of the companies in the usage from opening up their innovation strategies and on the other hand the barriers of which the firms are suffering from at the introduction of open innovation. Furthermore, the structural differences in relation to the use of new open innovation strategies are in the main focus of attention.

At the beginning essential definitional foundations of innovations were explained, starting with the first mention of innovation by Schumpeter and the Closed Innovation paradigm (Fleming, 2001; Schumpeter, 1911). Thereby, a new and emerging approach of open innovation can be discussed and its differences, compared to the traditional research and development process, can be seen. This approach is discussed in detail as well as the different approaches, namely the Inside-Out-, Outside-In- and Coupled process (Gassmann and Enkel, 2004). Also various empirical studies about different aspects and pervasion of open innovation are investigated (Chesbrough and Crowther, 2006; Enkel, 2011; Fitjar and Rodríguez-Pose, 2013; Lichtenthaler, 2008; Rahman and Ramos, 2013), whereby none of those have considered the Austrian characteristics in detail. Some papers have identified that the Outside-In activities are more commonly adapted than the Inside-Out practices because the collection of information is perceived as more valuable by the companies (Chesbrough and Brunswicker, 2013). They all have in common that open innovation is not just a trend but a new opportunity for the companies to improve their innovation process (Chesbrough and Brunswicker, 2013; Dahlander and Gann, 2010; Elmquist et al., 2009).

To address all of the questions that are stated in the beginning of this chapter a standardised empirical questionnaire was developed and conducted on a web-platform. 928 Austrian companies have been invited and 95 companies have followed the request to participate. This is equivalent to a return rate of 10,24%, which is not outstanding but still satisfactory. From the low-technology industry and the medium-low-technology industry not enough companies have participated to form individual groups, hence, for an improved statistical evidence of the analysis those two categories were combined to the *medium-low and low-technology* industry. The exact same constraint was in the knowledge-intensive-, and less knowledge-intensive service categories, which is why those are combined to the category production-related service industry. To ensure the statistical importance of the distribution of the size, which is based on the number of employees and the age of the company, three, respectively four, categories were introduced, which all had nearly the same size. If the size distribution of the participants is compared to the real distribution in Austria, it can be seen that the medium sized firms are under-represented

and the large companies are over-represented and, therefore, the results should be interpreted carefully due to this differences. However, apart form that the results of the online questionnaire are providing a robust data material for the empirical analysis of the role and importance of open innovation in the Austrian industry.

The empirical investigation provides several very interesting insights in the Austrian industry with regard to the field of innovation. The participating companies have highly agreed that their most prominent general innovation challenge is to identify the specific customer needs. This challenge can be easily addressed with the opening up of the development process towards the customers and with a greater customer-involvement. A lot of customers are intrinsically motivated and, therefore, very engaged and able to support the company by the development of the right products. Beside these general challenges also other innovation oriented motives, namely identification of technology trends and better access to markets are considered by the companies as the prime motivation to turn the innovation process to more openness.

Although this research was well designed and executed there are still some deficits and limitations in the interpretation. First of all, most of the invited firms were already related to the innovation topic. Therefore, only a small amount of non-innovative companies were contacted. In addition, the innovative firms that are already practicing open innovation are even more eager to share that information with the environment. In contrary, the less open minded companies are much more difficult to motivate. The Austrian companies can be categorised into size-groups based on their number of employees. This categorisation of the sample differs from the actual occurrence in terms of that the medium sized companies are under-represented and the large firms are over-represented and, therefore, the results that are based on that classification should be interpreted carefully due to this differences. In the paper a breath-ness metric is used to measure the openness of a company. For additional insights into open innovation in Austria other metrics, like the depth-ness or a cluster analysis could be used.

The main external sources for the companies to address those challenges are cooperation projects with customers. With the involvement of their customers in their development processes they are able to gain a deeper understanding of their customers and identify their needs and behaviour in a better way and, therefore, obtain a solution for their most important problem. In addition, the companies are also collaborating with universities and research institutions to be aware of the new trends and developments, which they can subsequently utilise. Due to the early recognition they are able to anticipate or create new customer desires. The Austrian companies are aware of the open innovation topic and they have already identified that they can tackle their problems with new innovation strategies. It is also revealed by the answers, that the firms do not have any problems with the management commitment. Furthermore, they have enough management know-how and experience to establish such a new culture and new innovation strategies.

Several companies are concerned that critical internal knowledge could get public if they adapt a more open approach. The internal know-how is mostly not protected by any legal documents or agreements, which means a disclosure has to be prevented. If the information would become public knowledge the companies would lose the competitive advantage. To solve this problem the participating firms suggested a solution - fostering the information and experience exchange with other like-minded companies through platforms and networks. With the aid of the information and experience exchange the companies are able to learn from each other and identify best practices and benchmarks. Furthermore, they are able to excerpt their weakness as well as their strength how they are retaining their know-how. Additionally, the financial support by public authorities is seen as a possible solution to overcome the barriers of open innovation.

In relation to the different industrial sectors in Austria there is no difference in the extent of using open innovation strategies. Hence, no statistically significant difference between the distinct sectors, with regard to the extent of open innovation, was identified. Although, when comparing the high-technology sector to the others, it is using open innovation approaches in a higher extent. The medium-high technology and medium-low and low-technology sectors are very close to the total Austrian pervasion. Moreover, small and medium sized enterprises are using open innovation in the same extent as large corporations. A detailed analysis reveled that no statistical significance between any of the compared combinations is given, even if there are slight differences between the means of the different categories. The differences are correlating with the increasing of the mean with the amount of employees. Therefore, in Austria open innovation is used transversely, regardless of the sector and the size of the companies. Open innovation provides advantages for all enterprises, independent of their sector of engagement or size because the firms are able to used different combinations of open innovation strategies, which are best suited to their specific needs.

Contrary, it was revealed that the Austrian firms, which have a higher research and development rate, are also more engaged in open innovation. This positive influence of the R&D-rate on the extent of open innovation is marginal significant, hence, the higher the research and development rate, the higher the usage of open innovation strategies. This provides an interesting basis for future research on that topic. Additionally, it was discovered that the Outside-In approach of the open innovation paradigm is more disseminated than the Inside-Out approach. This might be because the main partners are within the own value chain of the companies and they are trying to incorporate as much knowledge as they can to gain a competitive advantage. Due to the concern that important internal knowledge is getting lost, the companies are rather trying to acquire knowledge from externals by using the Outside-In approach than to reveal information in several ways by using the Inside-Out approach. The Outside-In approach is also more easier and more comfortable to adapt.

Different effects on the economical performance have been identified, whereby all impacts are positive and fostering the growth. First, the Outside-In approach has a positive impact on the resulting performance of the company. If the firms are using the Outside-In methods of open innovation in greater extends also their profits and number of employees increase. Their increased and better access to the resource pool would be beyond the companies' scope without the Outside-In approach because the resource pool is on the outside of the firms' boundaries. Second, the firms that are using open innovation are tending to develop more radical innovations, whereby radical innovations are products or services with unprecedented performance characteristics, which are coming from the exploitation of new technologies. Such radical innovations are creating a dramatic change that transforms existing markets or industries or even create new ones. This positive influence is regardless of the sector. The most important revealed effect is that companies, which are using open innovation, in general achieve a statistically significant higher economical performance.

Altogether, we have seen that the Austrian firms benefit immensely by using new innovation models, although they fear that they reveal important internal know-how to others. This drawback is compensated by a better understanding of the customer's desire and behaviour as well as the identification of new technology trends. To leverage the dispersion of open innovation in Austria, public grants by public authorities or experience exchange with like-minded companies on conferences or in networks could support this intention. In Austria the adoption of open innovation is independent of the sector or the company's size but companies with a higher R&D-rate are using it slightly more. However, through all sectors and all sizes the enterprises are implementing new and opened-up innovation processes because as we have seen it bears several positive outcomes for the Austrian firms. With the help of open innovation Austrian companies can achieve higher revenues and profits as well as more capability to develop radical innovations with the potential of changing whole industries.

A Questionnaire

1. Wie relevant sind folgende Herausforderungen für ihr Unternehmen bei der Verbesserung und Entwicklung von neuen Produkten und Dienstleistungen? (1... nicht relevant, 5... sehr relevant)

   a) Generierung guter Ideen
   b) Identifikation von konkreten Kundenbedürfnissen
   c) Beschleunigung des Entwicklungsprozesses aufgrund verkürzter Produktlebenszyklen
   d) Aufbau von technologischem Wissen
   e) Mangel an qualifiziertem Personal
   f) Umsetzung der Ideen im Betrieb gegen interne Widerstände
   g) Finanzierung der Innovation
   h) Marktmacht von etablierten Unternehmen
   i) Identifikation von Kooperationspartnern im Bereich Forschung und Entwicklung
   j) Identifikation von Kooperationspartnern für die Umsetzung am Markt
   k) Schutz der Innovation (z.B. durch Patent)

2. Welche der folgenden Aktivitäten verwenden Sie, um externe Wissensquellen zu erschließen? In welchem Ausmaß wenden Sie diese an? (1... überhaupt nicht, 5... in sehr hohem Maße)

   a) Kooperationsprojekte mit Kunden
   b) Informationsaustausch mit Kunden auf selbst organisierten Veranstaltungen (Workshops, Hausmessen)
   c) Identifikation und Kooperation mit Lead Usern
   d) Integration von Lieferanten
   e) Informationsaustausch auf Messen und dgl.
   f) Cross-Industry Innovation (Nutzen von Lösungen und Potenzialen aus anderen Branchen)
   g) Integration von webbasierten Ideen- und Lösungsplattformen
   h) Kreativitätsworkshops mit Externen
   i) Crowdsourcing (Auslagerung von Problemlösungen an Internetuser)

j) Kunden-Communities im Internet

k) Kooperationsprojekte mit Universitäten und Forschungseinrichtungen

l) Kooperation mit anderen Unternehmen (eigene oder fremde Industrie)

m) Nutzung wissenschaftlicher Publikationen

n) Teilnahme an Open Source Projekten

o) Externe F&E-Dienstleister

p) Patente und Patentdatenbanken

q) Erwerben von geistigem Eigentum (Lizenzen)

r) Andere:

3. Welche der folgenden Aktivitäten verwenden Sie, um interne Wissensquellen zu erschließen? In welchem Ausmaß wenden Sie diese an? (1... überhaupt nicht, 5... in sehr hohem Maße)

   a) Internes Vorschlagswesen

   b) Regelmäßige Arbeitstreffen zur kreativen Suche nach neuen Ideen

   c) Interne IT-Lösungen für Ideenfindung und Bewertung (Ideenmanagement-Systeme)

   d) Verfahren zur kontinuierlichen Verbesserung (KVP, Kaizen)

   e) Analyse von abgeschlossenen Projekten und Prozessen

   f) Nutzung von Wissensmanagementsystemen

   g) Spezifische Freiräume für Kreativität und Innovationen

   h) Job-Rotation

   i) SixSigma

   j) TRIZ-Methode

   k) Andere:

4. Welche der folgenden Aktivitäten verwenden Sie, um neben der klassischen eigenen Vermarktung Ideen zu kommerzialisieren? In welchem Ausmaß wenden Sie diese an? (1... überhaupt nicht, 5... in sehr hohem Maße)

   a) Kommerzialisierung in Kooperation mit anderen Firmen (Joint Ventures, Netzwerke)

   b) Förderung von Unternehmensgründungen und spin-offs

   c) Beteiligungen an anderen Unternehmen

   d) Akquisition von Unternehmen

   e) Teilnahme an Standardisierungen, Normungen etc.

   f) Verwertung von geistigem Eigentum durch Lizenzierung

g) Anpassung des Geschäftsmodells (Bsp. Anbieten von zusätzlichen Dienstleistungen)

h) Andere:

5. Was sind für Ihr Unternehmen die Hauptmotive für die Öffnung des Innovationsprozesses? (1... nicht relevant, 5... sehr relevant)

   a) Kostenersparnis in der Produktentwicklung

   b) Zeitersparnis in der Produktentwicklung

   c) Marktzugang

   d) Bessere Informationen über Kundenbedürfnisse und Verhaltensweisen

   e) Risikominimierung von Innovationsprojekten

   f) Ressourcennutzung

   g) Identifikation neuer Technologietrends

   h) Entwicklung von umweltfreundlicheren Produkten

   i) Qualitätsverbesserung

   j) Andere:

6. Welche Relevanz haben folgende Barrieren für die Umsetzung von Open Innovation Strategien in ihrem Unternehmen? (1... nicht relevant, 5... sehr relevant)

   a) Fehlendes Management Know-How und Erfahrung

   b) Management der Außenbeziehungen

   c) Durchsetzung notwendiger interner organisatorische Veränderungen

   d) Schutz von kritischem internem Know-How

   e) Not-Invented-Here Syndrom (Ablehnung von externen Entwicklungen durch die Mitarbeiter)

   f) Bürokratische Strukturen

   g) Partner können nicht motiviert werden am Innovationsprojekt teilzunehmen

   h) Zu lange dauernde interne Prozeduren

   i) Mangel an finanziellen Mitteln

   j) Bildung einer geeigneten offenen Unternehmenskultur

   k) Entwicklung des passenden Geschäftsmodells

7. Wie geeignet sind folgende Möglichkeiten, um die vorher genannten Barrieren zu überwinden? (1... nicht geeignet, 5... sehr geeignet)

   a) Training und Ausbildung

   b) Nutzung von Beratungsdienstleistungen

c) Formale Verträge und Geheimhaltungserklärungen

d) Neue rechtliche Mechanismen zum Schutz der Innovation

e) Finanzielle Förderung von Projekten durch die öffentliche Hand

f) Informations- und Erfahrungsaustausch mit anderen Unternehmen über Plattformen und Netzwerke

8. Waren Produktinnovationen (neue Produkte oder stark verbesserte Produkte), die Sie in den letzten 3 Jahren entwickelt haben, ...

   a) neu für den von Ihnen bedienten Markt (ja/nein)

   b) neu für Ihre Firma (ja/nein)

   c) eine Weltneuheit (ja/nein)

9. Wie hoch war im letzten Geschäftsjahr Ihr Umsatzanteil mit neuen Produkten, die nicht älter als 3 Jahre sind?

   a) Umsatzanteil ca. ..... (in %)

10. Wie hoch war im letzten Geschäftsjahr Ihr Umsatzanteil mit stark verbesserten Produkten, die nicht älter als 3 Jahre sind?

    a) Umsatzanteil ca. ..... (in %)

11. Wie hoch war die F&E-Quote Ihres Unternehmens im Jahr 2013? (ca.)

12. Wie hat sich die wirtschaftliche Performance Ihres Unternehmens in den letzten drei Geschäftsjahren im Vergleich zu Ihren wichtigsten Wettbewerbern verändert? (1... stark gesunken, 5... stark gestiegen)

    a) Umsatzerlöse

    b) Gewinne

    c) Anzahl der Mitarbeiter

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