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A Sectoral System of Innovation Analysis

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Abstract

For examining the factors that affect innovation in particular industries or sectors the *sectoral system of innovation* framework gained high significance. We applied the framework together with the triple helix model of university-industry-government relations on the Austrian software sector to investigate its characteristics and success factors. Therefore we analysed its innovation performance based on self-assessment as well as on the following innovation success measures: *Number and share of new developed products and services, share of turnover through new developed products and services* and *share of profits through new developed products and services*. Our results show that Austrian software companies generally achieve a high innovation performance and are also accordingly satisfied with their innovation success and capabilities. Regarding the effect of cooperation with universities and government institutions in innovation projects, we could show that cooperation has a positive effect on the innovation performance of Austrian software companies.

Kurzfassung

Das *Sectoral System of Innovation Framework* erlangte in den letzten Jahren zunehmend an Bedeutung zur Erforschung von Faktoren, welche die Innovativität in Industrien oder Branchen beeinflussen. Wir verwendeten dieses Framework in Kombination mit dem *Triple Helix Model* um die Eigenschaften und Erfolgsfaktoren des österreichischen Software Sektors zu bestimmen. Dafür erforschten wir die Innovativität des Sektors auf Basis von Selbsteinschätzung der Beteiligten und den folgenden Innovations-Messgrössen: *Anzahl neu entwickleter Produkte und Dienstleistung, Anteil der neu entwickelten Produkte und Dienstleistungen am gesamten Produkt- und Serviceportfolio, Umsatzanteil von neu entwickelten Produkten und Dienstleistungen*, sowie *Gewinnanteil von neu entwickelten Produkten und Dienstleistungen*. Die Resultate zeigen dass sich österreichische Softwareunternehmen generell durch hohe Innovativität auszeichnen und mit ihren Innovations-Fähigkeiten und ihrem Innovationserfolg auch dementsprechend zufrieden sind. Darüber hinaus hat sich gezeigt, dass Kooperationen in Innovationsprojekten mit Universitäten und staatlichen Institutionen einen positiven Effekt auf die Innovativität der Unternehmen hat.

Contents

CHAPTER 1

Introduction

This first chapter of the thesis is meant to provide an introduction to the topics and content of this thesis. Here we summarize the focus of research as well as the research question and point out why it is worth investigating.

1.1 Motivation

Innovations are the basis of progress and the engine of growth of every economy. Innovation became a buzzword that is nowadays omnipresent in everyday media, and hardly any day goes by, without us reading interviews and discussions with economist, politicians or managers who point out the importance of innovations. Especially for Europe that is apparently more dependent on continuous improvement of productivity and service quality than other regions of the world because of its lack of natural resources, high salaries, thinking is tremendously important. With Europe 2020 the European Union lately formulates its key strategy for a “smart, sustainable and inclusive economy”. With the so called Innovation Union, innovation has been listed as one of the key parts of this strategy providing economic growth and lower unemployment through improved conditions for innovation as well as access to financial support for research and product development [52].

In this thesis we therefore want to investigate the Austrian software sector for its ability and success to innovate. We define the Austrian software sector as all companies that develop and sell software as well as software services in Austria. As this definition suggests, we focus exclusively on product and service innovations. In the context of this evaluation we investigate the sector for its characteristics, structure and building blocks. We then derive the key factors that are relevant for its ability to innovate. This should get to suggestions of how to sustainably preserve the success of Austria’s software sector for the future by answering the following research question: “What are the relevant characteristics and key success factors of Austria’s software sector, that allow it to be innovative?”

A common scientific approach in innovation studies is the concept of *innovation systems*. One type of innovation system approaches that is used for sectoral analysis is the *sectoral system of innovation* (SSI) framework [40] [38] [39]. The framework provides an effective way to understand the innovation processes of a sector. Therefore it can be used to analyse and describe the structure and dynamics of a sector regarding its basic knowledge base and learning processes, the involved technologies and inputs, relevant actors, their relationships and networks and institutions as well as processes of variety- and selection-generation. In addition to a structural and functional analysis an SSI analysis provides a way to assess strengths and weaknesses of a specific sectoral system (i.e. features that block or induce innovation success).
In addition to the SSI framework, we make use of the *triple helix model of industry-university-government relations* (TH model) [33]. It serves as a tool to investigate the overlay of communication, information and roles among universities, government institutions and industry enterprises. This model states that innovation performance and success are maximized at the intersection of industry, university and government. In the combination with the SSI framework, we use the TH model in the context of the investigation of actors, their relationships and networks as well as functions.

Although scientific work has been conducted in the past in which the SSI framework was applied on software sectors, it has so far never been applied on a software sector in combination with the TH model. Moreover, there is so far no holistic investigation and evaluation of the Austrian software sector, like it is made possible through the perspective of the TH model and by the application of the SSI framework.

1.2 Thesis Outline

This thesis is structured in the following way:
In Chapter 2 we present the current state of scientific knowledge in this field of research. This contains an introduction of the innovation system approach, the sectoral system of innovation framework as well as the triple helix model. We present the Austrian software sector with its main key figures and characteristics. Moreover we conduct a comparison of the SSI framework and the TH model in the context of this thesis and present similar scientific work that has been conducted in the past.
The Chapter 3 provides a detailed illustration of the common research methods as well as the selection process of appropriate research methods for this thesis. Furthermore we discuss appropriate ways for measuring innovation performance and success and present a detailed plan of action, which explains step by step how the SSI framework and TH model were applied and how the results were achieved.
In Chapter 4 we present the results of the online questionnaire, which we used to survey Austrian software companies, and the interviews with universities and government institutions. Furthermore we conduct a within- and across-case analysis and derive the core theses, based on the answers of the questionnaire and the interviews.
The interpretation of the collected results is done in Chapter 5. In this chapter we firstly derive

the Austrian software sectoral system of innovation based on the SSI framework and a manual that suggests particular steps how to apply the framework on a particular sector. Secondly we assess the the innovation performance of the Austrian software sectors based on the presented results and answer the research question. Finally we propose interesting aspects in this field of research that could be focused on in future projects.

CHAPTER 2

State of the Art

In this chapter we present the relevant scientific concepts that have been incorporated in this thesis. We discuss the characteristics of software sectors in general and deal with the concept of innovation as well as theoretical background of the field of innovation studies. We discuss the concept of innovation systems and take systems theory into account to explain how innovation is created within a system through interaction of a systems actors. Moreover we present the triple helix model and the sectoral system of innovation framework, two common approaches from the field of innovation systems. Finally we compare these two approaches for similarities and differences.

2.1 The Software Sector

In the last years several technological trends transformed a ubiquitous indispensable factor in our everyday life. A vast variety of software products and services can be listed, from three different domains, i.e. business applications, consumer markets and research. Various definitions of software can be found, for this thesis we use the following definition: Software can be defined as: "... digital instructions and operating information that are contained in programs serving to guide machines in implementing desired operations" [36, 33].
Before we can analyse the Austrian software sector, we discuss the special characteristics of software as well as the related properties of software sectors.

2.1.1 Definition and Characteristics of Software Sectors

According to [36] software brings certain key features that influence the properties of software sectors and the markets of software products:

1. Disembodied character. Software generally is an intangible good, which means that once it is developed, it can be replicated easily and cheap.

2. Complementary with hardware. Since software needs hardware to be executed (and similarly does hardware require software to provide any advanced functionality), software and hardware are direct complementarity goods. Therefore strong linkages can be found between software and hardware industries (i.e. ICT sector)

3. Cumulative development. Usually software development and innovation activities are multi-stage processes, whereas the new developed products or features build up on previous innovation steps.

4. Short life cycles. The intangible character of software and the cumulative development contribute to a rather frequent release of software products and features.

Generally a software sector can be defined as the sum of companies that develop and sell software products or software services. Given the key features of software products above, [6] and [49] present the following characteristic properties of the software sector:

1. Software is expensive to generate but cheap to reproduce. There are moreover no natural limits for reproduction of software. Therefore the production of software is defined by high fix costs as well as very low variable and marginal costs. This has an immediate effect on pricing of software products. With almost no cost of producing an additional unit, software must be priced accordingly to consumer value, not accordingly to production costs. This implies that a software product should be sold at different prices to different customers, in accordance to their willingness to pay for it (i.e. differential pricing). We observe one type of differential pricing that is mostly used in software markets, namely *versioning*. Thereby a product is offered in different versions and customers can choose the version of the product, which is most appropriate for them.

2. Very often customers take a risk of high switching costs in buying a specific software solution (e.g. ERP-Systems). Re-eduction for new software, time and money expenses, compatibility issues as well as migration of data can be reasons for high switching costs. If the switching cost outweigh possible price differences that a cheaper competitor might offer, the customer will not switch to the competitor. If this happens, the customer is said to be locked-in.

3. In software markets network effects can arise. Network effects occur if “the utility that a given user derives from the good depends upon the number of other users who are in the same network as he or she” [28, 424]. In software markets *direct network effects* (i.e. an increased usage of a systems from other users leads to a direct increase in value for the focal user) can be observed in platform platform competitions or if a specific technology standard is defined. *Indirect network effects* (i.e. an increased usage of a product increases the value of a complementary product, which can in turn increase the value of the original) arise for example in form of standard software in combination with complementary consulting services (e.g. operating systems, office solutions, ERP-Systems). Network effects often lead to high switching costs and possibly to winner-takes-it-all markets where one dominant product arises.

4. Software markets are highly internationalized in terms of value added and sales. Software can be distributed globally very fast and cheap over the internet. Therefore three major phenomena are observed: Global competition between software companies, outsourcing of parts of the value chain to companies with expertise in particular niches as well as offshoring of parts of the value chain to countries with lower salaries.

5. Another phenomenon that can be observed in software market is platform competition. Therefore platforms are the basis of products or services whose functionality is extended by a third party [6]. The primary goal of a platform operator is to offer a wide range of complementary products, which are developed by third party producers. Thereby the customers of a platform are both the third party producers which develop programs for that platform as well as the end users of these programs. Typical examples of platforms in software markets are operating systems or ERP-systems. Platform markets are typically characterized by strong direct and indirect network effects.

6. Two major reasons imply strong cooperation between producers as well as customers in software markets. Platform markets demand cooperation in product development, since very often platform providers don't have additional resources to develop complementary products and services. Secondly, software becomes more and more complex. Therefore software producers cooperate with end consumers through alpha- and beta-versions (e.g. operation systems).

2.1.2 Actors of Software sectors

Because of the strong cooperation and interdependence between producers and consumers in software sectors, the actors of software sectors should be investigated in terms of "cooperation partners". Therefore we present the following categorization of cooperation partners in software sectors [21]:

1. Focal software company: A considered software company in accordance to our definition (companies that develop and sell software products or software services)

2. Customers: Purchasers of software products and services (and possibly also cooperation partners).

3. Suppliers: Companies which support product and service development through the supply of own software components and tools.

4. Complementary provider: A cooperation partner that offers complementary products or services, which support the supply of the focal software company (e.g. technology partners or services providers)

5. Competitors: Companies which offer alternative products and compete with the focal software company. They cooperate with the focal software company in form of *coopetition* (i.e. cooperation of competing companies with partial congruent interest)

2.1.3 Existing Innovation Analyses of Software sectors

Numerous different scientific studies on innovation systems, software sectoral systems of innovation or software sectors have been carried out in the past. However, intensive literature review did not reveal any actor- and network-oriented investigation of software sectors, like it is possible through the perspective of the triple helix model and by the application of the sectoral system of innovation framework. Nevertheless, there are some interesting studies which serve as an orientation for this thesis, as a motivation for the relevance of the research question and as a comparison for our results.

In [7] the rising software industry in Montevideo Uruguay was investigated to point out critical success factors for its rising economic significance. Therefore the sectoral systems of innovation framework has been used. The study outlines the building blocks of a sectoral system of innovation and their implementation in Uruguay's software sector. As research methodology a survey was chosen, consisting of 97 personal interviews with companies dealing with software development or consulting services.

In [50] the European software sector was investigated. This study provides a sophisticated comparison and demarcation to the (dominant) US software sector. For this reason the sectoral system of innovation framework has been applied. The findings provide an analysis of the major characteristics of the European software sector as well as its major purposes. Several strategical opportunities were identified and key responses, which should be undertaken to strengthen the performance of the European software sector, were suggested.

In [31] several software sectoral systems of innovation in Asia (i.e. China, India, Japan, Korea, Singapore and Taiwan) were analysed, with the major focus on industry-academia relations. Therefore a tech mining research methodology was applied to analyze relations between specific technologies and actors of the sectoral innovation system, based on input data from articles and patent databases. The study was conducted with the purpose of identifying strategic threats and inefficiencies in various software SSIs.

In [36] an overview on innovations across the software sector was developed to set out key issues and highlight policy perspectives. Thereby core innovation themes are provided as well as a holistic view on the software sector and its characteristics from the research and development, over invention, production and distribution to the final use of software.

Finally in [47] a heuristic framework for analysing and explaining the various patterns of change in sectoral system of innovation studies was introduced. This is based on the evolutions in SSI literature. Therefore researchers and analysts were identified who have implemented empirical studies of innovation systems. Moreover a bibliometric analysis based on keywords was conducted to establish a theoretical frame and state of art about SSI. The derived keywords were used to identify which topics SSI authors were interested in and the relevance of those topics over time. Therefore typical keywords (such as *sectoral innovation systems, information system, economic effects, sustainability, governance* etc.) that were used in scientific publications over

Number of companies	8000
Number of employees	32000
Total net revenue	5.5 billion Euros

Table 2.1: Key figures of the Austrian software sector (2002)

time were extracted as well as counted and the focus of researchers in the field of SSI (such as *relationship between organizations, institutional knowledge transfer, comparative analysis of specific sectors* and their change over time was derived.

2.2 The Austrian Software Sector

In this part an overview of the Austrian software sector is provided, including its characteristics, key figures and its structure. Since we could not always find relevant information about specific aspects of the software sector, we included information about the wider defined Austrian ICT sector, whenever we could. Therefore we provide an overview, including key figure of the Austrian- (and Viennese) Software- and ICT sector. We consider this nevertheless to be reasonable since the software sector is part of the total ICT sector.

2.2.1 Characteristics of the Austrian Software- and ICT Sector

The Austrian software sector (including software development, customizing, web-services, cloud computing services as well as sales of software and licences) corresponds to about 45% of the total ICT sector [24]. Economic effects from the software sector on the whole Austrian economy are presented in Table 2.1.
According to [45] the attractiveness of the Austrian ICT business location was evaluated with 17th place in the year 2011. While the total IT-sector (including software and excluding telecommunication) generated a revenue of 14,2 billion Euros in 2011, 6,4 billion Euros were generated exclusively in the software sector [24].

Because of the rather marginal information that can be found specifically about the software sector, we enhance our view to the broader ICT sector. According to [46] the ICT sector is defined as “a combination of manufacturing and services industries that capture, transmit and display data and information electronically”. In addition to the software sector this also includes information- and communication technology companies (e.g. computer hardware, radio, television, mobile communication etc.).
The ICT sector in Austria as a knowledge-based industry contributes significantly to innovation and competitive success of economies. Table 2.2 delivers an overview of the Austrian ICT sector’s contribution to the Austrian economy [1].

[1] Source: Eurostat, 2014; Oberlin et al. (2011) [45] (based on Advantage Austria, 2011; Rundfunk und Telekom Regulierungs GmbH, 2011; Eurostat, 2011)

Number of companies in the ICT sector (2008)	15’500
Number of Employees in the ICT sector (2008)	90’000
Total net revenue (2008)	18.5 Billion Euros
Percentage of the ICT sector on GDP (2010)	3,17 %

Table 2.2: Key figures of the Austrian ICT sector

The Austrian ICT sector is mainly concentrated around the three biggest cities, Vienna, Graz and Linz, while 75% of the total Austrian ICT revenues are generated exclusively in Vienna. About 85% of the Austrian software sector’s inputs are demanded domestically which leads to high economic multipliers in terms of employment and value added. It can fairly be said that (within the total Austrian software sector) Vienna represents a dominating business location, that is - regarding its contribution to the national sector - comparable to software hubs like the Silicon Valley in the USA or Bangalore in India [45] [24].
The ICT sector is moreover characterized by a high regional economic interdependence, since around 45% of the inputs are purchased from the same state (i.e. Bundesland). This leads to the large relative regional economic importance of the software- and ICT sector in Vienna since it contributes with around 2,5% to the total value added generated in Vienna. This exceeds the total value of tourism by the factor 6.5 [45] [24].

2.2.2 The ICT Hub Vienna

We have seen that the software- and ICT sectors play an important role within Austria. But they have an even more significant contribution to the Viennese regional economy. About 5,300 companies add up to 8% of the regional enterprise population. The ICT sector accounts to about 10% of the employment and 15 % of the total value added in the Austrian capital. This makes Vienna Europe’s third biggest ICT business location [45] [32].

Regarding the outstanding significance of the Austrian capital within the Austrian software sector, we claim that the Austrian software sector is mainly concentrated around the capital. Regarding the spheres and corresponding actors of the triple helix model, it can be claimed that most of these actors (particularly government institutions as well universities and research institutes) are located in the capital city. Especially since Vienna (with over 1.7 Mio inhabitants) comprises 20% of the total inhabitants of Austria.

Several nationally significant universities can be found in Vienna, such as the *Vienna University of Technology, Vienna University of Economics and Business, University of Vienna* as well as several universities of applied sciences. Research institutes that are relevant for the software sector can also be found in Vienna, such as the *Fraunhofer Austria Research GmbH* or the *Austria Institute of Technology*.

Numerous government institutions, which are involved in the support of innovation projects, are located in Vienna. The following federal institutions have been identified in the literature review:

- Austrian Federal Ministry for Education, Science and Culture (BMBWK)
- Austrian Ministry for Transport, Innovation and Technology (BMVIT)
- Austrian Economic Chambers (WKO)
- Austrian Council for Research and Technology Development (RAT-FTE)
- Austrian Research Promotion Group (FFG)

Moreover two institutions on the state level of Vienna have been found:

- Vienna Business Agency
- Vienna Science and Technology Fund (WWTF)

In addition there are two significant networks of software companies in Vienna, which are the *VÖSI (Verband Österreichischer Software Industrie)* and the *VITE (Vienna IT Enterprises)*.

As we have shown above, the Austrian software sector has a rather low level of interconnectedness with other countries. Furthermore we have shown the outstanding significance of Vienna within the Austrian software sector. These factors imply a geographically concentrated software sectoral system around Vienna.

2.3 The Concept of Innovation

The word *innovation* is originally based on the latin expression *innovatio*, which means "renewal". Nowadays there are many different (subject-specific) definitions of the term *innovation*. Therefore it is hard to give one generally valid definition. Since the concept of innovation is discussed in different fields of research and can be regarded from various business related perspectives, many different definitions exist. One widely used but rather general definition is the following: "Innovation is the generation, acceptance and implementation of new ideas, processes, products or services" [53, 2].
As this definition already suggests, various different types of innovation exist. Joseph Schumpeter, one of the first economists who contributed to the field of innovation in a scientific manner, proposed the following five types of innovation [48]:

1. Product innovations (i.e. the *introduction of a new product or a qualitative change in an existing product*)
2. Process innovations (i.e. the *process which is new to an industry*)
3. Input innovations (i.e. the *development of new sources of supply for raw materials or other inputs*)

4. Market innovations (i.e. the *the opening of a new market*)

5. Organizational innovations (i.e. the *changes in industrial organisation.*)

Each of these innovation types comes with an individual definition of innovation. Nevertheless, we're convinced that a more sophisticated definition of innovation should be given at this point. Therefore 60 definitions of innovation from various fields of business as well as research and across the different types of innovation have been analysed [3]. This work came up with an universally valid way of defining what innovation is and what innovation consists of. Therefore 60 definitions of innovation, which are based on a literature reviews, have been collected and a content analysis for the most common key attributes of innovation definitions has been conducted. Thereby six most common and important attributes of innovations (i.e. *stage, type, aim, nature, means* and *social*)have been identified. The result was the following definition:

"Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace." [3, 12]

As we've pointed out above, we're investigating the Austrian software sector exclusively for product innovations. We decided to apply this limitation because of two reasons. First of all this type of innovation seems to be of particular importance in the context of competition in software sectors. Secondly we are convinced that this limitation makes the focus of the thesis better researchable. To give an appropriate definition of product innovation, we refer to the OECD's *The Fourth Community Innovation Survey*.
Therefore we define a product innovation as *" .. the market introduction of a new good or service or a significantly improved good or service with respect to its capabilities."* [20, 23]

Another rather general and scientific categorization of innovations was given by Joseph Schumpeter. In his work he identified two major patterns of innovation activities, which are commonly known as Schumpeter Mark 1 and Mark 2. In these two categories innovation activities are structured and organized in different ways.

Schumpeter Mark 1 (which is also known as *creative destruction* or *widening*) is characterized by market entries and innovation activities performed by entrepreneurs and new (small) firms as well as high turbulence in the hierarchy of innovators [9].
Schumpeter Mark 2 (also known as *creative accumulation* or *deepening*) consists of dominant and (large) established firms as well as stability of the leading innovators [9].
Typical characteristics of Schumpeter Mark 1 and Mark 2 markets are [9]:
In the software sector, examples for both patterns can be found. *Schumpeter Mark 1* are rather competitive regimes, which can be recognized in mobile applications or communication systems [9] [11].
Schumpeter Mark 2 patterns are typically found in software markets with high network effects, for instance office applications, ERP-systems or e-commerce software [9] [11].

Characteristic	Schumpeter Mark 1	Schumpeter Mark 2
Patent growth rate	High	Low
Concentration of patents across firms	High	Low
Entry of new innovators	High	Low
Number of patents of new innovators	High	Low
Technological pervasiveness	Low	High
Variety of knowledge sources across technological classes	High	Low
Share of citations to patents from universities and public research centres	High	Low
Share of self-citations	Low	High

Table 2.3: Comparison of Schumpeter Mark 1 and Mark 2 patterns

2.4 From Systems Theory to Innovation Systems

At this point it is important to note that innovation performance is not a phenomena which is limited exclusively to companies or to research institutes. Rather it arises in different organizations or departments within the private industry or the public sector. In fact outstanding innovation performance is most often observed to arise within (social) systems and through strong interaction of their actors.
Therefore it can be said that innovations are *systematically* created. In this context we can observe so called innovation systems. To explain the basics of innovation systems the concept of *systems theory* is of significance and is therefore explained in this part of the thesis.

Systems theory can be used as a interdisciplinary and general approach to the topic of innovation systems. Systems theory describes concepts for the cross-disciplinary study of systems in general. Whereas systems are abstractly seen as “a set of objects together with relationships between the objects and between their attributes” [25, 1].
In terms of a general tendency of interdisciplinarity as well as continuing integration of sciences, such a general theory of systems can be of importance. It allows the understanding of system components as well as dynamics and enhances the matching of a system’s individuals with the corresponding environment [5] [54] [19].

Like already mentioned above, system theory is a general approach, which does not suggest any particular framework or strategy. It rather serves as a metatheory for understanding the characteristics of systems by “... by looking at the system as a whole, with its relationships and interactions with other systems, as a mechanism of growth and change” [19, 4].

2.5 Fundamentals of Innovation Systems

Given the definition of systems theory, we introduce the concept of innovation system in this section. It provides a deeper understanding of innovation development as well as its diffusion throughout (social) systems.
Innovation systems serve as a common analytical tool to investigate the innovation ability of nations, regions, sectors or specific technologies and are defined as a "set of actors and institutions and their interactions including the flow of information, knowledge and resources, as well as market transactions" [30, 2 f.]. The innovation systems concept points out that innovation performance is not mainly based on achievements of individual actors but is emerging in social processes, that result from interactions of different actors in institutional configurations [30].
In research, innovation systems provide a basis for a technology- and actor oriented analysis and are therefore used as frameworks for systematic analysis of determinants of innovation and economic growth. The development, diffusion and utilization of innovations are the goals of innovation systems [4].

Generally they can be viewed in various dimensions [8]:
On the one hand side there are geographical dimensions in which innovation systems can be investigated. In such a framework the focus lies on the geographical boundaries of the system. Common state of the art frameworks are *national systems of innovation*, *regional systems of innovation* and *local systems of innovation*.
If specific technologies or business sectors are important for the investigation, *sectoral systems of Innovation* and *technological systems of innovation* are widely-used frameworks.
Finally the time represents an further dimension. In this case various snapshot of the system at a particular point in time are made and represent the basis of investigation.

2.6 The Triple Helix Model

In this section we present the triple helix model. Therefore we provide a definition as well as the model's origin and development. Moreover we present different implementations of the triple helix model and their applications. Finally we point out the roles and contributions of the different actor groups (i.e. "spheres") of the model.

2.6.1 Definition

Analogue to the innovation system approach, the triple helix model of university-industry-government relations has been presented [33]. Generally the triple helix model serves as a framework for the analysis of innovation dynamics. Thereby the triple helix model is a methodological tool that focuses on the overlay of communication, information and roles among three institutional spheres - namely the university, industry and government - to investigate contemporary innovation processes [34].
The model focuses on the relationships between universities, government institutions and industry companies and points out the significance of interactions between the actors of these

institutional spheres for innovation in knowledge-based economies. Therefore it is rather the creation of new arrangements of institutional spheres than the development of new products that foster the conditions for innovation.

The implications of the triple helix model are expressed and presented in ten propositions [15]:

1. Relationships and arrangements among the spheres of the TH model are the source of innovation, thereby academic research more and more intersects with industrial advance and governmental policies.

2. Development of organizational innovations, new social arrangements and new interaction channels become important for fostering innovations. Typical examples are technology parks, coworking spaces as well as incubators and accelerators for startup companies.

3. Linear- and reverse-linear model of knowledge transfer interact. Thereby, technology push and market pull models coexist, interact and form an interactive model.

4. Capital- and knowledge creation process occur in parallel. This means that new organizational forms allow the combined growth of knowledge and financial capital, such as venture capital firms or incubator and accelerators.

5. Since universities are about to interact more and more with industry and government, human, social and financial capital become exchangeable and transform into each other.

6. Continuous firm formation, knowledge exchange and collaboration increase with organizational innovations on regional, national and international levels.

7. Developing countries and regions can speed up their developement process through the construction of niche knowledge sources. University networks can be used to open research frontiers. This allows to solve local problems and transfer local innovations abroad.

8. Technological innovations reshape the innovation landscape and foster reorganizations across institutional spheres, industrial sectors and nation states.

9. Universities can boost the regional economic development while new academic institutions are consciously launched by the government.

10. Broadbased research institutions, which are supported by the government and combined with strategic investments in emerging technologies and research areas, provide the basis for paradigm shifts, innovation behaviour and self-organizing networks of innovation.

2.6.2 Origins and Development

The state-of-the art triple helix model, which builds up on equally valued interacting and overlapping spheres, originated two essentially different standpoints: On the one hand there is the concept that the government controls academia and industry, the so called *Statist Model*. On the opposite side there is the *Laissez-faire Model* in which the government, the industry and

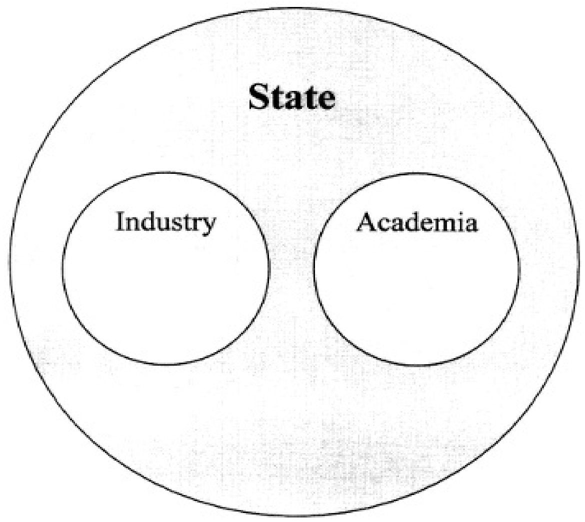

Figure 2.1: The statist model [16, 12]

academia interact only modestly and are separated through strong boundaries [16].

In this section we present these two models, identify similarities and differences and point out how these two different approaches opened out into the state-of-the art TH model of interacting fields.

2.6.2.1 The Statist Model

Different from an approach where all spheres are equally valued, the statist model represents an approach where the government encompasses the spheres of university and industry and acts as a dominant sphere (Figure 2.1). In this model research departments and specific industries are subordinated parts of the state, while the government coordinates the interaction between the other spheres, takes the lead in developing innovation projects and provides the necessary resources [16] [15].
The statist model is characterized by universities, which mainly act as teaching institutions and applied research institutes that are specialized for particular industries. The industry on the other hand is likely to follow central (production) plans, like the five-year-plan of centrally-planned economies or production plans of agricultural goods nowadays.

Typical examples for the statist model are military (research) projects or on the large scale political systems like the former soviet union or contemporary autocratic ruled countries like North Korea.
History has shown that the statist model can indeed produce great results. In times of national emergency like war, poverty or natural disasters outstanding performances and results in short times can be reached.

The disadvantages of the statist model are apparently a bureaucratic coordination of ideas and innovation processes that suppress other sources of innovation.

Several trends led to a step-by-step decline innovation systems which build up on the statist model. On the one hand this model dissolves as soon as the top-down control starts lacking. The fall of the USSR is an example for that. Bottom-up innovation was arising also trough trends like stronger municipal governments (like the "Bundesländer" in Austria) with own programs to strengthen the economy of the region and with stronger industry- or business associations.

2.6.2.2 The Laissez-faire Model

The laissez-faire model follows a quite oppositional approach where the three spheres are widely separated and are not intended to interfere too much with each other (Figure 2.2). This strict separation of spheres leads to narrow definitions of roles and strong boundaries between the spheres [15].

In this model the university provides trained people and basic research, while the industry receives useful knowledge from universities and is in charge of coming up with commercialized innovations and value creation. The role of the government is expected to be limited to clear cases (i.e. market failure), with clearly defined actions like regulation or activities that can not be provided by the market at a certain point of time, like buying or taxation. Generally functions and spheres are assumed to be related on a one-to-one basis (i.e. university - basic research, industry - production, government - regulation) [16].

The most typical example for this model is the widely deregulated free market economy of the USA. A strong presumption of individualism, combined with fundamental skepticism of government corresponds with the accepted US belief of a model of industry, university and government that operate in separate areas without strong connection [16] [15].

In reality the spheres are likely to operate closer together than expected and modifications of this policy of strict separation take place. On the one hand did national emergency situations motivate the US government to move away from its standpoint, since it did more and more interfere with open market. Further did the federal government (under the growing international industrial competition) start to turn over intellectual property rights of research results that were funded by the government. The goal was to transfer those property rights from the government and universities to private firms to raise the technological level of the industry [15].

2.6.2.3 The Field Interaction Model

A triple helix model which allows interaction between university, industry and government through overlapping spheres is represented by the field interaction model. As Figure 2.3 shows the models builds up on helices with internal cores and external (overlapping) field spaces.
This model allows that the university plays industry roles, while still staying a separate unite and without being a true enterprise. Vice versa, the industry can form teaching and research

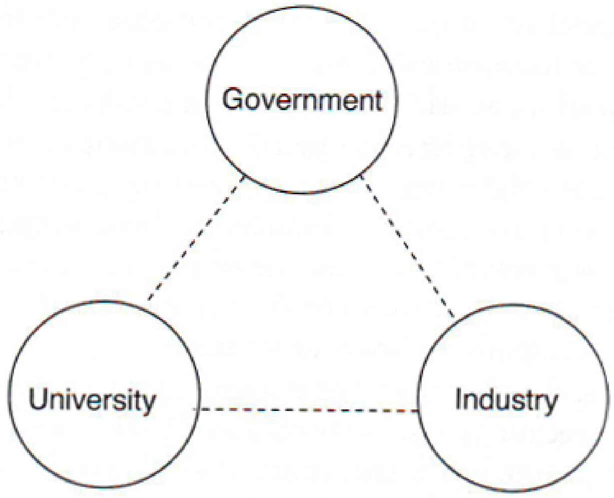

Figure 2.2: The laissez-faire model [16, 13]

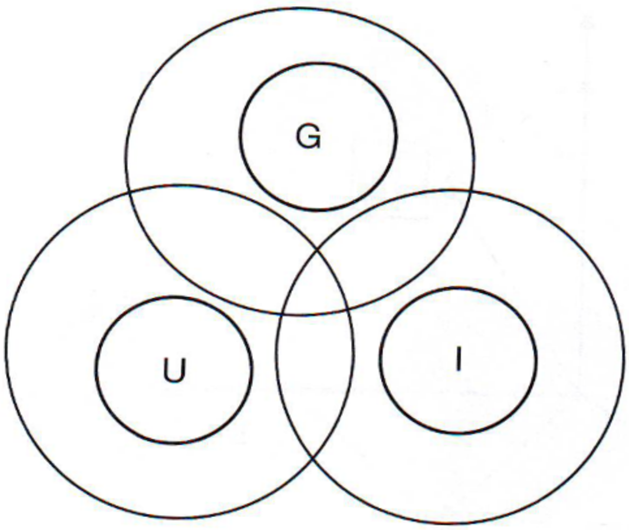

Figure 2.3: The field interaction model [16, 19]

entities, without loosing its core functions. Similarly public enterprises as well as cooperation between government and academia (e.g. through funding, property right transmissions etc.) may exist, while each sphere still keeps its own distinct and independent status. This balance between "taking-the-role-of-the-other" (this principle will be further explained in Section 2.6.3) but staying an independent sphere can be said to be the main characteristic of the field interaction model [16].

Nowadays we find forms of the field intersection model in well balanced social economies with moderately interfering governments and most countries and regions are trying to reach a triple helix similar to the field intersection model. It is important to point out the necessity of a well balanced model with interacting but independent spheres. If the government is to strong, a statist model might be formed, while to strong separation leads to a laissez-faire situation [16] [17].

2.6.3 Enhancing Roles of the Model's Spheres

In a well balanced triple helix model is the interaction between the spheres strong enough that each sphere partly takes the role of the other, while it preserves its primary role and distinct identity. This means that firms don't become universities and governments don't become businesses. Instead "taking-the-role-of-the-other" means to participate in the capitalization of knowledge and leads to the development of of new academic research and education programs. Therefore each sphere becomes the creative source of innovation [15].
In the following sections we present the enhanced roles of each of the spheres in a triple helix model.

2.6.3.1 The Role of the University

In the context of a TH model with overlapping but independent spheres, a transformation of academic institutions into so called *entrepreneurial universities* becomes necessary. Thereby universities become sources of knowledge, human resources and technology.

Four pillars define the a entrepreneurial university [16]:

1. Ability to formulate and implement a strategic vision
2. Legal control over intellectual property (e.g. patents) and physical property (e.g. university buildings)
3. Organizational capacity to transfer technology in terms of patents, licenses or through incubation
4. Entrepreneurial ethos among students, faculties and administrators

As the "capitalization of knowledge" becomes important, an entrepreneurial university should not consider its research results only as intellectual potential, but must also consider its commercial potential. Therefore it transforms into a natural incubator and provides support structures for professors, researchers and students to initiate new ventures [16].

2.6.3.2 The Role of the Firm

Entrepreneurial universities and governments, who operate supportively, as well as existing firms pursue growth strategies that are based on incubation and academic innovation. Especially in western service economies, so called knowledge-based firms have an outstanding role as a driver of economic growth and develop typically as spin-offs of either universities or existing firms [16].
Knowledge-based firms can be defined as those enterprises, which are considered to have knowledge as the most strategically important resource [22]. While universities are especially important for the creation of knowledge-based firms, there are ten factors that have been identified in regions with high emergence of knowledge-based firms [16]:

1. Existence of networks that link scientists and engineers among universities, firms and the government
2. Existence of research groups in fields of potential commercialization
3. Sufficient scientists and engineers who are interested in founding their own business
4. Availability of seed capital
5. Suitable and low priced office space for new firms
6. Availability of necessary equipment
7. Opportunities to learn business skills and access to necessary human resources in this field
8. University policies designed to encourage interaction with the industry, give academic credit and give clear guidance for appropriate industry activity
9. Applied research institutes, centers and incubators to assists firm development and provide mediating linkages between scientists and the industry
10. Residential community with the ability to hold qualified people

Therefore the role of the firms has transformed from a competitive unit, that is related to other companies only through the competition of the market, into a triple helix entity that is based on relationships with other firms, the government as well as academia and with a stronger focus on innovation and organizational change [16].

2.6.3.3 The Role of the Government

For a common TH model with equal spheres that are overlapping but independent, the role of the government must be established at a mid-point between its role in a statist - and a laissez-faire model. In the statist model triple helix relationships and innovation processes have been directed top-down. With the growth of civil society as well as the emergence of regions bottom-up initiatives appeared. In societies that implemented rather a laissez-faire model the emergence of a triple helix is associated with a stronger role of the state, that acts together with the industry and universities to shape innovation initiatives [16].

Innovation processes, which are coordinated entirely by the (central) government, benefit only from few sources of ideas and initiatives. As mentioned above, larger projects in the past could definitely be successfully implemented with a statist model. Nevertheless, most of the time it is not the most productive form, since regional and local levels as well as inputs from universities and the industry provide a much broader base for research and development. A decentralized innovation approach across institutional spheres can be more effective, since it provides more sources of creativity as well as ideas and takes regional differences into account.
Therefore the government is assumed to take a new role in innovation by encouraging the university-industry interactions, acting as a public venture capitalist and by filling the gap between university support for firm-formation and the take-up by private venture capitalists [16].
In the context of technology transfer, an expanded role of the government with more legitimization to interfere has developed. Regarding the connection between the location of research and the future location of industry - which is arising from that research - more pressure on the central government arose to increase research spending and to distribute it more broadly. Because of the apparent effects of those research spendings on local economic growth and the creation of new jobs [16]. The government has moreover the ability to influence university development, for instance through founding and funding universities, research institutes or military academy.

2.7 The Sectoral Systems of Innovation Framework

In this section we present the sectoral system of innovation framework. Therefore we provide a definition as well as the frameworks characteristics, i.e. building blocks, dynamics and transformation and geographical boundaries. Finally we present a scheme of analysis and manual for analysing these characteristics.

2.7.1 Definition

In the context of an analysis of sectoral system of innovation, we first want to give a proper definition of the term *sector*. A common definition of a sector is the following: “A sector is a set of activities unified by some linked product groups for a given or emerging demand and characterized by a common knowledge base” [40, 16].
Based on that and the definition of innovation systems, that was given above, we define a sectoral system of innovation (SSI) as “a set of agents carrying out market and non-market interactions for the creation, production and sale of sectoral products” [38, 1].
Alternatively, a more concrete interpretation defines sectoral systems of innovation as “a set of products, knowledge and agents that have different interaction for the creation, production and sale of products, which interact through processes of communication, exchange, cooperation and competition in search of creating a co-evolutionary transformation of these different elements” [47, 2].
The mentioned agents are either organizations or individuals. While individuals are typically easy to identify (e.g. consumers, scientists or entrepreneurs), organizations may be further di-

vided into firms (e.g. suppliers, buyers or competitors) as well as non-firm organizations (e.g. universities, government agencies or trade unions). They can arise within larger organizations (i.e. subunits) as well as across several organizations (i.e. group of organizations). Agents can furthermore be characterized by *competencies, learning processes, objectives, beliefs, behaviour* as well as *organizational structures* and interact with each other through *exchange, cooperation, competition, command* and *communication processes* [40].

2.7.2 Building Blocks

To describe and analyse a specific sectoral system of innovation, the framework proposes the following main building blocks [40] [38]:

1. Knowledge base and learning processes
2. Basic technologies, inputs and demand
3. Actors and networks
4. Institutions
5. Processes of variety- and selection-generation

2.7.2.1 Knowledge Base and Learning Processes

Knowledge represents the basis for technological change and is significantly important for innovation, especially in knowledge-based economies. Furthermore knowledge is often bound to a individual organisation and does not diffuse automatically and freely. Therefore cumulativeness, accessibility and opportunity are dimensions of knowledge and learning processes [40].

Cumulativeness, as the degree to which new knowledge builds up on existing knowledge, has three sources. The first source are dynamic increasing return returns at technology levels and learning processes. The second source are firm-specific organizational capabilities which define what a company can learn. The third source are feedbacks from the market. Through innovation success profits are generated, which can be reinvested into further research. Thereby the probability of new innovations is increased [38].

Accessibility on the other hand is the opportunity to collect knowledge that is external to a firm. Accessible knowledge can be external or internal to a sector. Higher accessibility internal to the sector implies that competitors can also collect knowledge and imitate innovations. External accessibility is related to scientific and technological opportunities [40].

The sources of *opportunities* differ among sectors. In some sectors opportunity conditions are related to major scientific breakthroughs. In other sectors opportunities come from advanced research and development, instrumentation and equipment [40].

2.7.2.2 Technologies, Inputs and Demand

Sectoral systems of innovation differ in terms of technology. Technology affects a wide variety of variables in a SSI, such as strategy, organization, performance and competition of a sector's companies [40] [38].
For some sectoral systems more than one technology may be relevant, therefore firms (even if they are specialized in one product) often have to master several technologies. However, firms that operate within the same sectoral system usually operate with similar technologies [38].

The same applies to the demand. "In a sectoral system demand is not seen as an aggregate set of similar buyers, but as composed by heterogeneous agents with individual attributes, knowledge and competencies who interact in various ways with producers" [38, 9]. Therefore demand has three sources, which are individual consumers, firms and the public sector. These sources are itself further affected by sectoral and national institutions and social factors. Demand is an important factor for the emergence and transformation of sectoral systems as well as for innovations in the sectors and constitutes a stimulus as well as a major constraint of innovation at the same time. As demand comes together with technology, it defines the problems that firms must solve with their innovation and production activities as well as the types of constraints and incentives on particular behaviour and organizations [40] [38].

2.7.2.3 Actors and Networks

Innovation systems typically consist of networks of agents which are related to each other. In sectoral systems those agents are called *actors*. Actors can be divided into two major groups: *Individuals* and *organizations*. Organizations can be further subdivided into *firms* - in the form of an economically independent organizational unit - and *non-firm organizations*, for example universities, financial institutions or government agencies [40].

Firms represent the key actors of every SSI and take part in innovation, production and sale of the sector's products as well as in the generation, adoption and use of novel technologies. As economically independent organizational units, they include not only those companies that are competing or collaborating in regard of a specific market or technology but also contain users and suppliers. While users put an emphasis on the factor *demand*, suppliers are involved in affecting innovation, productivity and competitiveness of downstream sectors. This shows that the actors, which are involved in a SSI, don't necessary have to be product or service producing companies in that sector itself, but may be operating in other sectors. A typical example are the strong relations between software companies and microelectronic producers (e.g. the WINTEL world as a collaboration between INTEL and Microsoft) [38].
The fact that firms are heterogeneous is an essentially important feature of SSIs. The heterogeneity regarding types, competencies, behaviour, beliefs and organizations is based on different reasons, such as differences in knowledge base, experience and learning processes, but also individual interaction with demand or specific firm histories [40] [38].
It is important to point out that a firm as a whole is not always the best analysis unit. Very often are firm subunits - e.g. the R&D department - or groups of firms - such as joint ventures - a

better granularity to investigate a SSI's actors and networks.
Beside firms, not-firm organizations - such as universities, research institutes, government institutions or technical associations - are the second group of actors. In numerous ways they support firms in innovation, production and diffusion of products. Similar to firms, significant heterogeneity can be found among non-firm organizations and their role differs significantly among sectoral system. The role of the military is a completely different for the robotics sector than for the financial sector for instance [40] [39] [37].

The actors of a SSI are interacting with each other and become interdependent through market but also non-market relationships. The sum of these interactions and interdependencies forms a *network*. Thereby different kinds of relations between the actors (firms as well as non-firm organizations) can be identified. On the one hand actors constantly perform processes of exchange, competition and command - for example in terms of vertical integration of the supply chain. On the other hand co-operation or informal interaction among firms and non-firm organizations but also between firms and non-firms organizations exists, which lead to various organizational forms, such as hybrid governance forms or formal R&D cooperation. Finally formal and informal interaction and co-operations emerge in uncertain and changing networks with heterogeneous actors. Therefore knowledge, capabilities and specialization are integrated in the network [38] [40].

2.7.2.4 Institutions

Institutions (for example norms, routines, habits, established practices, rules, laws and standards) affect the interactions of a sectoral system's agents. They may be more or less binding and differ among various sectoral systems of innovation. Institutions affect SSIs in two different ways:
On the one hand there are institutions which affect the development and innovation in specific sectors, those are called sectoral institutions. Sectoral institutions are either a results of deliberated planned decisions by a sectoral systems actors or they emerge as a unpredicted consequence of agents interactions. Typical examples are regulations in the financial sector or software standards [37] [38] [40].
On the other hand there are institutions which are valid across sectors, so called national institutions. These institutions effect various sectoral systems, whereas the effects can differ among the sectors. Moreover the same institution can take different features in different countries may therefore affect the same SSI differently in another country [37] [38] [40].

It is important to point out that the relationship between institutions and sectoral systems is not one way. It can occur that institutions of a specific sector become national standards and therefore relevant for other sectors [40] [38].

2.7.2.5 Processes of Variety- and Selection-Generation

There are two types of processes that influence the heterogeneity of sectoral systems and their actors: Processes of variety creation and processes of selection, which reduce the variety in economic systems and inefficient utilization of resources [38] [39].

Sectoral systems of innovation strongly differ in the heterogeneity of actors and have individual processes of variety creation. These processes are related to various mechanisms that interact on different levels, such as product development, market entry, imitation or sales. They create more variety in the SSI regarding products, technology, actors, institutions, strategies and behaviour. Typical examples may be the creation of new actors, which brings more variety of knowledge or approaches in innovation or production processes. Another example is the creation of new sectoral institutions, that support the emergence of new technologies [38].

Processes of selection on the other hand reduce heterogeneity. They affect the growth and decline of actor groups as well as the range of feasible organizational forms and behaviours. In addition to the typical selection within markets (e.g. selection of a standard product, selection of suppliers etc.), non-market selection processes exist, for instance with the involvement of the government and public interest [38].

2.7.3 Dynamics and Transformation

Sectoral systems of innovation and their variables are not static. Rather they are changing in terms of constant evolution and transformation processes.
Therefore changes in innovation patterns may occur, such that a sectoral system may change from a Schumpeter Mark 1 to a Schumpeter Mark 2 system or vice versa.
Moreover can the system's knowledge base change. Thereby either an evolution towards a dominant design or a drastic change occurs. The first option implies a growth of concentration and a rise of rather large and dominating firms. The second option implies a major industrial turbulence with entry of new firms and a turnover in the industrial leadership, which requires new types of competencies for innovation.
Finally significant modification take place regarding demand, users and application that have an influence on the context in which firms operate or entry a new market [40] [38].

2.7.4 Geographical boundaries

Geographical boundaries are an important factor in every analysis of sectoral systems. Traditional sectoral systems (e.g. agriculture) - which have learning processes with low degrees of opportunity, appropriabilities and cumulativeness as well as a knowledge-base that is embodied in equipment and material - are typically geographically dispersed. Software or modern microelectronics industries, which are associated with very high opportunity conditions and a wide variety of potential technological approaches, are typically geographically concentrated with simultaneous global and local knowledge boundaries. Empirical research has confirmed that major differences exist across various sectors regarding the patterns of innovation activities, while for the same sector such patterns are typically similar across countries [38].

Thus we can say that in contrast to a national system of innovation, national perspectives are not necessarily the right geographical boundaries of a sectoral system of innovation. Whereas in

some sectoral systems the relevant geographical boundaries are global, some sectors are highly localized and define the specialization of a whole region - such as machinery, but also information technology [39].
Software sectors can often be found as hubs with regional geographical dimensions, such as the Silicon Valley in California, the emerging software hub around Bangalore in India or the internet company startup ecosystem around Berlin in Germany.

2.7.5 Application of the Framework

In the context of this thesis we investigate the Austrian software sectoral system of innovation. Therefore we analyse it for structural components and functional patterns according to the SSI framework. [4] present a scheme of analysis and manual for analysing the characteristics, dynamics and functionality of sectoral systems of innovation. It consists of the following eight steps (Figure 2.4):

1. Definition of the focal SSI
2. Identification of the structural components of the SSI
3. Functional analysis of the SSI
4. Assessment of the fulfilment of functions and definition of process goals
5. Identification of features that block or induce positive functional development
6. Specification of key policy issues that block or promote positive functional development
7. Evaluation of the expected impact of different policy on inducement and blocking mechanisms and functional patterns
8. Reflection, learning and improvement of the manual

The starting point to derive a specific sectoral is the *definition of the sectoral system* that will be investigated. Therefore a specific technology, product or product group should be selected. Moreover the SSI should be further defined regarding the level of aggregation and specificity of the study. Next the range of applications of the product(s) or technology can be defined to narrow the focus further down [4].

After the definition of the SSI, which will be investigated, the next step is to *identify and analyse the structural components of the sectoral system* [4].
In terms of actors, firms along the value chain, universities, research institutes and public bodies, must be included in the study [4].
Networks are the second structural component. Regarding the TH model these networks occur within the individual spheres or between overlapping spheres. Both formal and informal networks exist, which are supposed to be identified. Typical formal networks are for example standard setting committees, consortia or industry associations. Informal networks on the other

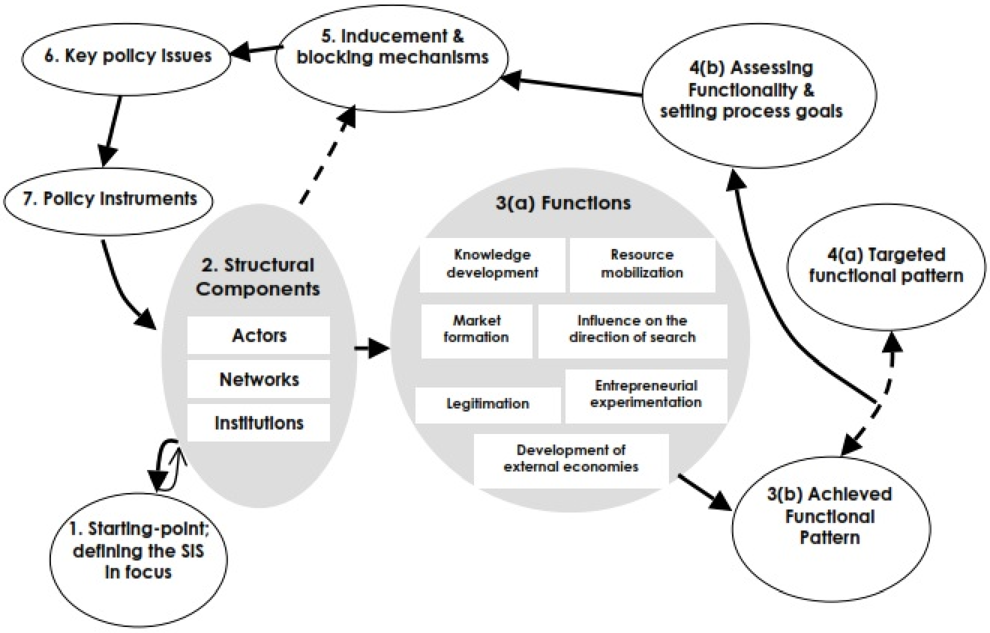

Figure 2.4: Graphical representation of the scheme of analysis [4, 3]

hand could be joint ventures or university-industry projects [4].
Finally institutions must be specified. They arise in a wide variety of forms (e.g. laws, culture, regulations or norms) and can be divided into national and sectoral institutions.

In the third step a *functional analysis of the SSI* will be performed. The structural components contribute to the innovation system's goals. This contribution is referred to as a "function". In this step of the SSI analysis a description of the functional patterns is conducted (i.e. to what extent the functions are filled in the SSI) [4].

The description of the functional patterns that have been conducted does not tell whether the functions are well implemented in the SSI. Therefore an *assessment of the fulfilment of functions and definition of process goals regarding the functional patterns* is to be performed to evaluate the goodness of a particular functional pattern. Two bases for an assessment are proposed, i.e. *industry lifecycle models* and *system comparisons* [4].

Furthermore a sophisticated identification of *features that block or induce positive functional development* must be conducted. Functions, which were identified to be weakly implemented, can be so because of various reasons. Structural features, which induce or block the development of these functions, must be uncovered. The relationship between inducement and blocking mechanisms can be mapped using diagrams (Figure 2.5) [4].

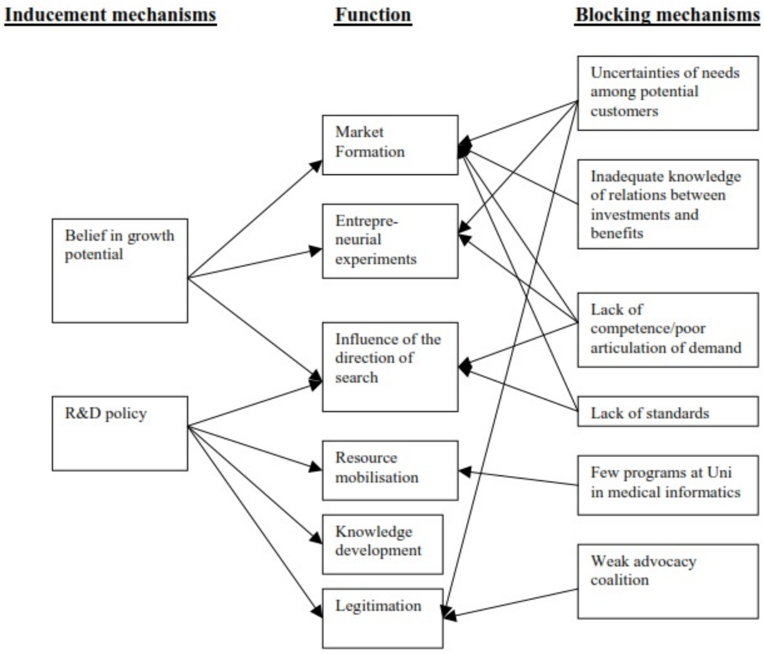

Figure 2.5: Example for inducement and blocking mechanisms [4, 23]

In a next step the manual suggests to specify the *key policy issues that block or promote positive functional development*. Policy issues that regard the features of the structural components can hinder or promote the development of desirable functional patterns. To remove poor functionality policies should add or strengthen inducement mechanisms and remove or weaken blocking mechanisms [4].

Moreover an *evaluation of the expected impact of different policy on inducement and blocking mechanisms and functional patterns* has to be conducted in which specific instruments, which deal with policy issues and help to achieve functional goals, need to be chosen [4].
In this context three problems have to be considered: First of all, there isn't a general "success model" for the stimulation of emergence and growth of sectoral systems of innovation. Secondly the complexity of functional patterns is rather high because of the interdependence of functions and mechanisms. This means that analyses require a profound understanding of the involved technologies, products and applications. Finally, the results of interventions are rather uncertain. This means that strategies as well as policies can have secondary effects and lead to feedback loops with unforeseen effects [4].
The approaches can be undertaken to evaluate the expected impacts: On the one hand the extent to which policy instruments are expected to effect the previously identified blocking or inducement mechanisms can be assessed by addressing the key policy issues that have been identified. On the other hand one can assess the influence, which a specific policy instrument is expected to have on the defined functions, their interactions as well as on the innovation system in gen-

eral [4].

The final step consists of *reflection, learning and improvement of the presented manual*. Thereby the authors suggest to implement a process of reflection, learning and feedback to improve the manual as well as the understanding or the opportunities and limitations of policy making [4].

2.8 Similarities and Differences

A sophisticated and detailed comparison of the triple helix model and the sectoral system of innovation framework, regarding the frameworks' specific definitions, characteristics and implications, would exceed the frame and also the focus of this thesis. Therefore we want to identify the most important similarities, differences and synergies, which are practically significant in terms of this thesis.
Therefore four major aspects will be discussed, which are identified to be significant for the application of the frameworks in this thesis. These four aspects have been identified in comparative literature, which compared the TH model with innovation system approaches.

1. The most obvious and most important difference is the fact the SSI framework provides a holistic approach to a systematic technology- and actor-oriented analysis of determinants of innovation and economic growth. For this holistic view it suggests several building blocks, which make up a sector specific system in which innovation can be implemented. A triple helix on the other side is an actor oriented approach, which focuses exclusively on the actors (spheres), their interaction and relationship to explain arising and successful innovation performance.

2. In sectoral systems firms represent the most important actor. Thereby innovation and product development take primarily place in the industry, while universities and the government play only a supporting role. The TH model proposes three equally important spheres of actors, which are industry, university and government. Innovations arise therefore not in form of product development in firms but as new activities in the interaction between the spheres [17] [15].

3. Regarding the roles of the actors, each actors plays only one traditional predefined role in innovation systems. The triple helix model incorporates several roles for each sphere. This means that the actors can perform multiple functions. This is metaphorically represented by the overlapping spheres. Therefore the industry can take educational and research functions, while universities can take industry- or firm-like functions, for example by operating as entrepreneurial universities [16] [17] [15].

4. Innovation systems have clearly defined boundaries, which can be geographical (e.g. in case of national systems of innovation or regional systems of innovation) or also product- or technology specific (e.g. technological systems of innovation or sectoral systems of innovation). The TH model does not presume a system that is a priori delineated in terms of

(geographical) boundaries but allows to explain the generation of innovation in social systems and provides a concept that allows to optimize social systems of industry-university-government relations for innovations [35] [15].
In this context the TH model is a framework for "investigating empirical questions at a level of systemness, defined in terms of regimes and trajectories" [35, 2].

It has been shown that there are several conceptional similarities as well as specific difference between these two approaches. Beside them we suggest to use these frameworks in a complementary way. The triple helix model can therefore be used to support and enrich a SSI analysis, for example when identifying the significant actors and their relationships as well as the actors' roles and functions of the sectoral system. Furthermore the TH model helps to reveal interdependencies and boundaries, which arise through the roles and interactions of actors. Therefore it has been stated that "...the Triple Helix perspective has enriched the conceptual and empirical dimensions of innovation as a systemic phenomenon, thus potentially improving the effectiveness of innovation policies at regional and national levels, and in a system where knowledge production is being increasingly globalised" [35, 18].

CHAPTER 3

Method

In the context of this master thesis we investigate the Austrian software sector for its ability and success to innovate and derive the Austrian software sectoral system of innovation. Since software becomes more and more a component of many everyday products (e.g. cars, kitchen equipment, home (energy) maintenance etc.), it is difficult to identify the boundaries of the software sector. In the context of this thesis we define the Austrian software sector as all companies that develop and sell software as well as software services in Austria. As this definition already suggests, we exclusively focus on product innovations (i.e. newly developed products and services).

3.1 Selection of research methods

Before specific research methodologies can be chosen and applied, an overview of the various kinds of methods and their areas of application must be gained. Generally one can distinguish between qualitative and quantitative research designs. More specifically in empirical social research, the following types of methods to inquire social data are generally distinguished [1]: *observation, survey, experiment* and *content analysis*.

3.1.1 Qualitative-, Quantitative and Mixed Research Design

In accordance to [51] three research paradigms exist: Qualitative -, quantitative - and mixed research methodologies. In the following paragraphs each research paradigm as well as its characteristics are presented.

Qualitative research can be defined as a research approach that focuses on "understanding the meaning people have constructed, that is, how people make sense of their world and the experiences they have in the world" [43, 13].
Therefore qualitative research is descriptive and of exploratory nature. It is used for generating new hypothesis and theories from data that has been collected during fieldwork and it used to

study the context in which specific behaviour occurs (i.e. the natural environment) [51].

Quantitative research can be defined as a research methodology used for explaining phenomena by collecting data which is analysed using mathematically based methods [51]. They help to quantify specific variables (such as attitudes or behaviour) by generating numerical data and generalize results from large data populations. Therefore specific behaviour is studied under controlled conditions [51].
In comparison to qualitative methods (in which the sample size is typically small), quantitative methods are typically more structured, systematic and are based on large data samples.

According to [51] a *mixed research design* is a research type in which qualitative and quantitative research methods are mixed in one overall study. Therefore a qualitative research paradigm is used in one stage of the study and a quantitative research paradigm is used in another stage. The goal of this approach is to mix qualitative and quantitative methods in a way that the resulting combination has complementary strength and non-overlapping weaknesses.

In [14] two mixed methods research designs are distinguished:
The *sequential design* implies collecting data in an iterative process in at least two steps, whereas in one step qualitative and in the other step quantitative research methods are used [10]. The data collected in one stage contributes to the data collected in a following stage. The major advantage of this approach is that it provides "more data about results from the earlier phase of data collection and analysis, to select participants who can best provide that data, or to generalize findings by verifying and augmenting study results from members of a defined population" [10, 121].
The *concurrent design* is a mixed method research approach, which is commonly used to "validate one form of data with the other form, to transform the data for comparison, or to address different types of questions" [10, 118].
One common concurrent methodology is the *methodical triangulation* or just *triangulation* [27]. Triangulation was generally defined as "the combination of methodologies in the study of the same phenomenon" [12, 291]. Using the metaphor of multiple reference points in geographical positioning, methodical triangulation improves the accuracy of scientific statements by collecting different kinds of data (qualitative and quantitative) of the same phenomenon [27]. For this thesis we decided to apply a methodological triangulation for the data collection about the Austrian software sectoral system of innovation and to make use of a qualitative and a quantitative research method concurrently.

3.1.2 Empirical Social Research Methodologies

We investigated characteristics and application of common empirical research methodologies to be able to select appropriate methods for this thesis. In this part we define and present the characteristics of *the observation, the survey, the experiment* and *the content analysis*.

3.1.2.1 Observation

According to [1] an *observation* is the systematic perception, recording and interpretation of perceivable behaviour at the time of its occurrence. Therefore a description or reconstruction of the reality in the context of a specific research question should be given. An observation can be conducted in the context of a qualitative as well as a quantitative research methodology.
A classification of the most important observation forms can be carried out according to the degree of their structured nature, their openness and participation [1]. An observation can be structured or unstructured, whereas the dimension of structuredness refers to the process of perception as well as its recording. Unlike unstructured interviews the structured approach demands a pre-created monitoring scheme, which defined what will be observed and how [1]. Openness as the second classification criteria refers to the observation, transparency of the situation for the observed and may vary between concealed and open [1]. In contrast to an open observation, in a concealed approach the observed don't know that they are under observation. The participation refers to the degree of participation of the observer on the social situation, which he is observing [1]. In a passive participation the observer is limited to observation without interacting any further with the observed. In a active participation the observer participates in participates with the observed and might even be in intensive contact with them [1].
Although the observation is a versatile research method, it is hardly used in contemporary empirical social research [1].

3.1.2.2 Survey

A survey is a planned approach with scientific objective, in which the test person is inclined to verbal reaction through a series of questions [44]. Surveys are typically conducted orally face-to-face or over phone, written or over the internet. [1] presents seven types of surveys, which are defined through the two dimensions *communication type* (i.e. unstructured, semi-structured, structured) and *form of communication* (i.e. oral, written). In the context of this thesis we performed a structured, written online survey as quantitative research method as well as semi-structured, oral interviews as qualitative research method. According to [1] these survey types are defined in the following way: A structured, written online survey demands a preconstructed questionnaire, whereas the content, number and order of the questions are defined by the examination goal. To carry out the survey a questionnaire is hosted online and can be accessed by the participants over a browser. The results are immediately stored, therefore no returning of answered questionnaires is necessary. A semi-structured, oral survey is an interview with prepared and partly predefined questions, whereas die sequence of the questions is variable. This allows to take and follow up topics that have arisen during the conversation. It can be conducted over phone or face-to-face (which has both been applied in this thesis).

3.1.2.3 Experiment

Even though an experiment is not a particular way to measure social data, it can be defined as research methodology as it is a defined examination arrangement, which allows to determine causal relationships [1] [42]. It allows checking of previously theoretically specified statements in accordance with specified conditions and differs from the other research methods in the following three aspects [1]:

1. It allows to integrate participants and subjects in an artificial process and to represent or reproduce social relationships under control.

2. Extreme situations can be produced and corresponding hypotheses can be tested under test conditions.

3. It is considered to be the safest method to determine causal relationships in the context of social phenomena.

3.1.2.4 Content Analysis

Content analysis can be defined as a research methodology that allows to investigate communication content (such as pictures, videos or text), with a focus on the analysis of texts [1]. It can be both either empirical or hermeneutic, while empirical content analysis is quantitative and hermeneutic is qualitative. Social communication can be described as an exchange of symbols between sender and receiver. This fact is interesting since it allows to reason from the features of a text on the context of its creation and use [1].
Even though content analysis is a term that is widely used to describe one particular research technique, it is used for several different methodologies that are used to investigate communication content on different levels [44] [26]. According to [26] there are the following three approaches:

1. In a *conventional content analysis* one derives the coding categories directly from the text data.

2. The *directed content analysis* theory and relevant research findings are used as guidelines for initial codes.

3. *Summative content analysis* involves comparison and counting of content and text-related keywords, followed by an interpretation of the context of the text.

3.1.3 Research Framework

We performed a methodological triangulation with a qualitative and quantitative research method. A structured, written online survey was applied as quantitative research method and a semi-structured, oral interviews as qualitative research method.

We applied an online survey to inquire, how innovative the participating companies see themselves and how innovative they really are, using three common measurements of innovation performance. Moreover we used it to collect information about cooperation partners in form of other software companies, universities as well as research institutes and government institutions. We furthermore conducted interviews with universities, research institutes and government institutions, which were mentioned as cooperation partners in the survey. We used these interviews to gain a deeper insight into the research topic and receive further details about the cooperation and information exchange between the industry, universities and the government in the context of innovation activities.

A profound description of the usage of these scientific methods with a step by step explanation will be given in the section *Research Framework*.

3.2 Measurement of Innovation Performance

There are different ways to measure innovation performance and success. An analysis of 77 scientific articles about innovation measurement revealed seven measurement aspects, which are to be considered when measuring performance and success of innovation activities [13]:

1. Range of measurement (company, department, project, product family)
2. Technique of data collection (interview, questionnaire)
3. Time of measurement (before introduction, after introduction)
4. Source / subject of measurement (self-assessment, experts)
5. Dimension of measurement (economical effects, technical effects)
6. Measures of innovation success (financial, non-financial)
7. Reference size of the measurement (deviation analysis, comparison of time, comparison of companies)

We followed the presented approach and measured the innovation performance and success of Austrian software companies in the following way:
We performed an investigation of innovation performance and success on a company level *(range of measurement)* by conducting a survey using an online questionnaire *(technique of data collection)*.
We decided to focus on past innovation activities and measure therefore the success of innovations after their introduction *(time of measurement)*. A time frame of three to five years in the past has been suggested to be reasonable [13].Wwe decided to focus on those innovation activities of Austrian software companies which have been conducted in the last three years (i.e. 2011 to 2013).
The questionnaire intended to be filled in by employees (preferably the management) of the company, furthermore the questionnaire contains questions for (subjective) self-assessment as well as questions regarding objective measurements *(source / subject of measurement)*.
Regarding the *dimension of measurement* 46 indicators for the measurement of innovation success of enterprises have been presented. In the context of product innovations five innovation success measurements have been extracted [13]:

1. Share of sales generated by innovations

2. Share of profit generated by innovations
3. Number of new products
4. Number of patents
5. Expenditure for innovation activities

We decided to focus on the first three measurements (i.e. share of sales, share of profit, number of innovations) since they are widely accepted in innovation literature and have a low level of bias [13]. We therefore focus mainly on economical effects *(dimension of measurement)* using two financial- and one non-financial measure *(measures of innovation success)*.
Our final results are considered as the actual characteristics of the Austrian software sectoral system of innovation. Future studies can build on our results or compare them with their findings in terms of time or companies *(Reference size of the measurement)*.

3.3 Research Framework

We applied a multi-stage research approach, which consists of the following stages:

A theoretical framework of the analysis was built upon a literature review about the theory of innovation, innovation systems, the triple helix model as well as the sectoral systems of innovation framework. We also searched for similar studies about software sectors that have been conducted in the past. Moreover we conducted a literature based investigation of the Austrian software sector.

In the second stage we applied a quantitative research design. Therefore we conducted a survey with an online questionnaire and invited Austrian software companies to fill it in. The goal of the survey is to assess the innovation performance and success of Austrian software companies and to collect information about their cooperation with universities, research institutes and government institutions.

In a third stage we applied a qualitative research design as complementary and counterpart of stage two. We conducted *standardized open-ended interviews* with representatives of the universities, research institutes and government institutions. The goal of these interviews is to counter-check the information that was collected with the questionnaire and to receive information about how universities, research institutes and government institutions perceive cooperation with software companies in Austria.

3.3.1 Restrictions

In terms of feasibility we decided to utilize a constricted version of the SSI framework.
For the purpose of this analysis, we focus on the first three building blocks. Thus we investigate the Austrian software sector for its *knowledge base and learning processes*, its *technologies, inputs and demand* and its *actors and networks*.

We are convinced that these restrictions are reasonable as well as necessary and we chose to apply them because of the following four reasons:

1. A sophisticated analysis of the Austrian software sector regarding all the building blocks exceeds the scope of master thesis in terms of the amount of work as well as in terms of time and complexity.

2. We consider structural aspects of the Austrian software sector to be the main drivers of its innovation capability and innovation success. Therefore we perform a structural analysis and focus rather on the sector's characteristics than on processes and functions.

3. Since the TH model as well as the SSI framework are approaches that explain innovation capability and success on the basis of a interactive innovation model, we consider it to be reasonable to focus on the actor and their interaction aspects, which include the collection of knowledge.

4. The selected building blocks have been investigated in comparable studies before and were thereby mentioned to be most important for the explanation of emergency and development of the industry and interactive innovation [7].

Therefore not all the mentioned steps, that were listed in the manual, would be feasible and necessary to be conducted for the derivation of the Austrian software sectoral system of innovation. Instead we focused on the first three steps as well as step five. We left steps four, six, seven and eight out. In accordance to the scheme of analysis we applied the following steps:
We defined the Austrian software sectoral system of innovation including focal products as well as services and its boundaries.
Furthermore we identified and analysed the corresponding structural components of the Austrian software SSI. We conducted an actor analysis (with regard to the TH model), reveal networks between these actors - which provide information flow, cooperation and (financial) support - and specified relevant institutions.
Moreover we performed a functional analysis to identify the contributions of the various agents. The specific contributions were previously revealed in the questionnaire and are mainly related to information exchange, cooperation as well as (financial) support of innovation activity.
Finally we identified features which block or induce innovation performance and success in the Austrian software sectoral system of innovation.

We abdicated an assessment of functional fulfilment and process goals. An evaluation of the goodness of a the functional patterns would exceed the frame of this thesis. It would require to put results in relation to a suitable industry life-cycle model or suitable comparison mechanisms. Step six and seven were also both omitted since policy issues were also out of the scope of the thesis' topic. Finally we also left out step eight (i.e. *reflection, learning and improvement of the manual)*.

Due to the size and outstanding economical importance of Vienna for the Austrian economy, a large part of the Austrian software- and ICT sector is located in and around the capital. This has a direct effect on the respondents of our questionnaire and interviews. Whereas a large share of the companies, which filled in the questionnaire, are located in and around Vienna, all government institutions and three of four universities, which participated in the interviews, are located in Vienna. The Graz University of Technology is the only university from outside of Vienna that participated in this study.

3.4 Literature Review

To gain a theoretical basis about the topic and various aspects of the thesis, a literature review has been conducted. These aspects included the theory of innovation and innovation systems, knowledge about the Austrian software sector, innovation (system) frameworks - including the triple helix model and the sectoral system of innovation framework - and state of the art scientific work in this field of research.

Therefore [29] proposes a literature review approach consisting of three-stages, which are *planning the review, conducting the review* and *reporting the review*.

The *Planning Stage* a review protocol is created. In this protocol the background of the thesis' field of research, the research question, the research strategy for relevant information and frameworks, selection criteria as well as the data extraction strategy and synthesis approach of the extracted data will be explained.

In the *Conduction Stage* the creation and adherence of a concrete search strategy was implemented. This search strategy was selected to identify the relevant literature about the theory of innovation, innovation systems, the triple helix model, the sectoral system of innovation framework as well as comparable or even complementary frameworks and state of the art scientific work in this field of research. Therefore we used primary and secondary literature, including scientific state of the art articles, (conference) papers, books as well as online content and statistical data from *Statistik Austria* and *EUROSTAT*. This allowed us to obtain a sophisticated theoretical basis of the topic and associated concepts. The research of these information sources has been done using libraries, digital libraries and interfaces like Google Scholar, ACM Digital Library and IEEExplore. In positive papers, related work papers and references to other interesting work as well as citations have been used to reveal similar interesting work.
As the next step selection criteria have been applied to select literature and frameworks that are feasible and reasonable to use.
We derived the following checklist with criteria for including a scientific paper or a specific innovation framework for the thesis:

1. Scientific literature about innovation theory or scientific work in the field of innovation research

2. Scientific literature about innovation (system) frameworks

3. Literature that provides information about the Austrian software sector

4. Scientific literature about the application of innovation frameworks on software sectors
5. Scientific literature about the measurement of innovation performance and success

Furthermore a data extraction strategy is chosen to merge the relevant information of the papers. Therefore articles and scientific papers that fulfilled the requirements of the checklists have been read and relevant information has been extracted. These informations were later merged and summarized in separated text files.
Finally a synthesis of the extracted data has been done, in which the information were again merged and visualized. This helped to get an overview about the general topics, the frameworks as well as the Austrian software sector. Based on this synthesis the application of the SSI framework in form of a proposed manual could later be conducted.

Reporting the review covers the communication of the results of the review, which has been done in form of this thesis.
Bibliography Management was provided through the use of a reference manager and a summary of quoted informations with references to scientific literature.

Since the literature review can be seen as a interactive process, it is impossible to reach a point when the review is entirely finished. Rather a review is a process that is repetitively conducted during a thesis whenever new interesting questions arise.

3.5 Survey with Software Companies

To investigate the innovation performance and success of the Austrian software sector and to learn about the building blocks of the Austrian software sectoral system of innovation we conducted a survey with numerous Austrian software companies. Therefore we set up an online questionnaire on *soscisurvey* [1], which is a free online survey tool designed for scientific purposes.

3.5.1 The Questionnaire

We developed a questionnaire to survey Austrian software companies. There are two widely used innovation survey questionnaires, which we used for orientation regarding the questions of the questionnaire:
The *Community Innovation Survey* (CIS) is a repeatedly conducted survey organized by the European Commission to investigate the innovation activities of European companies. It is used to monitor the EU member's progress on innovation and to analyse the effects of innovation on the economy. The collected data serves as the basis for the *European Innovation Scoreboard* [41].
The *Global Innovation Excellence Survey* developed and used by the American consulting company *Arthur D. Little* is a globally conducted cross-industry survey, which explores trends and best practices in innovation management. Thereby the study investigates approaches and processes used by companies in the context of innovation management. Moreover it shows how

[1] https://www.soscisurvey.de/

they contribute to innovation success and allows participating companies to compare themselves against other enterprises.

The questionnaire, which has been used to survey the software companies, can be found in the *Appendix*. Since we conducted the survey with Austrian companies, the questionnaire is in German. It consists of the following five parts:
Firstly we asked for general information about the company. Beside company name and address we were interested in company size (in terms of employees) and the share of employees with a university degree. This is covered by the first three questions of the questionnaire. We asked the questions about the company size and employees with university degree because these factors are considered to have an effect in the innovation performance of the companies and will be used for the interpretation of the answers.
In the following questions number four and five, we asked the companies to estimate their innovation capabilities and success in general as well as for product innovations and service innovations separately. We did so since the subjective self-assessment of innovation success and innovation capabilities will be used in the analysis of the software companies' innovation performance - for innovation performance in total and regarding product and service innovations separately. We considered these aspects to be significant, since it can reveal deviations between objective innovation performance measurements and self-assessment. Similar questions have also been used in the *Global Innovation Excellence Survey*.
In a third part we asked questions to investigate the innovation performance based on objective measures, which are *number of introduced innovations regarding new products and services, their share on the total product- and (service-) portfolio, their share of total turnover* as well as *their share on the total profit*. These aspects correspond to the questions seven to twelve. We asked these questions since they cover the three innovation success measures that we have presented in *Measurement of Innovation Performance* and selected for our study. Question six (which askes if the company developed services- or product-innovations in the years 2011-2013) serves as a preselection, if questions seven - twelve should be displayed at all.
In the fourth part we asked the firms about cooperation and information exchange with other companies, universities and research institutes as well as government institutions. We inquired about the significance of universities, government institutions, other companies as well as the own company as information sources. We did so since we consider information exchange as a (weak) form of cooperation. In the questions 16 and 17 we asked companies to specify universities and government institutions, which they cooperated with. Questions 15 (which asks if the companies cooperate with universities and government institutions) serves as a preselection question, if the questions 16 - 17 should be displayed. Questions 18 finally inquires if the company did receive financial support from the government, since this is also regarded as cooperation with government institutions.
The last part was used to ask questions about abandoned innovation activities and factors that facilitate or hamper innovation activities in Austria. Therefore question 19 explicitly asks, if innovation activities of the years 2011 - 2013 were abandoned or were still ongoing by the end of the year 2013. The intuition of these questions is to identify companies, which conduct innovation activities but have not been successful (according to our success measures) within the

defined timeframe. Question 20 provides ten blocking factors for innovation activities. These factors have been used in a similar way in the *Community Innovation Survey* (CIS) before and were considered to be important for this thesis. The reuse of this questions provides the advantage that results can be compared with previous CIS studies. Finally questions 21 and 22 are open questions about additional inducement and blocking factors for innovation activities that go beyond the list of question 20. These questions were not compulsory to be answered but are considered to be valuable to receive individual answers from companies about inducement and blocking factors.

3.5.2 Questionnaire Respondents

To identify relevant respondents for our questionnaire, we selected in total 240 Austrian software companies in a two step approach:

The *Computerwelt* magazine has identified the largest 100 Austrian software companies of 2013 (regarding annual revenue) and published a corresponding list in an article of a special edition magazine [18] as well as online [2]. We considered these companies to be a meaning- and useful set of respondents for the questionnaire and a solid basis for this study. We invited these 100 companies over email. Whenever we couldn't find an personnel email-adress of an appropriate contact-person, we called the information desk and asked for a direct contact. We consider this practice to be reasonable, since it might increase the return rate of the questionnaires in comparison to just write to a general company email-address.
In a second step we invited 20 additional Austrian software companies, which are members of *VÖSI* (Verband Österrechischer Software Industrie) to participate in the questionnaire.
Finally we invited Austrian software startup companies to the questionnaire. We did so to enhance the set of respondents with smaller companies and to investigate the role of startups for the innovation performance of the Austrian software SSI. Since it was not possible to receive a complete and structured list of Austrian software startups, we used a list of startup companies given on the platform *http://www.austrianstartups.com/ecosystem/*. From this list we finally contacted 120 enterprises that can (in accordance to our definition above) be called a software company. We chose to invite exactly 120 startup companies to have a equal ratio of bigger and smaller companies.

Out of these 240 invited companies 43 completed the questionnaire (i.e. participated in the study and answered all questions) and 27 companies answered our questionnaire partly. This is a return rate of 29,2%.

3.6 Interviews with Academic Institutes and Government Institutions

To further investigate the way and extend universities and government institutions interact, collaborate and support Austrian software companies in their innovation activities, we conducted

[2] http://www.top1001.at/rangliste/spezialgebiet/Software

semi-structured interviews with representatives from government institutions, universities and research institutes. Furthermore did the interviews allow us to collect information about how cooperation with software industry comes off, how satisfied universities and government institutions are with their cooperation projects and what they consider important for successful innovation activities.
This approach of semi-structured interviews in a qualitative design allows to deepen the research topic and to generate scientific hypothesis about the Austrian software sectoral system of innovation [23].
Because of the higher expenditure of time, a rather small number of interview partners is advisable. Therefore a range between six and ten interviews partners is mentioned to be reasonable [23].
Seven interviews have been conducted in total, which took between 25 and 35 minutes each.

3.6.1 Interview Candidates

The interview candidates were determined through the questionnaire. Therefore we asked software companies about universities, research institutes and government institutions, which they are cooperating with.

In total 22 academic cooperation partners could be identified. We decided to contact the four most mentioned universities and research institutes and invite them for an interview. These are *Vienna University of Technology, Vienna University of Economics and Business, Graz University of Technology* and the *Austrian Institute of Technology* (AIT). As the AIT is the only research institute that took part in this study, we don't mention specifically "research institutes" in further parts of this thesis. Whenever university respondents are addressed, research institutes are implied as well.
Moreover have five different government institutions been reported as cooperation partners. Three of them have been chosen as interview candidates, which are: The *Austrian Research Promotion Agency* (FFG), the *Vienna Business Agency* and the *Austria Wirtschaftsservice Gesellschaft* (AWS).

3.6.2 The interviews

For our interviews we chose a standardized open-ended interview structures, which means that the questions and their sequence were predefined in advance. We developed two different but similar lists of interview questions. One for the universities and one for the government institutions. Each questionnaire consisted of 13 questions. These questions can be found in the *Appendix*. Since the interviews were conducted in German, the questions in the Appendix are in German too. The interviews took between 25 and 35 minutes each. Except of the interview with a representative from the Technische Universität Graz, which we conducted on the phone, all interviews have been conducted at an office of the corresponding organisation and in form of face-to-face interviews.

The interview questions are very similar to the questions of the online questionnaire. We did

so since the interviews provide a counterpart to the questions asked to the software companies. Like the questions of the questionnaire, the interview questions were structured into into five parts:
We asked general questions about innovation activities in the Austrian software sector at the beginning and end of the interviews. This part is covered by the first question ("Was ist Ihrer Meinung nach für erfolgreiche Innovationstätigkeit am wichtigsten?"), question seven ("Was ist die typische Unternehmensgrösse der mit Ihnen kooperierenden Softwareunternehmen?") and the last question ("Gibt es von Ihrer Seite noch Anmerkungen oder fällt Ihnen noch etwas wichtiges ein, das noch nicht besprochen wurde?").
Like the second part of the questionnaire the following questions two and three serve as self-assessment questions about the satisfaction with innovation capabilities and innovation success. The questions of part three are the counterpart to the inquiry about objective innovation performance measurements in the questionnaire. Government institutions and universities are hardly involved in sales of software products and services, therefore the presented measures cannot be used. Instead we asked universities how many projects concerning product- or service innovations they have been involved in the focal period, and we asked the government institutions how many software companies they annually supported in their innovation activities.
Questions five, six, eight and nine are questions about the importance of each cooperation partner, how cooperation come about and how universities and government institutions cooperate with software companies. Furthermore we asked about the benefits of cooperation. These questions are also based on questions from the survey.
Finally we asked government institutions and universities about inducement and blocking factors for Austrian software companies to be innovative.

3.6.3 Within- and Across-Case Analyses

From the information, that was collected in the interviews, we want to identify which information is relevant to all respondents and which information is exclusively related to particular respondents. Therefore the individual respondents of the universities and research organizations are referred to as "cases". We conduct a two stage approach consisting of a *within-case analysis* and a *across-case analysis*.
The *within-case analysis* is used to analyse each university and research institution in detail and to find and present the significant statements of each interviewee; the *across-case analysis* is then used to compare the collected information of each case and identify categories of significant statements as well as common patterns among the cases [2]. The combination of within-case and across-case methods allows the development of generalization regarding the investigated aspects and major topic [2].

3.7 Data Analysis

The results that will be presented consist of two stages:
In the first stage we derive the Austrian software sectoral system of innovation and incorporate the significance of university-industry-government relations stated by the TH model. Therefore

we use the introduced scheme of analysis and derive the Austrian software sectoral system of innovation. In terms of feasibility we decided to utilize a shortened version of this scheme of analysis and focus on particular aspects. This will be explained in Section 3.3.5.

In the second stage we evaluated the Austrian software sector for its innovation performance and success. Therefore we asked software companies, universities and government institutions to self-assess their innovation performance in terms of satisfaction with innovation success and innovation capabilities. Moreover we used three innovation performance measures: *Number and share of new products and services, share of sales generated through new products and services* and *share of profit generated through new products and services*. Based on the self-assessments and the innovation measures we infer the innovation performance of the Austrian software sector and check if companies, which cooperate with universities and government institutions, perform better than non-cooperating companies.
This provides a basis to identify strength and weaknesses of the Austrian software sectoral system of innovation and derive its key success factors. We finally use and discuss these findings to answer the research question (i.e. "What are the relevant characteristics and key (success-) factors of Austria's software sector, that allow it to be innovative?").

CHAPTER 4

Results

In this chapter we present the questionnaire and interview results.
The section *Questionnaire Results* contains three parts: The first part presents our findings regarding the innovation performance of Austrian software companies and their satisfaction with their innovation capabilities and innovation success. The second part contains our findings about the cooperation of the companies with universities as well as research institutes and government institutions. In the third part we present factors that facilitate or hamper the innovation activities of Austrian software companies.
The interview results present the findings that were collected during the personnel interviews with universities and government institutions. Similar to the questionnaire results the interview results are structured in three parts: The first part contains questions about the satisfaction and success of cooperation with software companies. The second part relates to cooperation habits and forms of these institutions and the way they support Austrian software companies. The third part focuses on factors that facilitate or hamper the innovation activities.

4.1 Questionnaire Results

Our questionnaire consists of 23 questions. We invited 240 Austrian software companies to take part and ended up with 43 companies that answered the questionnaire completely and 27 companies that answered our questions partly. This corresponds to a return rate of 29,2%.
For surveys a minimum number of 25 respondents should be chosen [23]. Since this number has been exceeded in this thesis, we consider it fair to say that our results can be called scientifically relevant.

The questions of our survey can be divided into three categories:
Firstly we inquired about the innovation performance of the companies and asked them about their satisfaction with their innovation capabilities and their innovation success. In addition to these subjective self-assessment questions, we asked questions regarding the three innovation

performance measurements, that we use in this thesis (i.e. *number and share of new developed products and services*, the *share of turnover through new developed products and services* and the *share of profits new developed products and services*).
In a second part we asked questions regarding the cooperation of the companies with universities as well as research institutes and government institutions. We distinguish two different levels of cooperation: Strong cooperation forms in the context of new product development as well as weaker forms of cooperation through financial support and information exchange.
The third part focused on factors that facilitate or hamper the innovation activities of Austrian software companies. Therefore we ask questions about abandoned innovation activities as well as the circumstances which delayed, interrupted or abandoned the innovation activities.
The questionnaire in German language with all the questions can be found in the Appendix.

4.1.1 Innovation performance of Austrian software companies

We first analyse the innovation performance of Austrian software companies in accordance to the satisfaction with their innovation success and their innovation capabilities. Moreover we investigate their innovation performance according to the number and share of new developed products and services as well as the share of sales and profit generated through new products and services. Finally we want to figure out if the cooperation with universities and government institutions has a positive effect on the innovation performance of Austrian software companies. Therefore we compare the mentioned innovation performance measures between cooperating and non-cooperating companies.
To be able to investigate the values of the self-assessment scales (i.e. satisfaction with innovation success and satisfaction with innovation performance) not at all satisfied, rather not satisfied, undecided, rather satisfied, very satisfied, we indexed into the numerical values 1, 2, 3, 4, 5. We then created boxplots based on these indexed values.

4.1.1.1 Self-Assessment

A vast majority of companies surveyed consider themselves to be satisfied with their innovation success. Out of 70 companies which answered the corresponding questions, 77% (i.e. 54 companies) agreed or strongly agreed on being satisfied with their general innovation success, while only 9% (i.e. six companies) claimed rather not to be satisfied. 68% (i.e. 48 companies) agreed or strongly agreed on being satisfied with their innovation success regarding development of new products and only 4% (i.e. three companies) mentioned rather not to be satisfied with it. Finally 60% (i.e. 42 companies) agreed or strongly agreed on being satisfied with their innovation performance regarding services with 10% (i.e. seven companies) mentioned rather not to be satisfied with it (see Figure 4.1).
As it can be seen in Figure 4.1 and Figure 4.2, the companies tend to be more satisfied with their product innovation success than with their service innovation success.

Also most of the companies are content with their innovation capabilities and therefore consider themselves to be innovative. Out of 68 companies which answered the corresponding questions, 66% (i.e. 45 companies) consider their capabilities regarding product related inno-

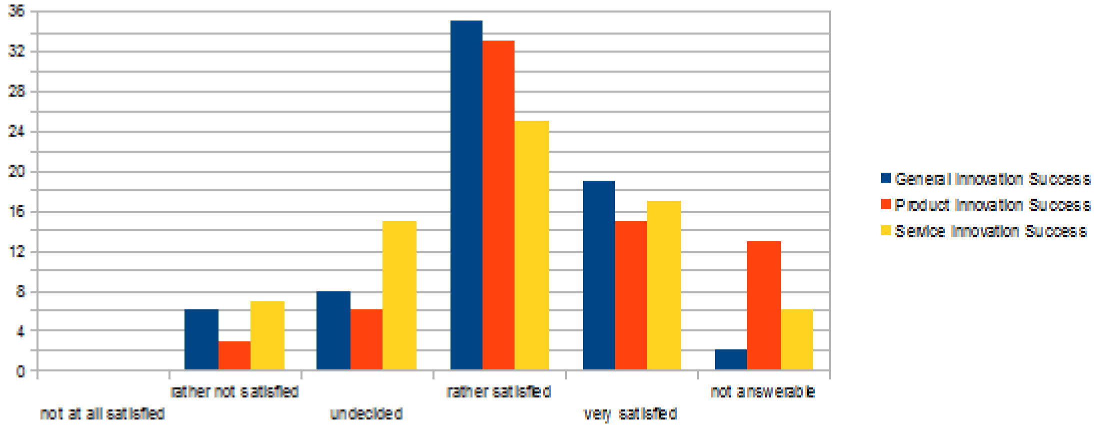

Figure 4.1: Satisfaction with product and service innovation success

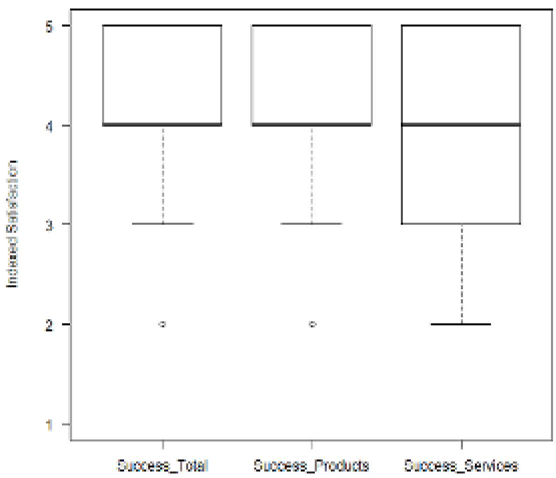

Figure 4.2: Indexed satisfaction with product and service innovation success

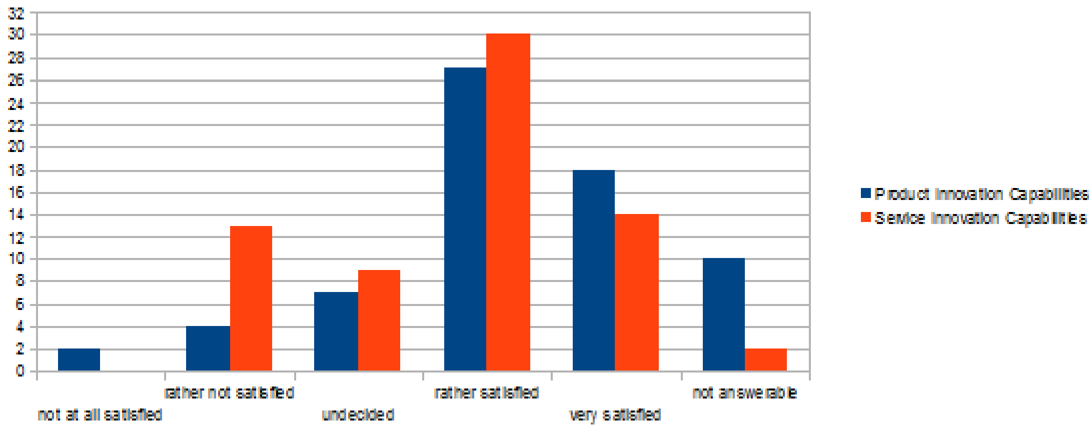

Figure 4.3: Satisfaction with product and service innovation capabilities

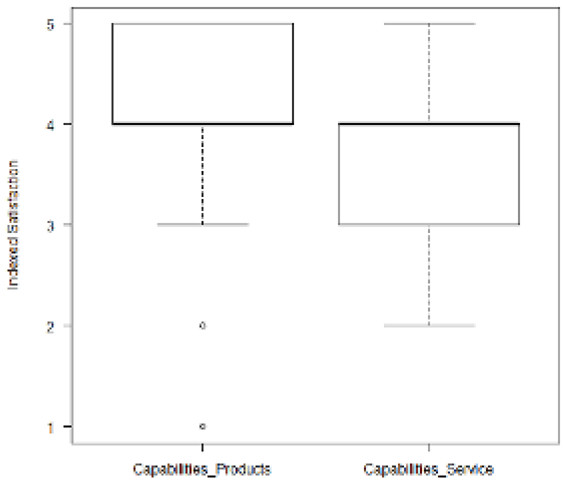

Figure 4.4: Indexed satisfaction with product and service innovation capabilities

vation as very satisfying or rather satisfying and 65% (i.e. 44 companies) feel very satisfied or rather satisfied with their capabilities in service related innovation. On the other side 9% (i.e. six companies) of the companies are not satisfied with their capabilities regarding product related innovation and even 19% (i.e. 13 companies) are not satisfied with their capabilities in service related innovation. (see Figures 4.3).

4.1.1.2 Innovation Performance Measurements

Regarding the measurement of innovation performance we collected *the number and share of new developed products, the share of sales through new developed products and services* and

Innovation performance measure	Mean	SD	Min	Q1	Median	Q3	Max	n
Number of new products and services	6,34	7,87	1,00	2,00	4,00	7,00	43,00	58
Number of new products	4,54	5,78	0,00	1,00	2,00	5,00	33,00	48
Number of new services	3,95	5,53	1,00	1,00	1,50	3,75	30,00	38
Share of new products	0,54	0,38	0,00	0,18	0,50	1,00	1,00	46
Share of new services	0,56	0,35	0,07	0,25	0,50	1,00	1,00	37
Share of sales	0,44	0,33	0,00	0,15	0,46	0,74	1,00	42
Share of profit	0,35	0,38	0,00	0,00	0,20	0,58	1,00	42

Table 4.1: Innovation performance measures

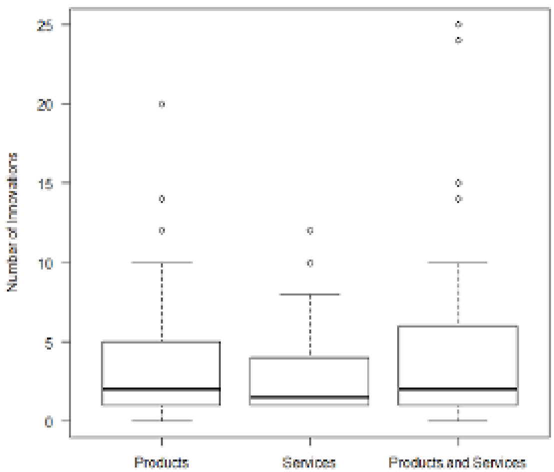

Figure 4.5: Number of newly developed products and services

the share of profits through new developed products and services) from the companies, which is presented in Table 4.1.

Regarding newly developed products and services we can see that in the three years between 2011 and 2013 the participating software companies developed 6,34 new products or services in average, whereas 4,54 new products and 3,95 new services have been developed during that time. We observe for all three scenarios a significant deviation to the median, which is 4,00 for products and services together, 2,00 for products and 1,50 for services (see Table 4.1). In Figure 4.5 we can see that the distribution of the development of new products and services is highly asymmetric. The distribution shows outliers versus high values and is therefore skewed right. These characteristics can be observed for the distribution of service- and product development too.

For the share of new products and services, we can see that these new developed products and services represent over 50% of the average product portfolio of Austrian software companies

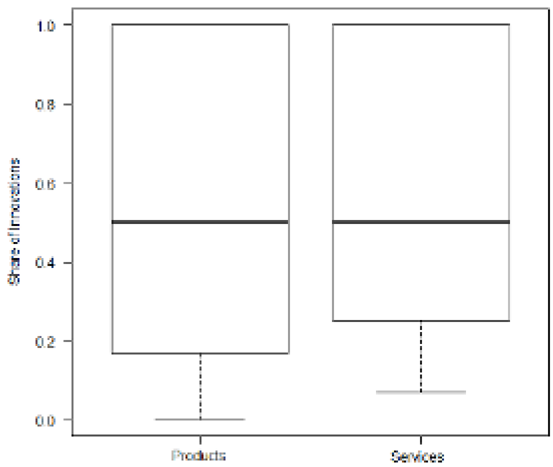

Figure 4.6: Share of newly developed products and services

(i.e. 54% regarding products and 56% regarding services; the median values are 50% for both). These figures can be seen in Table 4.1. Therefore these innovations are a significant part of the totally offered products and services.

Regarding the share of sales through new products and services, we can see that the Austrian software companies generate 44% of their total turnover from new developed products and services. The median share of sales is a bit higher with 46% (see Table 4.1). The table moreover shows that the average profit which was generated through new developed products and services was 35%, with a median of 20%. In Table 4.1 we can see that the share of new products and services on the total product portfolio is about 50%. Therefore these 50% generate 44% of the total turnover and about 35% of the total profit. With regard to these numbers four aspects are significant:

1. The significant share of turnover and profit allows to call the innovation activities of Austrian software companies financially successful in general.

2. Regarding the deviation of average and median it can be said that the sample contains lower outliers for the share of sales and higher outliers for the share profit. This can also be seen in the boxplots of Figure 4.7.

3. The share of sales is higher than the share of profit, this shows that the development of new products and services brings significant costs (e.g. costs of development, costs of marketing etc.). After some time these costs are amortized. Therefore the share of profit will be rising and the innovations will generate new cash for new innovations.

4. All these factors imply that Austrian software companies manage to conduct successful and sustainable innovation activities.

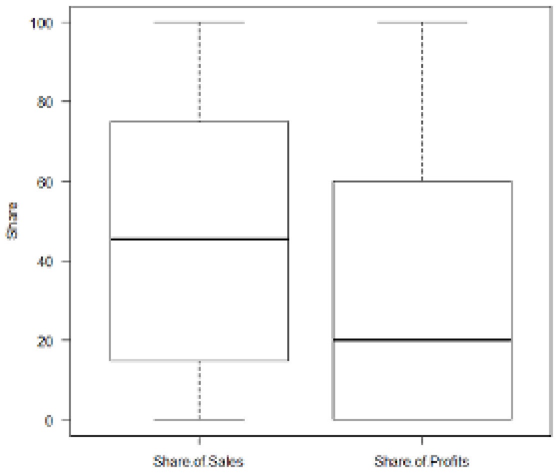

Figure 4.7: Share of sales and profits generated by new developed products and services

	All	No Cooperation	Cooperation
Innovation success (general)	0,7714	1,0000	0,7879
Innovation success (products)	0,6000	0,7143	0,5152
Innovation capabilities (products)	0,6618	0,7143	0,7273
Innovation capabilities (services)	0,6471	0,8571	0,6364

Table 4.2: Satisfaction with innovation success and capabilities

4.1.1.3 Comparison of the Innovation Performance of Cooperating and Non-cooperating Software Companies

To compare the innovation performance of cooperating and non-cooperating software companies, we compared the self-assessment based innovation measures (i.e. satisfaction with innovation success and satisfaction with innovation performance) as well as the three objective innovation performance measures (the number and share of new developed products and services, the share of profits and the share of turnover of new developed products and services). Therefore we classified the responding companies into three classes: All companies which answered the corresponding questions (this includes companies which didn't answer if they are cooperating or not), companies which answered not to be cooperating with universities or government institutions at all, companies which cooperated with universities and government institutions.

Self Assessment As it can be seen in Table 4.2, companies which are cooperating with universities or government institutions are not more satisfied with their innovation success or innovation capabilities than companies which don't cooperate. Regarding the product innovation capabilities companies that are cooperating are about equally satisfied as companies that are not cooperating, whereas for service innovation capabilities non-cooperating companies feel more satisfied again. This is an interesting finding, since we expected that cooperation with universities and government institutions would foster (successful) innovation projects and thereby also the satisfaction with innovation success and capabilities. One possible explanation for this finding is that companies, which consider themselves to be capable of developing successful innovation and which are satisfied with their innovation success, are less likely to cooperate for innovations in the first place.

It has to be mentioned that the very small sample size of only seven companies does not allow any statistical significance. From 70 companies that answered the corresponding questions, 33 mentioned to be cooperating and seven answered not to be, therefore we have 30 companies from which we don't know, if they are cooperating or not and which possibly would have changed the values.

Innovation Performance Measures Looking at 4.3 it can be seen that for almost all performance innovation measures, cooperating companies perform with higher average and median values. We can see that the average values of the number of newly developed products is higher for non-cooperating companies than for cooperating companies. This is a very interesting finding. In Figure 4.8 we can see that the distribution of newly developed products of non-cooperating companies is right-skewed and the average is pulled upwards. Therefore it is more helpful to compare median values for this factor. Using this median value we can say that cooperating companies also perform clearly better than non-cooperating companies.

Interestingly Table 4.3 shows that the average and median share of profit was higher in non-cooperating companies than in companies that cooperated with software companies. Investigating the relationship between these figures, it can be said that the share of new products and services is significantly higher in cooperating companies. Cooperating companies moreover reach a higher share of sales with these innovations. The share of profits is meanwhile however smaller than in non-cooperating companies. Therefore the costs of these innovations must be higher in cooperating companies than in non-cooperating companies. One possible and reasonable explanation would be that more sophisticated and expensive product and service innovations are developed through cooperation between university and software companies. Since it takes longer time for these innovations to amortize the costs and pay off, the average share of profits generated through new products and services is lower in cooperating companies.

4.1.2 Cooperation of Austrian software companies

We asked the companies various questions about their cooperation with other companies, universities and government institutions in terms of their innovation activities. In total 33 companies mentioned to be cooperating with other companies, universities or the government in terms of innovation activities. From 33 companies which answered that question, almost all (i.e. 29) answered to be cooperating with other companies. 22 mentioned to be cooperating with universities, while only seven work together with the government to develop innovations.

	All	No Cooperation	Cooperation
Number of new products (average)	4,54	7,83	3,85
Number of new products (median)	2,00	1,00	2,00
Number of new services (average)	3,95	2,50	3,05
Number of new services (median)	1,50	1,00	2,00
Share of new products (average)	0,54	0,41	0,63
Share of new products (median)	0,50	0,38	0,50
Share of new services (average)	0,56	0,45	0,71
Share of new services (median)	0,50	0,42	1,00
Share of sales (average)	44,00	42,57	46,10
Share of sales (median)	46,00	41,00	50,00
Share of profit (average)	35,00	41,71	36,06
Share of profit (median)	20,00	41,00	40,00

Table 4.3: Median and average values of innovation measures

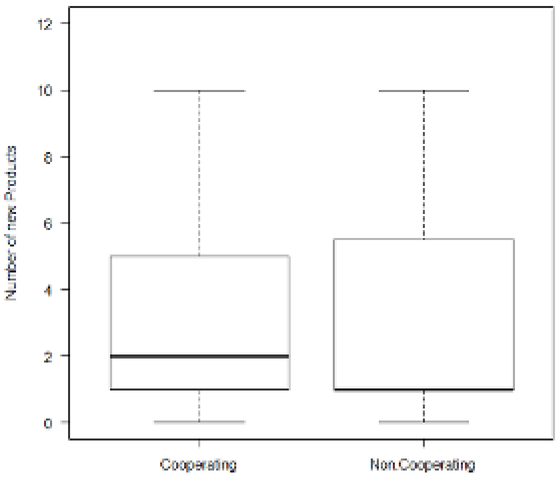

Figure 4.8: Number of new developed products of cooperating and non-cooperating companies

	Other companies	Universities	Government
Unimportant	0	8	21
Rather unimportant	7	12	9
Undecided	8	8	4
Rather important	15	7	3
Important	10	4	2
Not answerable	0	1	1

Table 4.4: Importance of information sources for innovations (n=40)

We also asked the companies about concrete cooperation partners. 19 universities were mentioned as cooperation. We decided to conduct interviews with the four most mentioned cooperation partners (i.e. *Vienna University of Technology, Vienna University of Economics and Business, Graz University of Technology* and the *Austrian Institute of Technoloy* (as the largest non-university research institute of Austria).
Moreover five government institutions were mentioned as cooperation partners in the questionnaire. We decided to conduct personal interviews with the three most mentioned government institutions (i.e. *Austrian Research Promotion Agency (FFG), Austria Wirtschaftsservice (AWS)* and *Vienna Business Agency*).

Despite cooperation activities in terms of software product and service development, we considered information exchange (between software companies, between academia and the industry as well as the industry and government institutions) as a form of cooperation.
Other software companies are seen as the most important partner for information exchange of our respondents. From 40 respondents who answered these questions, 25 consider *other software companies* as an important or rather important information source for innovation, with eight more companies are undecided and consider it therefore not as a priori unimportant. Only seven consider it as rather unimportant. *Universities and research institutes* are the second most important source of information, while being said to be an important or rather important information sources for eleven companies with eight companies being undecided about it. 20 respondents consider them as unimportant or rather unimportant. Finally *government institutions* are the least important information source for innovation activity, since they are mentioned to be important / rather important by only five companies with four companies being undecided and 30 companies see them as unimportant or rather unimportant (see Table 4.4).
Finally we consider financial support provided by the government as a form of cooperation. From 49 companies that answered this questions, 25 claimed that they received financial support from the government between 2011 and 2013. Exact numbers distinguished by local and federal government can be found in Table 4.5.
By looking at our dataset of recipients of governmental financial support, it can be claimed that financial supports from local government and federal government were about equally important for our respondents (i.e. 18 recipients from local government vs. 16 recipients from federal government). Moreover only a minority of companies has been funded by both local and federal government (i.e. 9 companies), while most of the companies either received financial support

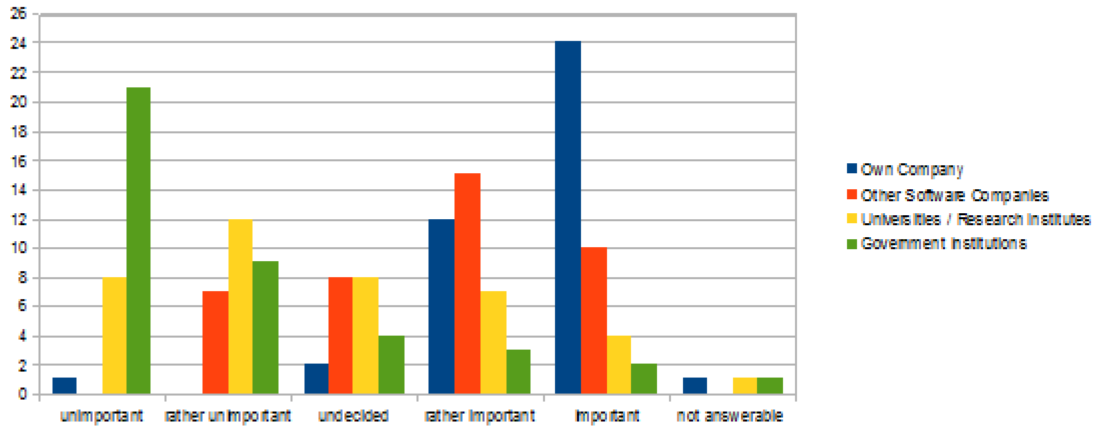

Figure 4.9: Importance of software companies as information source for innovation activities

Political level	Number of companies
Local government	25
Local government only	18
Federal government	16
Federal government only	7
Local and federal government	9
TOTAL	25

Table 4.5: Source of financial support provided by the government (n=49)

from their local or from the federal government.

4.1.3 Innovation Incentives and Barriers

In the last part of the questionnaire we asked companies about abandoned innovation activities and factors that facilitate or hamper innovation activities in Austria.

From 46 companies which answered this question, 13 reported that they interrupted or abandoned innovation projects in the last three years (2011 - 2013). 25 companies stated that they have innovation projects that are still ongoing after this period.

Furthermore we wanted to figure out the reasons for the interrupted and abandoned innovation projects. We asked questions about the factors that prevented or hampered the innovation activities of the firms surveyed. These questions with the corresponding factors have been used before by the *Global Innovation Excellence Survey* of Arthur D. Little [1]. Since this question-

[1] Arthur D. Little; URL = www.adlittle.com; Accessed: 2015/08/26

	Number of firms	Percentage of firms	n
Innovation costs too high	30	0,6977	43
Uncertain demand for innovation products or services	26	0,6047	43
Lack of qualified personnel	25	0,5814	43
Lack of information on markets	26	0,5676	37

Table 4.6: Major innovation obstacles for Austrian software companies

naire is a widely excepted toolkit, that has been used for investigation of innovation success across industries, and these factors are considered to be main drivers of hampered or prevented innovations, we decided to use the same questions accordingly.

As we want to figure out the main obstacles for innovation in the Austrian software sector, we omitted those factors which were considered to be unimportant or rather unimportant by the majority of the companies surveyed. Therefore we kept the factors that were considered to be important, rather important or at least undecided by the majority (over 50%) of the respondents (see table 4.6).
Even though these questions provide a wide range of factors that could hamper or prevent innovation activities, we furthermore asked open questions about factors that facilitate or hamper innovation activities of Austrian software companies.

Beside the factors above, the following (possible) obstacles for innovation activities have been mentioned by the companies surveyed:

1. Too high tax burden
2. Too high bureaucratic and regulatory hurdles
3. Legal uncertainty
4. Short term expectations of profits
5. Several innovation projects of a company compete for resources

Concordantly the following incentives, that (would) facilitate innovation activities, have been mentioned:

1. Tax relief
2. Competitive venture capital
3. Financial security
4. Agile competitive environment
5. Higher financial support from the government

6. Ancillary wage costs
7. Strong perspective on customers and markets
8. Innovative company culture
9. Superiors who promote and reward innovative thinking
10. Increase in market share
11. Development of unique selling proposition
12. Research funding
13. New trends and markets
14. Government support of investments in innovation
15. Attention of (potential) customers
16. Reliable investors in innovative (competitive) environment
17. Cooperation in research and development
18. Qualified employees in the region due to strong research universities or other software companies

4.2 Interview Results

In terms of the qualitative research methodology we conducted eight semi-structured interviews with representatives of government institutions and universities. These interviews focused on innovation performance and satisfaction, innovation cooperation activities as well as innovation incentives and barriers. The questionnaires used in the interviews can be found in the *Appendix* (in German language). All interviews took between 25 and 40 minutes.

The questions that were asked in the interviews are similar to the questions asked in the questionnaire to the software companies. Thereby the intention is to investigate the opposite view from the universities and government institutes' point of view. Same as in the questionnaire, the interviews are structured in three categories of questions: *Innovation performance, cooperation in innovation activities* and *innovation incentives and barriers*.

After gathering the information from the interviews, we analyse it in matters of the research question. The mentioned categories of questions represent the basis for the within-case analysis and the across-case analysis. We use the within-case analysis to analyse each organization in detail. The across-case analysis is then used to identify across-case patterns and core theses that have been made by the interview respondents to each category of questions.

Organization	Acronyms	Department	Date	Duration (hrs:mins)
University 1	U1	Faculty of informatics and bio-medical engineering	16.04.2015	0:30
University 2	U2	Digital safety and security department	13.04.2015	0:40
University 3	U3	Informatics innovation center	08.05.2015	0:40
University 4	U4-A	Institute for information business	26.03.2015	0:29
University 4	U4-B	Department for information systems and operations	26.03.2015	0:25
Government Institution 1	G1	Organization / information technology	17.04.2015	0:28
Government Institution 2	G2	Basic programs	13.04.2015	0:35
Government Institution 3	G3	Technology services	15.04.2015	0:31

Table 4.7: Key information of the interviewees and the interviews

4.2.1 Within-case Analysis

The within-case analysis is used to analyse each organization in detail. Therefore, this chapter focuses on the results of each university or government organization separately. All seven within-case analyses are structured in the same way: *Innovation performance, cooperation in innovation activities* and *innovation incentives and barriers*.
Due to confidentiality we assigned acronyms to each organization (universities and government organizations) in order to guarantee anonymity; i.e. U1, U2, U3, U4, G1, G2, G3. The acronyms indicate the group they belong to (e.g. U1 = university 1; G1 = government organization 1)

4.2.1.1 University 1 (U1)

All the gathered data from university 1 was received in one interview with the vice-dean of the faculty of informatics and bio-medical engineering. The interview took place on 16.04.2015 and lasted 30 minutes.

Innovation Performance The satisfaction with the *success of cooperation in innovation projects* is very high. On a scale from one to five a grade of five was considered, since the faculty is the one with the highest third-party funds acquisition in Austria.
The satisfaction with the *capabilities for successful cooperation in innovation projects* is simi-

larly very high (again a five on a scale from one to five). The organization is strongly cooperating in a national as well as on international level with over 100 constant cooperation partners.

Cooperation in innovation activities Software companies are the organization's most important cooperation partner. They are considered to be very important (a five on a one to five scale). Other universities are rather seen as necessary partners. They are not particularly important for innovation projects (a three on a one to five scale). Most of the academic partners are foreign universities, which are however very important for international networking. Government institutions are seen as a rather unimportant cooperation partner in innovation projects (a two on a one to five scale).
The cooperation usually takes place in form of joint research programs between universities and private companies. These programs are usually funded by government institutions. This funding is very crucial.
The collaborations come about in different ways. Either companies contact universities or vice versa - both happens regularly.
Mostly bigger companies are cooperating with the organization, since smaller companies have usually not enough financial resources for shared innovation projects.

Innovation incentives and barriers The implementation of innovative concepts and inventions into marketable products and services is considered as the most important factor for successful innovation activities. This demands a profound market knowledge.
The most important incentive for innovation in the software sector is the necessity of innovation to survive in the market. The software industry is changing very fast. A company that does not innovate will not survive long.
According to U1 do universities benefit mainly through financial resources, which is used for research as well as for teaching. Additionally do universities gain a higher reputation through successful innovation projects. Which has again a positive effect on future research projects.
U1 mentioned that the most significant barrier for innovations are scarce financial resources. Innovations are expensive and sometimes it is difficult to fund them.

4.2.1.2 University 2 (U2)

We conducted one interview with an executive of the organization's digital safety and security department. The interview took place on 13.04.2015 and lasted about 40 minutes.

Innovation Performance The satisfaction with the *success of cooperation in innovation projects* is very high (a five on a scale from one to five). Many projects take place with government institutions. More shared innovation projects with companies would be desirable.
Since a higher efficiency in the cooperation could be achieved, the *capabilities for successful cooperation in innovation projects* are considered good but improvable (a four on a scale from one to five).
Currently the organization participates in about 400 larger and smaller cooperative innovation

projects. While not all of them are software projects, IT and software typically are involved and serve as a crossover technology.

Cooperation in innovation activities Software companies, universities and government institutions are equally very important for U2's innovation projects (all would be a five on a scale from one to five). However they all contribute in different ways. While software companies serve as customers in licensing and patenting based innovation projects, other universities are involved in basic research and as a supplier of basis technology. Government institutions contribute trough coordination, knowledge support, and funding. They often serve as mediators in international cooperation programs.
The organization takes part in three kinds of cooperation: Research contracts where the company pays for the project, licensing and patenting of technology by a cooperating company, cooperative research projects with private companies funded by government organization.
There are various ways how cooperation comes about: Mediation by government organization, direct requests from companies, networking or through international announcements.
Regarding the size of cooperating companies, mostly SMEs are cooperating with the organization since there are few large-scale enterprises in Austria (which are mostly foreign companies).

Innovation incentives and barriers The implementation of new ideas and concepts into marketable products and services is considered most important for successful innovation activities. This implies a combination of knowledge about customer needs as well as about the market and involved technology. Moreover is sufficient funding and leadership important.
The most important incentive for innovation activities in the Austrian software sector is the need to be innovative itself, which is necessary to compete in the market and provide high quality products and services.
Cooperation is mainly beneficial for universities, since it provides know how about the domain and particular technologies, about customer needs as well as about the market.
According to U2 the barriers for innovation activities widely depend on the size of the company. Since there are mostly small- and medium-sized software enterprises in Austria, their biggest barrier is the difficulty of small enterprises to internationalize (which is important in an international software market).

4.2.1.3 University 3 (U3)

We conducted one interview with an executive of the organization's informatics innovation center. The interview took place on 08.05.2015 and lasted about 40 minutes.

Innovation Performance The organization's satisfaction with the *success of cooperation in innovation projects* is generally high. However is it still growing and there is room for improvement. We interpret this as a four on a scale from one to five.
Regarding the *capabilities for successful cooperation in innovation projects* the interviewee did not directly answer to this question but pointed out the variety of cooperation programs they are involved in. An exact number of innovation cooperation programs could not be ascertained.

Cooperation in innovation activities Software companies, universities and government institutions are considered to be equally important. The interviewee did point out the different contributions of each group of cooperation partners and that they are thereby all important, did however refuse to estimate the importance on our scale.
The way the organization is cooperating is mainly through spin-offs / start-up companies as well as diploma thesis. We could not receive any information about how the cooperation comes about in detail.
The interviewee pointed out that ideas and innovations come from startup companies. Therefore the innovation projects consist of cooperation with startups.

Innovation incentives and barriers According to U3 the most important factor for successful innovation projects is an entrepreneurial culture and ecosystem. This implies well-educated employees, room for creativity, sufficient workspace, cooperation of different knowledge holders and sufficient funding.
Especially well-funded programs to support research cooperation between industry and university are considered to be an incentive for Austrian software companies to be innovative.
Universities benefit mainly through networking, knowledge about the industry and the market, funding for research and interesting research assignments.
Mentioned barriers for innovation activities are manifold: Unnecessary bureaucracy, brain drain of knowledge workers, not enough financial support of startup companies as well as cultural factors, such as the high risk aversion in Europe.

4.2.1.4 University 4 (U4)

With university U4 we could conduct two interviews, one with the the head of the institute for information business and the other one with the head of department for information systems and operations. The interviews took place on 26.03.2015 and lasted 29 minutes and 25 minutes. We assigned the acronyms U4-A and U4-B to the two interviewees.

Innovation Performance U4-A mentioned to be generally satisfied with the *success of cooperation in innovation projects* (a four on a scale from one to five). Improvements could still be done regarding reporting of results and administration.
Regarding the satisfaction with the *capabilities for successful cooperation in innovation projects* U4-A mentioned to be very satisfied (a four on a scale from one to five), since they benefit from highly competent research offices.
The interviewee U4-A mentioned to be involved in seven cooperation projects with software companies, 2 large international projects, and several smaller cooperation projects which are funded by the FFG.

U4-B considers the *success of cooperation in innovation projects* to be very satisfying (a five on a scale from one to five), since there are typically running several cooperations with software companies in parallel.
Because of their expertise in certain domains (e.g. ERP-Systems) U4-B estimates the *capabili-*

ties for successful cooperation in innovation projects as very good, with a five on a scale from one to five.
Many cooperation projects with software companies are running in parallel but since the number is not recorded, the question could not be answered.

Cooperation in innovation activities U4-A answered that software companies and government institutions are equally important for innovation cooperation projects (both four on a scale from one to five). While software companies typically are the “direct” cooperation partners, government institutions contribute significantly through funding. Other universities are considered to be most important. They contribute through domain specific knowledge and provide a basis for networking, for example in the initiation phase of shared innovation projects. Therefore they are very important (five on a scale from one to five).
According to U4-A the cooperation usually takes place in form of larger international projects (mostly with cooperation partners from other EU countries), in form of FFG-funded projects or through smaller projects with software companies in which U4-A organization participates as a subcontractor.
Typically the cooperation projects arise through personal acquaintances, which are partners at other universities or colleagues in software companies, direct cold-acquisitions are rare.
Regarding the size of cooperating companies, there is no general pattern. U4-A mentions to be cooperating with both smaller and larger companies.

The interviewee U4-B considers especially other universities as a very important cooperation partner, especially in basic research (five on a scale from one to five). While government institutions are hardly considered to be reasonable (two on a scale from one to five), software companies are valuable partners in applied research (four on a scale from one to five).
U4-B mentioned that cooperation in innovation projects usually takes place through basic research or applied research projects together with other universities or software companies.
These cooperation projects are typically initiated through graduates from university, who are meanwhile working in software companies, networking and events, as well as diploma theses and internships of students.
Since the sizes of cooperating companies are not recorded, no answer was given regarding this question.

Innovation incentives and barriers U4-A considers the implementation of innovations into marketable products and services (combined with the foundation of businesses if necessary) as the most important factor for successful innovation projects.
Knowledge gain as well as the possibility to acquire future employees is considered as the most important incentive to innovate and cooperate in innovation projects for Austrian software companies.
Universities benefit in different ways from innovation cooperation: Funding, concept evaluation, foundation of spin-off companies and knowledge gain.
U4-A mentioned that the barriers for innovation in the Austrian software sector is that the management of companies is often not aware that universities have domain-specific knowledge that

is valuable for innovation projects. Moreover are many companies too risk-averse and very sceptical about cooperation in general.

According to U4-B the most important factor for successful innovation projects are free-space and capacity in research projects.
Major innovation incentives are the combination of willingness to take risks as well as innovative customers, who buy innovative products.
Universities can benefit in different ways from innovation cooperation projects: Interesting research projects and case studies for teaching, higher quality of teaching and interesting diploma theses, synergies in research projects as well as funding.
The major barriers for innovation are first of all the risk-averse investors (banks and the public sector) as well as the high non-wage labour costs. Moreover are the customers of the Austrian software sector not innovative enough to buy innovative software products and services.

4.2.1.5 Government Institution 1 (G1)

We conducted one interview with an executive of the organization's department for organization and information technology. The interview took place on 17.04.2015 and lasted 28 minutes.

Innovation Performance Regarding the self-assessment of the organization's innovation performance, the interviewee considered himself not to be able to answer about the satisfaction with the *success of cooperation in innovation projects* and the *capabilities for successful cooperation in innovation projects* and answered both with "non applicable".
From 6000 companies, that are annually supported by G1, between 100 and 200 are software companies.

Cooperation in innovation activities Regarding the significance of cooperation partners, software companies are considered to be very important (five on a scale from one to five). Universities are rather unimportant(two on a scale from one to five) for G1, as there is only few cooperation with universities (which mainly focus on the knowledge transfer from universities to industry companies). G1 also cooperates rather rarely with other government institutions (only in regional funding programs), therefore their significance was also mentioned to be rather unimportant (two on a scale from one to five).
There are two contributions of G1 in innovation (cooperation) projects. On the one hand side does G1 provide direct funding for innovation projects. Moreover does G1 offer garantuees / securities to banks, which then give credits to software companies.
The initiation of cooperation is usually always the same: The companies contact G1 directly for financial support. This is the case for about 80% to 90% of the cooperation with software companies. In case of funding provided by banks, is it the bank that contacts G1.
The interviewee answered that G1 itself does not provide particular funding programs for cooperation between universities and software companies, but mentioned that other government institutions do however provide such programs.
Regarding the size of cooperating software companies, the G1 estimates that 2/3 of the com-

panies are small-sized enterprises, about 1/3 are medium-sized and very few are large-sized enterprises. Their focus lies on SMEs.

Innovation incentives and barriers Two things were mentioned by G1 that are primarly important for successful innovation projects: A “healthy” business location and environment - which implies sufficient funding, cooperative technology partners, high level of education and security - and entrepreneurial spirit and culture, that allows to fail (similar as in the USA).
The question about the major incentives was not answered by G1.
Software companies can benefit in several ways from cooperation with G1: Firstly through funding, secondly does G1 provide mediation to other companies, banks and (federal) funding programs. Finally can they benefit through coaching, which implies help in their business plan as well as company organisation and rethinking about their innovation concepts.
Regarding barriers for innovation activities G1 pointed out that the software market is multinational, which implies several significant characteristics: A global competition of software companies and the fact that it is mainly sales of software products that is done in Austria, the significance of software hotspots (like the silicon valley) as well as the significance of taxes and quality of universities for multinational software companies.

4.2.1.6 Government Institution 2 (G2)

We conducted one interview with an executive of the organization’s department for basic programs. The interview took place on 13.04.2015 and lasted about 35 minutes.

Innovation Performance G2 did not want to estimate the satisfaction with the *success of cooperation in innovation projects* and the *capabilities for successful cooperation in innovation projects* and a scale. Nevertheless G2 pointed out the wide variety of cooperation programs and the high share of university partners and considers that the organization is doing well in regard of both.
According to G2 own statistic 296 ICT have been funded in the year 2013. Even though these projects are not exclusively software projects, software (as a product or service) is mostly involved.

Cooperation in innovation activities For G2 universities are the most important cooperation partners (five on a scale from one to five), software companies were also said to be important (four on a scale from one to five). Other government institutions are moderately important. Even though funding of two government institutions in parallel is not allowed in Austria, successive funding of two different government institutions implies overlap where cooperation can exist.
G2 provides various programs for the cooperation with software companies, such as the *Innovationscheck*, the *Basisprogramm*, the *Bridgeprogramm* as well as participation in European funding programs (where G2 does not provide funding but coaching).
There are different ways how cooperation with universities and software companies come about. It depends widely on the type of cooperation program, mentioned before. For the *Innovationscheck* software companies can search a platform - that is provided by G2 - for universities and

research institutes with suitable competences. G2 provides funding for cooperation partners with appropriate projects. For the *Basisprogramm* the contact to cooperation partners usually existed before, for the *Bridgeprogramm* the universities usually search for software companies and contact G2 afterwards for funding.
G2 provides four ways to fund cooperation between software companies and universities: *Innovationscheck*, the *Basisprogramm*, the *Bridgeprogramm* as well as topic-specific programs.
The typical size of cooperating software companies is distributed in the following way: 40% large-sized enterprises, 10% medium-sized enterprises, 30% small-sized enterprises and 20% universities.

Innovation incentives and barriers For G2 the market success of an innovation is most important for successful innovation activities. This implies that an innovation is something new and not just a improvement.
G2 considers three main incentives for Austrian software companies to be innovative: Software companies benefit from low market-entry barriers (no machines need to be bought etc.). Secondly does innovation provide a way to develop a competitive niche focus for (smaller) companies. Finally does innovation provide higher- product and service quality.
Software companies benefit in two ways from the cooperation with G2: They benefit through financial support and achieve a higher quality of their business plan and innovation concepts through feedback and coaching.
The main innovation barrier for Austrian software companies is the globalized software market. This implies two major effects: A lack of uniqueness for domestic companies as well as strong competition from other regions of the world (e.g. Asia).

4.2.1.7 Government Institution 3 (G3)

We conducted one interview with an executive of the organization's department for technology services. The interview took place on 15.04.2015 and lasted about 31 minutes.

Innovation Performance G3 claims to be content with the *success of cooperation in innovation projects* and considers the satisfaction as a four on a scale from one to five. Similarly he is very content with their *capabilities for successful cooperation in innovation projects* and rates it as a five on a scale from one to five.
Over 50% of the technology companies, that G3 is cooperating with, are software companies. Therefore G3 estimated the number of annually supported software companies to be about 50 - 60.

Cooperation in innovation activities The most important cooperation partner for G3 are private companies (five on a scale from one to five). Universities and other government institutions are equally important (four on a scale from one to five). Even though funding of two government institutions in parallel is not allowed in Austria, supported companies can receive funding from one government institutions and funding from another one. In this case G3 is indirectly cooperating with other government institutions.

G3 mentions four ways how they cooperate with software companies: Through funding of innovation projects, coaching in innovation projects, contact mediation with cooperation partners as well as support in networking and finally the possibility of future business with the public sector. For these forms of cooperation software companies usually contact G3 directly. Moreover does G3 provide business events for partners of the public sector and software companies. This provides a contact platform.
G3 does not offer any particular programs to support the cooperation between software companies and universities. Therefore this combination occurs rarely. They offer however mediation to other government institutions, which are more specialized in the support of these forms of innovation projects.
Since large-sized companies are not approved for most of G3's funding programs, they are mainly cooperating with small enterprises. The majority of 50% to 60% are one-man businesses and about 30% are SME's.

Innovation incentives and barriers For G3 the most important factors for successful innovation activities is a profound business idea, which is defined in a business plan and sufficiently funded.
G3 points out four major incentives for software companies to be innovative: Austrian software companies benefit from a very diverse funding landscape, there is a very active ecosystem of startup companies (especially around Vienna), many possibilities for networking with other companies, universities and government institutions as well as low market entry barriers (since hardly any capital is required to found a software company).
Software companies benefit from cooperation with G3 in five different ways: First of all do they benefit through financial support. Secondly can they get into contact with other companies, universities and research institutes. G3 helps moreover to define business ideas and implement business plans. G3 also provides information about business events for networking. Finally companies benefit from mediation to potential customers.
Regarding the innovation barriers, G3 mentions three factors that hamper innovation in the Austrian software sector: Too much bureaucracy, high taxes and not enough funding for young enterprises.

4.2.2 Across-case Analysis

After the within-case analyses, we conduct an across-case analysis to identify and describe across-case patterns between universities U1, U2, U3 and U4 as well as between government institutions G1, G2, G3. Therefore the focus of the across-case analysis lies on the comparison of the within-case analyses results to provide core theses of universities and government institutions about *innovation performance, cooperation in innovation activities* and *innovation incentives and barriers*.

Innovation Performance All universities are highly satisfied with their innovation cooperation success and innovation cooperation capabilities. As it can be seen in Table 4.8 three of five interviewees are very satisfied with the satisfaction with cooperation success and as well as the

	Cooperation success	Cooperation capabilities
Very satisfied	3	3
Rather satisfied	2	1
Undecided	0	0
rather unsatisfied	0	0
Very Unsatisfied	0	0
Not answerable	0	1

Table 4.8: Universities' satisfaction with cooperation success and cooperation capabilities

	Cooperation success	Cooperation capabilities
Very satisfied	0	1
Rather satisfied	1	0
Undecided	0	0
rather unsatisfied	0	0
Very Unsatisfied	0	0
Not answerable	2	2

Table 4.9: Governments institutions' satisfaction with cooperation success and cooperation capabilities

satisfaction with innovation cooperation capabilities. Whereas non of the university-respondents mentioned to be unsatisfied with any of these the measures, one interviewee refused to assess the satisfaction with innovation cooperation satisfaction.
Regarding the number of innovation projects that universities were involved in the three years between 2011 and 2013, the answers strongly diverged. Two university respondents mentioned not to be able to answer that question. From the three interviewees who responded the answers widely differ. While one interview partner mentioned the number of cooperating companies to be nine, another respondent claimed it to be around 100 and the third respondent estimates it to be between 400 and 500 industry partners in the last year. Two interviewees from universities could not answer the corresponding question and answered that these numbers are not recorded. These deviations can be explained by different reasons: On the one hand does it seem possible that some respondents answered only for the project of one research group, while other answered rather for larger organizational entities (e.g. faculty, department or whole research institute). Another explanation may be the orientation and network of the respondent's organization. While some organizational units mainly cooperate with companies from Austria, others are rather internationally oriented. Finally did some companies count all ICT projects as software is considered to be involved but not necessary the main product or service component.

Two of three government institutions did not want to assess their innovation cooperation success and innovation cooperation capabilities. Both interviewees mentioned that they do not have an overview of all projects and all necessary information to do so, but pointed out the diversity of

	Software Companies	Universities	Government Institutions
Very important	2	3	1
Rather important	2	0	1
Undecided	0	1	0
Rather unimportant	0	0	2
Very unimportant	0	0	0
Not answerable	1	1	1

Table 4.10: Importance of cooperation partners for universities

cooperation programs that they offer. As it can be seen in Table 4.9 one government institutions mentioned however to be satisfied with both measures. Nevertheless is it not possible to point out any cross-government-institution pattern and derive any conclusion about their satisfaction with these two measures.
The government institutions were asked about the number of software companies that they annually support in innovation projects. The answered numbers were also rather imprecise and divergent. While one respondent estimated the number of cooperative software project around 50 to 60, another respondent mentioned numbers of the respondents between 100 and 200. The third interviewee answered this question with 296 ICT projects in 2013. Also here we observe a wide divergence of answered numbers. A possible reason is that one institution (i.e. Wirtschaftsagentur Wien) is only supporting innovation projects in Vienna, while the other support projects in whole Austria. Moreover does the very high outlier seem to relate to all ICT project, not only to software projects.

Cooperation in innovation activities Looking at the importance of cooperation partners for universities (see Table 4.10), it can be seen that software companies represent the most important cooperation partners. Four of four university respondents (who answered the corresponding questions) consider software companies to be rather or very important cooperation partners. Other universities are considered to be similarly important. Three of four university respondents mentioned them to be very important. One interviewee was undecided about the importance of universities. The importance of government institutions seems to depend on the university with two of four rather or very important and two universities considering them as rather unimportant. One respondent did not want to answer the corresponding questions, we count this as “not answerable”. These numbers can be explained by the answers that have been given by university respondents about their innovation cooperation behaviour. In innovation projects where universities are involved, the government serves mainly as an capital provider and partly as a mediator and contact platform for common innovation projects (*“Governmentally funded research programs for projects with university-industry cooperation”*, cooperation comes about *by the mediation of the FFG or the BMVIT*). While this role is certainly important, many cooperation projects are funded directly by (mainly bigger) companies (*“Normally we cooperate with larger companies, since small companies often do not have enough financial resources.”*)

	Software Companies	Universities	Government Institutions
Very important	2	1	0
Rather important	1	1	1
Undecided	0	0	1
Rather unimportant	0	1	1
Very unimportant	0	0	0
Not answerable	0	0	0

Table 4.11: Importance of cooperation partners for government institutions

Common research projects between universities and software companies, which are funded by government institutions are the one major way of how universities cooperate with software companies and was mentioned by four of five interviewees. Other possibilities that were mentioned once each are: *Spin-offs, Diploma theses* as well as *research contracts / licensing and patenting of developed technology* were universities get work order from a software company.
Regarding the way of how cooperation between universities and software companies comes about, *personal acquaintances and networking* as well as *direct contacts / cold-acquisitions* were most often mentioned (by three and two respondents out of four). Moreover was *(international) announcements* as well as *diploma theses and internships* mentioned once each.
Since the answers regarding the size of cooperating companies strongly diverge. We cannot identify any general pattern. While two university respondents claimed to be cooperating with smaller companies, one respondents mentioned exclusively be cooperating with large companies. One interviewee answered that both (small and large cooperation partners are typical) and one interviewee did not answer the question at all, since the company size is not recorded. Therefore no general pattern can be derived regarding this aspect.

For government institutions software companies are clearly considered to be most important in their projects, with three out of three consider them to be rather or very important. Also universities are mainly rated to be important, with two interviewees estimating them to be rather or very important and one university mentioned them to be rather unimportant. Looking at Figure 4.11 it can be said that government institutions were considered to be moderately important.
The reason for the dominating importance of software companies and universities for government institutions is mainly the fact that it is not allowed for companies to receive funding from two government institutions in parallel. Even though there are certain exceptions (e.g. funding from an Austrian state in addition to particular programs from FFG or AWS), this implies little cooperation between different government institutions in specific innovation projects.

The major way how government institutions cooperate in innovation projects is *direct funding of software companies* (this has been considered by all three respondents). Other ways of cooperation that have each been mentioned once are: *securities for banks which fund software companies, funding of university-industry cooperation, coaching, contact mediation* as well as the *mediation of business with the public sector*.

There are various ways how these forms of cooperation come about: Mostly software companies (and universities) *contact government institutions directly* (mentioned by all three government institutions). Beside that *business events and networking* (mentioned twice) as well as *software platforms* that match software companies to cooperation partners (mentioned once) are possibilities.
Regarding the size of cooperating companies we could see that mainly small- and medium-sized enterprises cooperate with government institutions. Two respondents mention to be hardly cooperating with large-sized enterprises and one respondents estimated their share to be around 40%. Beside the fact that there rather few software companies in Austria, G3 moreover mentioned that large companies are not approved to its innovation programs.
From three interviewed government institutions only one (i.e. G2) offers particular programs to support the cooperation between software companies and universities in innovation projects.

Innovation Incentives and Barriers For universities the most important factor for successful innovation activities is the implementation of ideas, inventions and innovative concepts into products and services, which are successful in the market and generate profits. This was mentioned to be important by three of five university respondents. Moreover was knowledge about technology, customer needs and the market (2 respondents) as well as entrepreneurial spirit and culture, competitive business location, sufficient funding and free-space for research (each mentioned by 1 respondent) considered to be important.
Universities considered the necessity of innovation to survive in the fast changing software market to be the most significant incentive for innovation. This was mentioned by two of five respondents. Furthermore was higher product- and service quality, systematic funding of the cooperation of universities and software companies, knowledge gain, potential future employees and risk affinity mentioned to be an important incentive.
Regarding innovation barriers the main mentioned factor was risk aversion of investors, company managers and customers (this was mentioned by three of five university respondents). Other barriers that were stated are: Difficulty for small Austrian software companies to internationalize in the global software market, brain drain, bureaucracy, unawareness of expertise of cooperation partners and high non-wage labour costs.
We asked universities how they benefit from cooperation with software companies. Financial resources for research and teaching was the most often mentioned aspect (by four of five respondents). Furthermore did university respondents consider growing reputation, knowledge of technologies, industries and markets as well as interesting research projects and case studies for teaching.

The interviewed government institutions had different priorities regarding "most" important for successful innovation activities. Whereas one pointed out the necessity of market success (like most universities did), another government institution primarily pointed out the value of a culture and system that supports entrepreneurial spirit. Finally has the importance of a good business plan combined with sufficient funding been pointed out.
Government institutions regard the low-market entry barriers, higher quality of product and services as well as the strongly connected and divers-funded economic landscape in Austria as main

incentives for Austrian software companies to be innovation.
Similarly mentioned government institutions the difficulty to be successful in a globalized software market as barrier number one for (smaller Austrian software companies). This was mentioned by two of three government institutions. Moreover were scarce financial resources, high taxes and bureaucracy mentioned.
Finally we asked government institutions how software companies benefit from the cooperation with them. Funding and coaching were mentioned most often (by all three government institutions). Moreover did two respondents mention mediation and networking with cooperation partners as a benefit for cooperating software companies.

CHAPTER 5

Discussion and Conclusion

This chapter of the thesis provides the interpretation of our findings in accordance to the research question: "What are the relevant characteristics and key success factors of Austria's software sector, that allow it to be innovative?" Therefore we firstly evaluate the innovation performance of Austrian software companies and secondly and derive the Austrian sectoral system of innovation.

The findings have been produced in the following manner:
We firstly conducted a literature review to gain a theoretical basis about the topic and various aspects of the thesis. These aspects included the theory of innovation and innovation systems, innovation system frameworks and state of the art scientific work in this field of research. Moreover we gained an overview about the Austrian software sector. This included characteristics, key figures and important actors of the Austrian software sector.
Secondly we made use of a mixed research design, consisting of a qualitative and quantitative research method. We applied these methods concurrently (commonly called methodical triangulation). This allowed to compare and validate the data collected with each of the two research methods [10]. Different types of questions can be addressed and more information can be collected.

5.1 Interpretation of Results

To be able to interpret the results, we merge the results of the literature review, the questionnaire as well as the interviews. Then we analyse them in accordance to the research framework to assess the innovation performance of Austrian software companies, derive the Austrian software sectoral system of innovation and finally answer the research question ("What are the relevant characteristics and key success factors of Austria's software sector, that allow it to be innovative?").

5.1.1 The Austrian Software Sectoral System of Innovation

To provide a definition and characterization of the Austrian software sectoral system of innovation, we use the introduced scheme of analysis and derive the Austrian Software sectoral system of innovation in the following way:
Firstly we provide a definition of the focal sectoral system of innovation. Secondly we conduct a structural analysis and identify actors, their interaction and arising networks. Furthermore we determine functional patterns (i.e. the functions and contributions of the innovation system's actors). Finally we investigate the features that induce or block functional development of innovation performance in the Austrian sectoral system of innovation.

In accordance to the presented *sectoral system of innovation framework* and *triple helix model* we consider the Austrian software sectoral system as all Austrian companies, universities and government institutions which participate in the research, development and sale of software products or services. Thereby the geographical boundaries are explicitly defined on a national level. This means that even if a company or organization operates internationally or multinationally, we only consider activities in Austria.

5.1.1.1 Structural Components

Actors According to the triple helix model we identified three types of actors (which correspond to the triple helix spheres):

1. *Software companies* which research, develop and sell software products and services.

2. *Universities* which are involved in research and development of software products and services (as a source of knowledge, human resources and technology) and which can participate in the sale of products and services (as an *entrepreneurial university*).

3. *Government institutions* which support innovation projects of software companies and / or universities.

Many different software companies provide software products and services in Austria, from these companies we invited about 240 software companies to respond to our online questionnaire.
Similarly there are numerous universities, (technology) colleges and research institutes in Austria. To identify the most important ones for cooperation in the Austrian software sector, we asked the software companies about their cooperation partners. We identified the four most important universities and research institutes for innovation cooperation, which are *Vienna University of Technology, Vienna University of Economics and Business, Graz University of Technology* and the *Austrian Institute of Technoloy*.
Moreover we identified the three most important government institutions for cooperation in software innovation projects in Austria (i.e. *Austrian Research Promotion Agency (FFG), Austria Wirtschaftsservice (AWS)* and *Vienna Business Agency*).

Interaction It can be claimed that the actors of the Austrian sectoral system of innovation strongly interact with each other (i.e. within and across the defined actor types). From 33 software companies which answered the corresponding questionnaire questions, 29 answered to be cooperating with other companies, 22 mentioned to be coopering with universities and research institute, while seven work together with government institutions in the context of innovation projects.

In terms of cooperation in form of information exchange, software companies see other software companies as the most important partner for information exchange. From 40 respondents 25 consider other software companies as an important or rather important information source for innovation, with eight undecided and only seven consider it as rather unimportant. Universities are the second most important source of information, while being important or rather important for 11 companies with eight companies being undecided and 20 respondents consider them as unimportant or rather unimportant. Finally government institutions are the least important information source for innovation activities, since they were mentioned to be important / rather important by only five companies with four companies being undecided and 30 companies see them as unimportant or rather unimportant.

From five universities respondents four claimed to be cooperating with software companies, government institutions and other universities. One interviewee did not answer the corresponding question. Their estimation of the importance of cooperation partners shows that the cooperation with software companies was most important for innovation projects. Four of four universities consider software companies to be very or rather important. Other universities are considered to be second most important. Three of four universities answered that they see them as very important, while one was undecided. Finally government institutions were considered to be very or rather important by two of four university respondents. Two mentioned them to be rather unimportant.

Regarding the cooperation behaviour of government institutions we have shown that software companies are considered to be the most important cooperation partner. All three respondent mentioned them to be very or rather important for their innovation cooperation. Second most important cooperation partners for Austrian government institutions are universities. Two of three government institutions considers them to be very or rather important. One respondent estimates their importance as rather unimportant. Other government institutions are only moderately important. From three respondents one considers them to be rather important, one was undecided and one respondents said that they are rather unimportant.

Analogous to the importance of software companies as cooperation partners of government institutions, we asked the companies if they receive financial support from government institutions. Totally 51% (i.e. 25 of 49) of the companies answered that they were funded by government institutions between 2011 and 2013. This shows significant role of government institutions as a capital provider in the Austrian software sectoral system of innovation.

Networks Networking has been mentioned to be an important source of cooperation projects by three of five university respondents. Two of five consider it to be a major benefit of innovation cooperation for universities. From a government perspective networking is the third most important benefit for companies to cooperate with government institutions.

We identified three different kinds of networks which arise through the described cooperation of software companies, universities and government institutions. We have learned about the following networks:

1. *Informal networks*. They don't exist in form of specific organizations but arise through acquaintances and cooperation between different actors.
2. Numerous *platforms* exist for software companies to present themselves, do acquaintances and plan future cooperation projects. In the context of this thesis, we learned about *www.austrianstartups.com*, which is an online platform by the Austrian startup community intended to increase visibility of its members and strengthen the Austrian entrepreneurial ecosystem. Moreover did two government institutions mention that they provide platforms intended for acquaintances and networking.
3. *Industry networks.* In the context of this thesis we also learned about two industry networks of Austrian software companies. *VÖSI (Verband Österreichischer Software Industrie)* (which is a community of interest of the leading 30 Austrian IT companies) as well as about *VITE (Vienna IT Enterprises)* (i.e. a network for information and telecommunication technologies in Vienna).

5.1.1.2 Functional Patterns

As it was already mentioned in Section 3.3.1, we rather focus on structural aspects in this thesis than on processes and functions. Nevertheless we want to point out our findings regarding the most important contributions of the identified actors to the Austrian software sectoral system of innovation.

Based on the literature review as well as on the questions of the interviews and the questionnaire, we identified the functions of each actor type and its contributions to the Austrian software SSI:

- *Universities* contribute mainly as cooperation partners of companies or other universities in research projects. While the funding is either provided by the government or the software companies, universities contribute as a knowledge provider and (according to the triple helix model) act as an *entrepreneurial university* through research contracts and licensing of technology and founding spin-off companies.
- *Software companies* innovate with the goal to develop marketable products and services. Unlike universities, which are strongly represented in basic research, companies strongly focus on applied product development.
- *Government Institutions* do cooperate with universities and software companies in terms of innovation projects. Their main contribution is to provide financial resources. Therefore they either fund innovation projects directly or act as a mediator between companies and universities on the one side and investors (e.g. banks, venture capitalist or business angels) on the other side. We have learned that beside funding they support companies in networking and coaching.

5.1.1.3 Inducement and Blocking Mechanisms

Based on the answers from the questionnaire and the interviews about innovation incentives and barriers several inducement and blocking mechanisms have been identified.
The following innovation incentives have been mentioned across universities, software companies and government institutions, which are considered to be inducement mechanisms for successful innovation activities in Austria:

1. Sufficient funding / financial security. Independent of each other software companies, universities and government institutions pointed out the positive impact of versatile and systematic funding and financial security for universities and software companies.

2. High product and service quality. Universities and government institutions both mentioned the incentive of higher product and service quality as an inducement factor for innovation activities.

3. Competitive and strongly connected business location. The Austrian software sector benefits from its strong connectivity between government institutions, which offers various forms of funding and support, as well as universities and software companies, which cooperate in basic and applied research. This is considered as a major innovation incentive for Austrian software companies and universities.

4. Innovation-affine mindset through the necessity to be innovative. Several respondents pointed out the importance of innovation to survive in the dynamic and fast changing software market. Companies which do not innovation will therefore have problems to stay up-to-date with modern technology and deliver competitive quality of products and services. This necessity to be innovative supports an innovation-affine mindset in company managements and their cooperation partners.

Analogously several common innovation barriers have been mentioned by software companies, universities and government institutions that (in aggregated form) work as blocking mechanisms for successful innovation activities in the Austrian software sectoral system of innovation:

1. Globalized software market. Universities and government institutions both mentioned the difficulty for (rather small) Austrian software companies to innovate, since they compete with software companies that often benefit from very good site-related factors in other countries (for example in ICT hubs such as the Silicon Valley or Bangalore).

2. High taxes and non-wage labour costs. Software companies, universities and government institutions pointed out the negative effects of high taxes and non-wage labour costs on the capabilities of companies innovation to conduct innovation activities. Especially in a globalized software market, where Austrian software companies compete with enterprises from other companies with lower labour costs and / or taxes, this factor is significant.

3. Unnecessary bureaucracy. Universities and government institutions consider a lot of unnecessary bureaucracy in Austria to be harmful for local businesses to innovate and therefore a major blocking mechanism.

4. Risk aversion. Software companies and universities considered risk aversion of company managers (when it comes to conduct innovation activities or cooperate with universities and other companies), investors and customers (who are often careful to buy innovative products) to be an important innovation blocking factor in the Austrian software sectoral system of innovation.

5.1.2 Innovation Performance of the Austrian Software Sector

To determine the innovation performance of the Austrian software sector, we firstly evaluate the innovation performance of the involved actors separately and then appraise the overall innovation performance of the Austrian software sector.

Generally Austrian software companies show a high innovation performance. On average they developed about 4,5 new products and 4,0 new services (median value of 2,0 and 1,5) in the years from 2011 to 2013. Furthermore did they generate in average 44% of the annual turnover (median value of 46%) and 35% (median value of 20%) of the annual profit through new software products and services. Therefore we claim that innovation activities of Austrian software companies are financially successful.
The surveyed companies also see themselves to be accordingly innovative. Of all surveyed software companies 77% agreed or strongly agreed on being satisfied with their general innovation success, while 68% agreed or strongly agreed on being satisfied with their innovation success regarding development of new products and 60% agreed or strongly agreed on being satisfied with their innovation performance regarding services. Moreover most of the companies are content with their innovation capabilities and therefore consider themselves to be innovative. 66% consider their capabilities regarding product related innovation as very or rather satisfying and 65% feel very or rather satisfied with their capabilities in service related innovation.

Since the innovation performance of universities and government institutions cannot be measured with the three proposed measures (as they don't develop or sell end-products), we inquired the satisfaction with their cooperation success and their satisfaction with their cooperation ability. Furthermore we asked the universities about the number of innovation projects, they have been involved between 2011 and 2013. Similarly the government institutions were asked how many software companies they annually support in their innovation projects.
Looking at the innovation performance of universities, which participated in innovation projects, it can be seen that the interviewed university representatives are generally satisfied with their innovation cooperation success. All university respondents mentioned to be very or rather satisfied. Similarly they estimate their ability to cooperate with government institutions and software companies to be good. Four of five are very or rather satisfied.
Three of five universities answered the questions about the number of innovation project that the respondents organization were involved in the three years between 2011 and 2013. This formulation implies strong deviations, since one respondents could only answer for his own research group, while another answered with regard to the whole university. Therefore we received strongly diverging answers: One interview partner mentioned the number of cooperating companies to be nine, another respondent claimed it to be around 100 and the third respondent

estimates it to be between 400 and 500 industry partners in the last year. Taking this sample it is fair to say that Austrian universities generally show a strong commitment in innovation cooperation projects.
Unfortunately we cannot make any conclusions about the innovation cooperation satisfaction and the organizations cooperation ability of the interviewed government institutions. From three respondents of government institutions two wouldn't answer these questions. Looking at the answers regarding the number of software companies that they annually support in innovation projects, we again received diverging answers. Estimations from 50 to 60, between 100 and 200. till 296 ICT projects (which include software projects) were given. Also for this sample it can be said that the commitment of Austrian government institutions, which are engaged in innovation cooperation with the software sector, can fairly be called to be strong.

Regarding the effects of cooperation on the innovation performance of Austrian software companies, we figured out that companies which cooperate with universities or government institutions are not more satisfied with their innovation success or innovation capabilities than companies which don't cooperate. However did cooperation show positive effects on new product and service development. The questionnaire results show that the development of new products and new services is two times higher in cooperating companies than in non-cooperating companies. Cooperating companies performed with a higher share of sales but a lower share of profits generated with new products and services than non-cooperating companies. Therefore it can be claimed that even though companies which do not cooperate with universities and government institutions are more satisfied with their innovation success and capabilities, the used measures show that cooperating companies are more likely to develop more innovative products and services. Moreover do they gain a higher share of sales through innovative products and services, which makes product and service development financially successful and sustainable.

Moreover we want to determine the strengths and weaknesses of the Austrian software sector and use them to answer the research question (*"What are the relevant characteristics and key success factors of Austria's software sector, that allow it to be innovative?"*). Therefore we refer to the identified inducement and blocking mechanisms.
We identified the following four innovation incentives as inducement mechanisms for successful innovation activities in the Austrian software sectoral system of innovation.

- Various forms of funding. The numerous and versatile governmental funding programs in Austria, which financially support software companies in their innovation activities, is the most significant inducement factor in the Austrian software sectoral system of innovation.

- High product and service quality. The incentive of higher product and service quality serves as a natural inducement factor for Austrian software companies to innovate.

- Strongly connected business location. Universities and software companies benefit from a strongly connected business location. This is based on two major factors. Firstly the small size of the country as well as the concentration of technology companies around Vienna. Secondly are companies, universities and government institutions well-connected in Austria. This represents an important inducement factor for universities and software companies to innovate.

- Innovation-affine mindset through the necessity to be innovative. The globalized software market, which is characterized through high competition and saturation level, demands innovation from its companies to survive. This necessity to be innovative supports an innovation-affine mindset in company managements and their cooperation partners.

Analogously we identified four major weaknesses, which were mentioned by software companies, universities and government institutions. We consider them as blocking mechanisms for successful innovation activities in the Austrian software sectoral system of innovation.

- Globalized software market. Austrian software companies are typically rather small- or medium-sized enterprises. Which makes it difficult to compete with larger multinational software companies in the globalized market. This is considered to be the most significant blocking mechanism for Austrian software companies to innovate.
- High taxes and non-wage labour costs. We identified the comparatively high taxes and non-wage labour costs as an important blocking mechanism for innovation activities in Austria. It motivates companies to move their research and development to other countries and makes innovation activities for local companies more expensive.
- Unnecessary bureaucracy. Bureaucracy makes innovation activities more complicated and complex, which is seen to be another blocking mechanisms to undertake attempts in innovation activities for Austrian software companies and universities.
- Risk aversion. Innovation activities are usually associated with risks. Company managers, investors and customers were claimed to be rather risk-averse by the interview and questionnaire respondents. This risk aversion is considered to be another blocking mechanism for universities and software companies in Austria to be innovative.

Summarized we feel confident to say that *the numerous and versatile governmental funding programs, the possibility to improve product- and service quality, the strongly connected business location in Austria (especially around Vienna)* as well as *an innovation-affine mindset through the necessity to be innovative* are the key factors for the success of the Austrian software sector.

5.2 Conclusion

Since a systematic analysis of the innovation performance of the Austrian software sector combined with an identification of structural components and functional patterns as source of innovation capabilities as well as arising inducement and blocking factors of innovation performance has been missing in the past, we applied the sectoral system of innovation framework and combination with the triple helix model on the Austrian software sector. We conducted a mixed research design consisting of a online survey with software companies (quantitative method) and semi-structured interviews with universities and research institutes (qualitative method). In both we inquired about innovation activities, cooperation behaviour as well as factors that foster and block software product- and service innovations in Austria. This was preceded by a literature review about the characteristics of the Austrian software sector. We used these finding to define and characterize the Austrian software sectoral system of innovation and assess its innovation performance.

The innovation performance of Austrian software companies was measured in terms of three common innovation success measures: *number and share of new developed software products and service, the share of turnover through new developed products and services* and *the share of profits new developed products and services*. Moreover we investigated how satisfied software companies, universities and government institutions are with their innovation capabilities and innovation success.
Our results show that Austrian software companies show a high innovation performance. The average Austrian software company developed 4,5 new products and 4 new services (median values of 2,0 and 1,5) in the three years from 2011 to 2013. Moreover did they generate in average 44% of the annual turnover (median value of 46%) and 35% (median value of 20%) of the annual profit through new software products and services.
Austrian software companies also consider themselves to be accordingly innovative. 68% of the surveyed companies agreed or strongly agreed on being satisfied with the innovation success regarding development of new products and 60% agreed or strongly agreed on being satisfied with their innovation performance regarding services. Also most of the companies are content with their innovation capabilities. 66% consider their capabilities regarding product related innovation as very satisfying or rather satisfying and 65% feel very satisfied or rather satisfied with their capabilities in service related innovation. Analogously the interviews showed that Austrian universities and government institutions generally participate with strong commitment in innovation cooperation projects.
We could show that even though companies which cooperate with universities or government institutions are not more satisfied with their innovation success or innovation capabilities, did cooperation show positive effects on the measured innovation performance. Cooperating companies develop more innovative software products and services. Cooperating companies generate a lower share of profits through their new products and services, however is the share of sales through innovative products and services higher. This was explained by the fact that the (sophisticated) innovations developed by software companies and universities are costly. These costs must be amortized. However it also means that product- and service development is generally financially successful and sustainable, since the cashflow can be used for new innovations when the costs are amortized.

For the definition and characterization of the sectoral system of innovation analysis we identified:

1. Structural components. This contains the most important actors of the Austrian software sectoral system of innovation. The forms and intensity of their interaction as well as arising networks.

2. Functional patterns. This presents the functions of each actor type and its contributions to the Austrian software sectoral system of innovation.

3. Inducement and blocking mechanisms. Several innovation incentives and barriers, which were mentioned across universities, software companies and government institutions, have been identified to be inducement or blocking mechanisms for successful innovation activities in Austria.

To answer the research question ("What are the relevant characteristics and key success factors of Austria's software sector, that allow it to be innovative?"), we reached the conclusion that the key success factors of the Austrian software sector, that allow it to be innovative are *the numerous and versatile governmental funding programs, the possibility to improve product- and service quality, the strongly connected business location in Austria (especially around Vienna)* as well as *an innovation-affine mindset through the necessity to be innovative*.

5.3 Limitations

It must be said that the achieved results are not universally valid and that a few threats to validity exist:
First of all is the number of interview respondents is rather small. We conducted five interviews with representatives from universities and three interviews with representatives of three different government institutions. While these institutions are considered to be most important for innovation projects in the Austrian software sector, other organizations can nevertheless play important roles too, especially in other states than Vienna.
Moreover did we do interviews with only one employee of each organization (except of the Vienna University of Economics and Business where we could interview two professors). While these particular employees answered the questions from their point of view, other employees could have answered the questions differently.
As some software companies answered our questionnaire only partly, certain questions were answered only by few companies. Therefore is the answer set for these question not representative.
Beside the questions which were mentioned to be used also in the *Community Innovation Survey* or the *Global Innovation Excellence Survey*, the selection of questions has been done according to our own preferences and focus of this thesis. Other questions could have revealed other important aspects regarding the Austrian software sectoral system of innovation or the innovation performance of the Austrian software sector.
We must also point out that the focus of this thesis regards exclusively innovation activities between the years 2011 and 2013. We decided to focus on innovation activities of the last three years, since it was suggested in similar studies of the past. A wider time-frame or the selection of other three years could reveal other findings.
Since the frame of a master thesis is limited and the topic included many aspects (i.e. innovation performance of Austrian software sectors, definition and analysis of the Austrian software sectoral system of innovation, innovation theory, innovation system concepts and the triple helix model) some aspects could not be profoundly investigated and discussed. These aspects will be suggested for other scientific work in the section *Future Work*.

5.4 Future Work

There are still several aspects that can be investigated to extend the findings of this thesis and to increase the meaningfulness of the derived conclusion:
It would be interesting to compare the findings of this thesis with results of other sectoral system of innovation studies that were applied on software sectors of other countries. Therefore the innovation performance as well as strength and weaknesses could be compared.
As we limited the time frame of innovation activities to the years between 2011 and 2013, it would be interesting to repeat a sectoral system of innovation study of the Austrian software sector in the future. This would allow to investigate if the innovation performance increases or decreases over time.
As we have used particular questions from the *Community Innovation Survey* and the *Global Innovation Excellence Survey*, it would be worth comparing the answers of these questions with the answers that were given by software companies of former studies.
While we have investigated the "whole" Austrian software sector, which explicitly implies national boundaries, it would be interesting to focus on other geographical dimensions. Therefore a regional (e.g. Styrian software sectoral system of innovation) or even local (software sector in Linz) investigation of the software sector in Austria could be worth investigating.

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APPENDIX A

Appendix

A.1 Questionnaire / Survey with Software Companies

Vorschau | [standard] [barrierefrei]

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Druckansicht vom 03.04.2015, 19:50

Bitte beachten Sie, dass Filter und Platzhalter in der Druckansicht prinzipbedingt nicht funktionieren. Fragen, die mittels PHP-Code eingebunden sind, werden nur eingeschränkt wiedergegeben.

Korrekturfahne **Variablenansicht** **PHP-Code anzeigen**

Seite 01
Startseite

Willkommen zu dieser Studie

Im Rahmen einer wissenschaftlichen Studie der TU Wien untersuchen wir die Innovativität des österreichisches Softwaresektors bezüglich Produkt- und Service-Innovationen. Diesbezüglich sind wir auf Ihr Unternehmen aufmerksam geworden und bitte Sie sich ca. 10 Minuten Zeit zu nehmen um den vorliegenden Fragebogen auszufüllen.

Die Daten werden vertraulich behandelt und nur für wissenschaftliche Zwecke im Rahmen der Studie verwendet.

Vielen Dank für Ihre Unterstützung.

Seite 02
Allg Info

Falls Ihr Unternehmen Teil einer (internationalen) Unternehmensgruppe ist, beantworten Sie bitte alle Fragen des Fragebogens ausschliesslich für die österreichische Unternehmenseinheit.

1. In welcher Sparte (bzw. Branchenzweig) ist Ihr Unternehmen tätig?

Sparte

2. Wie viele Mitarbeiter hat Ihr Unternehmen (in Österreich)?

Anzahl Mitarbeiter

3. Wieviel Prozent Ihrer Mitarbeiter (ausschliesslich Mitarbeiter in Österreich) haben einen Hochschulabschluss (Universität / FH)?

[Bitte auswählen]

Seite 03

Zufriedenheit

4. Wie zufrieden sind Sie mit den Ergebnissen und Auswirkungen ihrer Innovations-Tätigkeit?

Im Zusammenhang dieser Umfrage ist mit Service-Innovation die Entwicklung neuer Dienstleistungen gemeint, während Produkt-Innovation für die Entwicklung neuer Produkt in Form von Gütern steht.

	stimme gar nicht zu	stimme eher nicht zu	unentschieden	stimme eher zu	stimme voll zu	Nicht beantwortbar
Die Ergebnisse unserer Innovations-Tätigkeit sind zufriedenstellend.						
Die Ergebnisse unserer Produkt-Innovations-Tätigkeit sind zufriedenstellend.						
Die Ergebnisse unserer Service-Innovation-Tätigkeit sind zufriedenstellend.						

Seite 04

Faehigkeit

5. Bitte beurteilen Sie Ihre Fähigkeiten für die folgenden Arten von Innovationen?

	stimme gar nicht zu	stimme eher nicht zu	unentschieden	stimme eher zu	stimme voll zu	Nicht beantwortbar
Unser Unternehmen zeichnet sich durch überdurchschnittliche Fähigkeiten bezüglich Produkt-Innovationen aus.						
Unser Unternehmen zeichnet sich durch überdurchschnittliche Fähigkeiten bezüglich Service-Innovationen aus.						

Seite 05

InnovationsEinfuehrung

6. Hat Ihr Unternehmen in den Jahren 2011 bis 2013 Produkt- oder Service-Innovationen entwickelt?

Produkt-Innovation bedeutet die Entwicklung eines neuen (phyischen) Gutes, welches entweder für Ihr Unternehmen oder für den Markt in, in dem das Gut vertrieben wird, neuartig ist.

Service-Innovation bedeutet die Entwicklung einer neuen Dienstleistung, welche entweder für Ihr Unternehmen oder für den Markt in, in dem die Dienstleistung vertrieben wird, neuartig ist.

	Nein	Ja
Produkt-Innovation		

Service-Innovation

Seite 06

NeueGueter

7. Wie viele Produkt-Innovationen (ohne Dienstleistungen) wurden in Ihrem Unternehmen (bzw. in der österreichischen Niederlassung Ihres Unternehmens) in den Jahren 2011 bis 2013 entwickelt?

Anzahl neuer Produkte

8. Wie viele Produkte bietet Ihr Unternehmen insgesamt an?

Anzahl angebotener Produkte insgesamt

Seite 07

PHP1

Seite 08

Neue DL

9. Wie viele Service-Innovationen (Dienstleistungen) wurden in Ihrem Unternehmen (bzw. in der österreichischen Niederlassung Ihres Unternehmens) in den Jahren 2011 bis 2013 entwickelt?

Anzahl neuer Dienstleistungen

10. Wie viele Dienstleistungen bietet Ihr Unternehmen insgesamt an?

Anzahl angebotener Dienstleistungen insgesamt

Seite 09

PHP2

Seite 10

UmsatzGewinn

11. Wieviel Prozent Ihrer Einnahmen im Jahr 2013 wurden durch neue oder signifikant verbesserte Produkte oder Dienstleistungen (die in den Jahren 2011 bis 2013 entwickelt wurden) umgesetzt?

Umsatzanteil in %

12. Wieviel Prozent Ihres Reingewinns im Jahr 2013 wurden durch neue oder signifikant verbesserte Produkte oder Dienstleistungen (die in den Jahren 2011 bis 2013 entwickelt wurden) erwirtschaftet?

Gewinnanteil in %	

Seite 11

InfoSource

13. Wie wichtig waren die folgenden Informationsquellen für die Innovationstätigkeiten Ihres Unternehmens während des Zeitraums 2011 bis 2013?

	unwichtig	eher unwichtig	unentschieden	eher wichtig	wichtig	Nicht beantwortbar
Eigenes Unternehmen / Unternehmensgruppe	○	○	○	○	○	○
Andere Unternehmen	○	○	○	○	○	○
Universitäten und Forschungseinrichtungen	○	○	○	○	○	○
Staatliche Institutionen	○	○	○	○	○	○

Seite 12

KoopJaNein

14. Hat ihr Unternehmen während der Jahre 2011 bis 2013 im Rahmen der Entwicklung von Produkt- oder Serviceinnovationen mit anderen Unternehmen, Universitäten oder staatlichen Institutionen kooperiert?

Unter Kooperation wird die Zusammenarbeit mit anderen Unternehmen oder nicht-kommerziellen Institutionen an Innovationsaktivitäten verstanden. Dabei müssen nicht zwangsläufig beide Partner kommerziell profitieren. Ausgeschlossen hierbei sind die reine Vergabe von Aufträgen.

	Nein	Ja
Kooperation fand statt	○	○

Seite 13

Kooperationspartner

15. Mit welcher Art von Kooperationspartnern haben Sie im Rahmen ihrer Innovationstätigkeit zusammengearbeitet?

	Nein	Ja
Kooperation mit anderen Unternehmen	○	○
Kooperation mit staatlichen Institutionen	○	○

Kooperation mit Universitäten / Forschungseinrichtungen	○	○
Andere	○	○

Seite 14

KoopStaat

16. Sie haben angegeben, dass Sie mit staatlichen Institutionen im Zuge Ihrer Innovationstätigkeit kooperieren bzw. kooperiert haben. Bitte nennen Sie Institutionen mit denen Sie zusammengearbeitet haben.

staatliche Kooperationspartner	

Seite 15

KoopUni

17. Sie haben angegeben, dass Sie mit Universitäten / Forschungseinrichtungen im Zuge Ihrer Innovationstätigkeit kooperieren bzw. kooperiert haben. Bitte nennen Sie Institutionen mit denen Sie zusammengearbeitet haben.

universitäre Kooperationspartner	

Seite 16

FinanzSupport

18. Erhielt Ihr Unternehmen während den Jahren 2011 bis 2013 finanzielle Unterstützung für Innovationstätigkeiten von Seiten des österreichischen Staates?

Nein Ja

Lokale oder regionale Behörden	○	○
Bundesregierung (inkl. zentrale Regierungsbehörden und Ministerien)	○	○

Seite 17

Erfolglos

19. Wurden von Ihrem Unternehmen in den Jahren 2011 bis 2013 Innovations-Aktivitäten unternommen, die aus folgenden Gründen zu keiner Produkt- / Service-Innovation geführt haben?

	Nein	Ja
Vor dem Abschluss unterbrochene oder aufgegebene Innovations-Aktivitäten	○	○
Laufende (Weiter-) Entwicklung am Ende des Jahres 2013	○	○

Seite 18

Hinderung

20. Wurden Sie durch die folgenden Faktoren in Ihrer Innovations-Tätigkeit behindert? Falls dies zutrifft in welchem Ausmass haben die einzelnen Faktoren Ihre Innovations-Tätigkeit eingeschränkt?

	stimme gar nicht zu	stimme eher nicht zu	unentschieden	stimme eher zu	stimme voll zu	Nicht beantwortbar
Mangelnde Liquidität	○	○	○	○	○	○
Zu hohe Innovationskosten	○	○	○	○	○	○
Mangel an qualifizierten Fachleuten	○	○	○	○	○	○
Mangelnde Technologie-Expertise	○	○	○	○	○	○
Mangelnde Markt-Expertise	○	○	○	○	○	○
Mangel an Kooperationspartnern	○	○	○	○	○	○
Dominierende Marktstellung von konkurrenzierenden Unternehmen	○	○	○	○	○	○
Unsicherheit bezgl. der Nachfrage für spezifische innovative Produkte / Dienstleistungen	○	○	○	○	○	○
Kein Innovationsbedarf aufgrund vorangegangender Innovationen	○	○	○	○	○	○
Kein Innovationsbedarf aufgrund mangelnder Nachfrage für innovatives Produkt / Dienstleistung	○	○	○	○	○	○
Andere Gründe	○	○	○	○	○	○

Seite 19

AndereHinderung

21. Sie haben angegeben, dass Sie durch andere Faktoren im Zuge Ihrer Innovationstätigkeit eingeschränkt wurden. Bitte nennen Sie diese.

Hinderungsfaktoren	

Seite 20

Anreize

22. Gibt es Ihrer Meinung nach Faktoren, die spezifische Anreize für Innovationstätigkeiten schaffen? Falls ja, bitte nennen Sie diese.

Anreizfaktoren	

Seite 21

Abschicken

Sie haben alle Fragen beantwortet und können Ihren Fragebogen nun abschicken.

Letzte Seite

Vielen Dank für die Teilnahme an dieser Umfrage!

Ihre Antworten wurden übermittelt. Sie können den Tab / Browser nun schliessen.

B.Sc. Christoph Moser, Technische Universität Wien – 2014

A.2 Interview with Government Institutions

Interview-Questionnaire
(Government Institutions)

1. Was ist Ihrer Meinung nach für erfolgreiche Innovationstätigkeit am wichtigsten?

2. Wie zufrieden sind Sie mit dem Erfolg der Kooperation Ihrer Organisation mit österreichischen Softwareunternehmen und/oder Universitäten? (Skala 1-5)

3. Wie beurteilen Sie die Fähigkeit Ihrer Organisation bzgl. Kooperation mit österreichischen Softwareunternehmen und/oder Universitäten? (zB. Personal / Vernetzung etc.) (Skala 1-5)

4. Wie wichtig sind für Sie folgende Innovations-Kooperationspartner im Software-Sektor(Skala 1 – 5)?
   - Unternehmen
   - Staatliche Institutionen
   - Universitäten / Hochschulen

5. Wie viele Softwareunternehmen werden jährlich von Ihnen in Innovationsprojekten unterstützt?

6. Wie sieht die Kooperation mit Softwareunternehmen in der Regel aus? Wie fördern Sie Softwareunternehmen im Rahmen ihrer Innovationstätigkeit?

7. Typische Unternehmensgröße der kooperierenden Unternehmen (Grosse Unternehmen vs Startups)?

8. Wie kommen in Ihrer Organisation Kooperationen mit Softwareunternehmen üblicherweise zustande?

9. Auf welche Weise profitieren Softwareunternehmen von der Kooperation mit Ihnen?

10. Wird die Kooperation von Unternehmen & Universitäten gefördert? Wenn ja, wie?

11. Welche Anreize sehen Sie für österreichische Softwareunternehmen innovativ zu sein?

12. Welche Hinderungsgründe sehen Sie für österreichisch Softwareunternehmen innovativ zu sein?

13. Gibt es von Ihrer Seite noch Anmerkungen oder fällt Ihnen noch etwas wichtiges ein, das noch nicht besprochen wurde?

A.3 Interview with Universities and Research Institutes

Interview-Questionnaire

(Universities & Research Institutes)

1. Was ist ihrer Meinung nach für erfolgreiche Innovationstätigkeit am wichtigsten?

2. Wie zufrieden sind Sie mit der Kooperation Ihrer Organisation mit österreichischen Softwareunternehmen und / oder staatlichen Institutionen? (Skala 1-5)

3. Wie beurteilen Sie Ihre Fähigkeit Ihrer Organisation bzgl. Kooperation mit österreichischen Softwareunternehmen und / oder staatlichen Institutionen? (Skala 1-5)

4. Wie wichtig waren dabei folgende Innovations-Kooperationspartner im Software-Sektor(Skala 1 – 5)?
   - Softwareunternehmen
   - Staatliche Institutionen
   - Andere Universitäten / Hochschulen

5. Bei wie vielen Projekten bzgl. Produkt- / Serviceinnovationen waren Sie 2011 bis 2013 involviert?

6. Wie sieht die Kooperation mit Softwareunternehmen in der Regel aus? Wie fördern Sie Softwareunternehmen im Rahmen ihrer Innovationstätigkeit?

7. Typische Unternehmensgröße der kooperierenden Unternehmen (Grosse Unternehmen vs Startups)?

8. Wie kommen in Ihrer Organisation Kooperationen mit Softwareunternehmen üblicherweise zustande?

9. Auf welche Weise profitieren Universitäten von der Kooperation mit Unternehmen? Eigene Motivation / Zweck für Kooperation?

10. Welche Anreize sehen Sie für österreichische Softwareunternehmen innovativ zu sein?

11. Welche Hinderungsgründe sehen Sie für österreichisch Softwareunternehmen innovativ zu sein?

12. Gibt es von Ihrer Seite noch Anmerkungen oder fällt Ihnen noch etwas wichtiges ein, das noch nicht besprochen wurde?