Filip Krstanovic

Insights into the Chinese Innovation System

The Beijing Case

Masterarbeit

zur Erlangung des akademischen Grades

M.Sc.

Softwareentwicklung-Wirtschaft

eingereicht an der

Graz University of Technology

Adviser: Univ.-Ass. Dipl.-Ing. Harald Wipfler
Auditor: Univ.-Prof. Dipl.-Ing. Dr. techn. Stefan Vorbach

Institute of General Management and Organization

Graz, December 13, 2015

EIDESSTATTLICHE ERKLÄRUNG

AFFIDAVIT

Ich erkläre an Eides statt, dass ich die vorliegende Arbeit selbstständig verfasst, andere als die angegebenen Quellen/Hilfsmittel nicht benutzt, und die den benutzten Quellen wörtlich und inhaltlich entnommenen Stellen als solche kenntlich gemacht habe. Das in TUGRAZonline hochgeladene Textdokument ist mit der vorliegenden Masterarbeit identisch.

I declare that I have authored this thesis independently, that I have not used other than the declared sources/resources, and that I have explicitly indicated all material which has been quoted either literally or by content from the sources used. The text document uploaded to TUGRAZonline is identical to the present master‘s thesis.

Datum / Date

Unterschrift / Signature

Acknowledgments

I would like to express my tremendous gratitude to everyone who has supported this project or contributed to it in any possible way, without them I would not have been able to realize this endeavor.

In particular, I would like to express my deepest gratitude to my research supervisors Professor Dipl.-Ing. Harald Wipfler and Professor Univ.-Prof. Dipl.-Ing. Dr. techn. Stefan Vorbach from the Institute of General Management and Organisation of the University of Technology in Graz, who approved the topic and, since the very first day, have given me their invaluable assistance and support. They were instrumental in enabling me to embark on the study of the Chinese context and complete the Thesis, which this research represents. Without them, the realization of this Master's Thesis would never have been possible.

To the subjects in this study, my debt is enormous as without them, I would not have been able to obtain the relevant data or to develop sufficient understanding of the Chinese context.

I would also like to offer my special thanks to Ms. He Yajie (aka Amy) at the Division of International Exchanges and Cooperation of the Administrative Committee of Zhongguancun Science Park for her continued efforts and kind assistance in helping me gain access to the participants and the relevant data.

Likewise, I would like to express my very great appreciation to Mr. Simon Wang and Ms. Chenwei Wang of the Beijing Makerspace, and Ms. Yuan Yuan at the Enterprise Development Department of TusPark Business Incubator Co., Ltd. for their support, valuable insights and input on this project.

I would also like to acknowledge Advantage Austria, Science and Technology Office of the Austrian Embassy in Beijing, and its kind and supportive staff for being generous with their time and knowledge to aid me in my research project.

I am particularly grateful for the assistance and opportunities provided by Mr. Joseph Tenzin Oliver and Mr. Simon Kubski of We impact, Beijing, with whom I have had the privileged to collaborate, and from whom I have learned so much in such a short time.

I recognize that this research would not have been possible without the financial assistance of two institutions which backed this project. The research for this Master Thesis was financially supported by the KUWI Scholarship of the Graz University of Technology (TU Graz) and the Beijing Institute of Technology (BIT) in the form of waiver of tuition fees. In this regard, I would like to acknowledge Ms. Dipl.-Ing. Katrin Landfahrer of the International Relations and Mobility Programmes Office at TU Graz and Ms. Xin Zong (aka Summer) of the Office of International Student & Exchange Student Office for HK, Macao and Taiwan at BIT, who guided me and provided assistance at all levels.

Finally, last but not least, a special thank you is reserved for my girlfriend and best friend Maša and my family for their unconditional support and encouragement, for always being there for me, and without whom I would not have succeeded in realizing my goals. I love them and I dedicate this Thesis to them.

Abstract

Since the global innovation divide continues to persist, pressure has been put on the nations on the wrong side of the innovation divide to speed up their progress in driving innovation. The study tries to give an overview of China's rapid transition into an innovation-driven economy and the success it has achieved. Given that China has transitioned rapidly, it can be a role-model for all the nations on the wrong side of the innovation divide. The study aims to give answers to how this transformation was even possible and what mechanisms were behind it. The methods used in this study are based on the qualitative approach and include data and document analysis of numerous primary and secondary sources, as well as six in-depth semi-structured interviews with relevant stakeholders in Beijing.

The results of the study have shown that in order to catch up in innovation, the governmental support has been proven to be crucial for late-coming nations, which is also true for China, where the government played a leading role in the development of Science, Technology & Innovation (STI). As China is too vast and too unevenly developed, the main focus of the research was on Beijing, which is not only the political, but also the STI and educational capital of China, while a special emphasis is given to the Zhongguancun Science Park, which is China's oldest, largest and leading science park, located in Beijing. Zhongguancun S&T Park has played and still plays a leading role not only in the development of STI in Beijing, but entire Mainland China.

Contents

Figures

Tables

Abbreviations

CAE	Chinese Academy of Engineering
CAS	Chinese Academy of Sciences
CAST	China Association for Science and Technology
CPC	Communist Party of China
CPCI-S	Conference Proceedings Citation Index - Science
EI	Engineering Index
GCR	Global Competitiveness Report
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GII	Global Innovation Index
HR	Human Resources
IASP	International Association of Science Parks
IPR	Intellectual Property Rights
IT	Information Technology
KIP	Knowledge Innovation Process
MNE	Multinational Enterprises
MOA	Ministry of Agriculture
MOE	Ministry of Education
MOF	Ministry of Finance

MIIT	Ministry of Industry and Information Technology
MOST	Ministry of Science and Technology
NDRC	National Development and Reform Commission
NIS	National Innovation System
NPC	National People's Congress
NSFC	National Natural Science Foundation of China
OECD	Organization for Economic Cooperation and Development
O2O	Online-to-Offline
PCT	Patent Cooperation Treaty
PRC	People's Republic of China
RI	Research Institution
RIS	Regional Innovation System
SAR	Special Administrative Regions
SCI	Science Citation Index
SIPO	State Intellectual Property Office of the People's Republic of China
SOE	State-owned Enterprise
STI	Science, Technology and Innovation
TEEC	Tsinghua Entrepreneur and Executive Club
UAE	URI-affiliated Enterprise
URI	Universities and Research Institutes
VAT	Value-added Tax
VPN	Virtual Private Network
WIPO	World Intellectual Property Organization

ZGC	Zhongguancun Science Park

1. Introduction

1.1. Research problem

Nowadays, the world finally seems to be leaving behind the longest-lasting and furthest-reaching financial and economic crisis of the last eighty years. Although, the outlook for growth has improved in comparison to the previous years, especially in the advanced economies, however, significant issues still remain due to the ever-rising income gap, tense geopolitical situations and tightening of financial statuses. Therefore, it is of great importance to address these challenges and many other existing obstacles, in order to enable a more sustainable growth (World Economic Forum, 2014). Economic growth is in need of sustainability and shared increase in income per capita, as well of a technological upgrade of production and structural changes in the economy towards goods and services of higher value. As nowadays both the global market and its competition are becoming even more and more knowledge-based; innovation alongside traditional components like technological processes and costs, has become essential for a successful business and its competitiveness. Consequently, it is nothing unusual that innovation is the focal point of contemporary theories of economic development and growth (Szirmai et al., 2011).

According to the World Economic Forum (2014), competitiveness is defined as a set of factors, policies and institutions that specify the level of country's productivity and is thereby in direct relation with the prosperity of a country. In their most recent report, the Global Competitiveness Report 2014-2015, not only the competitiveness environments of 144 economies have been evaluated, but also insights into the key drivers of country's productivity have been given, which set the level of prosperity that an economy can achieve. Furthermore, this edition heavily emphasizes innovation as a key driver of economic growth and an increasing influence on the competitiveness of the global economy, especially in these times of economic recovery from the crisis. In addition, availability of capable talent, powerful institutions and the high capability to innovate are essential for success of every economy and will become even more essential in the future (World Economic Forum, 2014).

On the other hand, IMD World Competitiveness Center (2015), describes competitiveness as an analysis of how enterprises and nations manage the wholeness of their resources and competences in order to accomplish long-term prosperity. In their latest report, the World Competitiveness Yearbook 2014, which is a study of world competitiveness that assesses the competitiveness of 60 countries using 4 factors, 20 sub-factors and over 338 criteria, the IMD World Competitiveness Center emphasizes the essential role of powerful institutions in fostering and stimulating innovation and entrepreneurship to increase prosperity. Competitiveness helps to comprehend the factors which make prosperity possible, since prosperity is more than mere economic performance of a country and in addition to economic, it also includes non-economic dimensions. Although there is no definitive formula how to attain competitiveness, however, this edition highlights the essential role of institutions in fostering entrepreneurship and innovation in order to increase prosperity (IMD World Competitiveness Center, 2015). Regardless that two different definitions of competitiveness are given, both of the reports emphasize innovation as a key driver of economic growth and its increasingly important role in national and global competitiveness, thereby directly effecting the level of prosperity a nation can attain.

In line with this view, innovation as well as its efficient diffusion play an essential role in the competitiveness of nations, regions and enterprises and their economic development. Today, when it comes to governmental policy agendas, innovation has become a top priority (Guan et al., 2009). In addition, Shah et al. (2015) emphasizes the importance of innovation as it generates the creation of new businesses that will successively drive economic development and growth. This holds regardless if these new businesses are startups or if they are new businesses within existing enterprises, while the last-mentioned has been recently denoted as intrapreneurship. Since these aforementioned enterprises take advantage of innovations in such a way of increased income and profit margins, therefore the sum effect is an increase of the national, but also of the global economy as well. The yearly rate of increase in a country's gross domestic product (GDP) is not merely a measure of economic growth, but also of general welfare of the population in a certain economy. Furthermore, the Cornell University, INSEAD and WIPO (2014) recognize innovation as a key for economic growth and welfare, as well as a subject of substantial significance because it fosters sustainable growth in today's highly dynamic and extremely competitive market. Therefore, innovation is being studied by scholars world-wide thoroughly to ascertain the various actors such as government, industry, academia, research institutions (RIs), and factors like infrastructure, funding, knowledge/technology transfer, R&D, incubation, mentoring, etc.; which all have been identified as crucial to any innovation ecosystem. Moreover, their last report, the Global Innovation Index (GII) 2014, highlights that creative and critical thinking, as well as willingness for risk taking and entrepreneurial thinking are at least as important as technical qualifications.

Despite the rise of the globalization of R&D, the GII 2014 affirms that the global innovation divide continues to exit, even within income groups. Furthermore, the GII deploys a broader, a more holistic view of innovation, by including more factors than mere of R&D expenditure and scientific publications, which were geographically concentrated over the past three decades in only a few centers of excellence. Nonetheless, findings have shown that regardless of the wider view, harsh divides in the innovation performance continue to exist widespread, across and within not only income groups, but geographical regions as well. The innovation divide certainly exists between and within world regions, and when regions are ranked based on their average GII score, the regional innovation divide becomes even more evident. The highest ranking geographical region in the world is Northern America (58.11), followed by Europe (47.23) and South East Asia and Oceania (41.72), while Northern Africa and Western Asia (35.73), Latin America and the Caribbean (32.85), Central and Southern Asia (27.48) and Sub-Saharan Africa (27.45) are lagging behind. (Cornell University, INSEAD and WIPO, 2014)

This ever-present innovation divide can also easily be seen from the European context, the closest possible context, as Europe displays substantial gaps in the ranks and GII scores across nations; examples vary from the first five countries in the world Switzerland, United Kingdom, Sweden, Finland and Netherlands, respectively, to Portugal (32nd) and Romania (55th) Cornell University, INSEAD and WIPO (2014). In addition, the gap in the innovation performance within the European Union can be more thoroughly examined in the European Commission's Innovation Union Scoreboard 2014, which provides a comparative assessment of the innovation performance of the EU Member States. The report states that although the EU as a whole has become more innovative in recent years, which resulted in closing half of the innovation gap towards the US, however, there are still high differences in the innovation performance within the EU and between Member States, which diminish only slowly. In fact, member states are classified into four different performance groups based on their average innovation performance. The first performance group of Innovation leaders includes member states Denmark, Finland, Germany and Sweden with the innovation performance well above the average of the EU, i.e. more than 20% above the EU average. The second performance group of Innovation followers consists of member states such as Austria, France, Netherlands, the UK, etc., with the innovation performance approximately of the EU average, i.e. more than 90% of the EU average and less than 20% above it. The third performance group of Moderate innovators contains member states with the innovation performance bellow the EU average, more exactly between 90% and 50% of the EU average. Some of the countries in this group among all are Spain, Portugal, Croatia, Italy. The last, fourth group, the Modest innovators Bulgaria, Latvia, and Romania performing well bellow average with an innovation performance less than 50% of the EU average. In addition, at regional levels within the EU member states the innovation gap widens and according to European Commission's Regional Innovation Scoreboard 2014, which complements the Innovation Union Scoreboard 2014, in almost one fifth of the EU regions innovation performance has worsened (European Commission, 2014).

As previously stated, innovation is broadly considered as the main process driving national competitiveness and economic growth, however, a long time period is needed for a nation to attain the technological frontier with innovation as the main driver (Hu and Mathews, 2003). Although less-developed nations continue to make progress, they are often incapable to keep up with the pace of improvements being made by high-income nations. The advantages of legacy investments in the institutional context and human capital are hard to replicate quickly in many low-income countries; i.e. investments in the educational infrastructure may need years in order to yield results in terms of skilled graduate students and even more time to produce measurable innovation outputs. Thereby, increasing the necessity and the pressure on the nations on the wrong side of the innovation divide to speed up their progress and efforts in driving innovation Cornell University, INSEAD and WIPO (2014). Nevertheless, through modern history there were a few cases of exceptional latecomer economies which managed to catch-up or even overtake the leading economies. In the 19th century it has taken latecomer economies, Germany and the USA, between 50 to 100 years to catch-up with and overhaul the leader, the United Kingdom. Subsequently, in the postwar period of the 20th century, Japan managed to catch up with the leaders with an miraculous recovery. Another more recent example is the truly superb case of the "Asian Tiger" economies: Korea, Taiwan, Hong Kong and Singapore, which managed to perfect their production processes (Hu and Mathews, 2003), while the most recent case is the case of China. Over the last past decades the world has witnessed China's outstanding economic development and a thrilling transformation of its economy and industry; China has transitioned from an underdeveloped economy heavily relying on agriculture with unskilled labor and labor-intensive products to one of the biggest producers of manufactured exports and the so-called "factory of the world". As a result, China is today the largest economy in terms of trade and the second largest in terms of GDP in the world. Despite the recent global economic recession which severely hit other industrialized economies, China managed to maintain a fast growth rate. Furthermore, China is currently in an ongoing transition into an innovation-driven economy, which has accomplished remarkable achievements so far, resulting in its placement on the global innovation landscape, while China's rapid development and intense investment into science and technology (S&T) has been attracting increasing attention worldwide (Fu, 2015).

According to the Global Competitiveness Report (GCR) 2014-2015 by the World Economic Forum (2014) China is ranked 28th out of 144 countries in the world, up one position from the 2013 – 2014 rankings and keeps on leading the BRICS economies by a wide margin; well in front of Russia (53rd), South Africa (56th), Brazil (57th), and India (71st). Small gains in ranks related to higher education and training (65th, up five), business sophistication (43rd, up two) and technological readiness (83rd, up two), which is also China's weakest showing in all the GCR rankings, managed to contribute to the development of a more favorable environment for innovation and entrepreneurship. While China has become more innovative (32nd), it is still not an innovation powerhouse yet, but the macroeconomic situation remains advantageous (10th), which is of great importance in order to be able to continue heavy investments in innovation; budget deficit has been reduced, inflation is below 3 percent, gross savings rate amounts to a astonishing 50% of GDP, and public debt-to-GDP ratio is among the lowest in the world, at 22.4 %. China is constantly improving and has done an outstanding job in moving among the world rankings in a short period of time, however, weaknesses still persist as well as a lot of place for improvements. Despite that in the assessment of China's governance structures there were miniature changes (47th), the efficiency of the government improved (now 31st), however, institutional framework continues to weaken due to lack of transparency (43rd), corruption (66th), security concerns (68th, up seven) and low levels of accountability (80th, up two). Furthermore, the financial sector (54th) and the functioning of the market (56th) remain as main handicaps and challenges. Even though the functioning of the market has improved (up five), many limiting barriers and measures for entry exist, as well as investment rules, which heavily hinder competition. The main problems of the financial sector are the fragility of the banking industry and access to loans which remain very difficult for many SMEs. In summation, although the trends are positive to a great extent and a lot of has been improved, there is no space for China to be complacent, since China is not a destination for inexpensive labor-intensive activities any more and is not only losing manufacturing jobs to developing economies, but even to some advanced economies. Therefore, the need to sustain the rising standards of living by creating high-value jobs has never been higher. In addition to the Global Competitiveness Report 2014-2015, the GII 2014 ranks China 29th out of 143 countries in the world, which is a significant move from the 35th position that it held in the previous year (GII 2013). Furthermore, China is ranked 7th in the South East Asia and Oceania region and 1st among the upper middle-income countries, alongside Malaysia, the only upper-middle income country coming closer to the high-income group. Some of China's biggest strengths are general infrastructure, research & development (R&D) and education, however, weaknesses such as ecological sustainability, tertiary education, political and regulatory environment still exist that need immediate attention. Nevertheless, China is improving at a considerably faster pace than its BRICS counterparts, and if it continues to improve at this rate it is only matter of time until it moves from the current 29th position to the top 25 in the world (Cornell University, INSEAD and WIPO, 2014).

Motivation for the topic stemmed from the aforementioned context of the persistent innovation divides within the EU member states and their regions, the present and future challenges in the competitiveness of the EU, as well as the fact that I come form a member state which is already on the wrong side of the innovation divide, and seriously lagging behind. Thus, China's rapid transformation into an innovation-driven economy could serve as a role-model for countries on the wrong side of the innovation divide and could provide useful insights and best-practices, which could be disseminated in other contexts. Therefore, this study aims to: investigate the Chinese government's strategies for business environment improvement and entrepreneurship innovation climate development; investigate government measures and incentives which foster innovation; and lastly, explore the functionality of the Chinese innovation support system in the Beijing area. Specifically, based on the Chinese context and China's rapid transition, the study tries to give answers to the following research questions: which measures and incentives foster innovation and how can an entrepreneurial/innovative climate be developed/encouraged; how a country can improve from an innovation underachiever to a fast follower or innovation leader and gain global visibility in a relatively short period of time?

The methods used in this study are based on the qualitative approach and include data and document analysis, and interviews. Numerous primary and secondary sources of information have been analyzed and in total six in-depth semi-structured interviews with relevant stakeholders in Beijing have been conducted; of which three participants are affiliated with organizations related to science, technology and innovation (STI) in Beijing, while the other three participants are entrepreneurs, owners of startup companies. The research was conducted during a semester abroad as an international foreign student exchange at the Beijing University of Technology in the duration of 5 months and under the KUWI scholarship, offered by Graz University of Technology (TU Graz). The research context is set in China's capital, Beijing, which indeed is one of China's leading economic and S&T regions (Guan et al., 2009), and has played a vital role in the development of the innovation environment and S&T in China (Guan and Yam, 2014). Furthermore, it is home to the Zhongguancun science park also known as the "Z-park" or "China's Silicon Valley", China's oldest high-tech economic zone and the focal point of the research (Guan et al., 2009). Moreover, for the purpose of the study the Zhongguancun science park as well as two innovative incubators: TusStar and the Beijing Makerspace, have been visited, which gave valuable insights into the state of innovation in both Beijing and China. TusStar innovative incubators are located in TusPark, which is not only one of the most famous science parks in the Zhongguancun science park, but also a world-class university science park and the largest single-university science park in the world. On the other hand, due to the growing importance of the Maker movement in the world and in China as well, the Beijing Makerspace was certainly worth visiting as it is the largest Makerspace not only in China, but entire Asia.

The main findings of the study indicate that in order to catch up in innovation, governmental support has been proven to be crucial for the late-coming nations, which is also true for China as well (Gao, 2015). The role of the government in the development of STI in China has been manifold; it issues important plans and guiding policies documents for STI, such as the National Medium- and Long-term Program for Science and Technology Development (2006-2020); issues S&T programs, laws and regulations related to STI; coordinates relationships between various governmental departments, local governments and the central government concerning education, science and technology; establishes S&T parks; promotes a culture of innovation and entrepreneurship in order to "fuel" the next era of China's economic growth, among other. Given that Beijing is not only the political and S&T capital of China, but also the center of the Chinese university education system and home to the Chinese Academy of Sciences as well as 172 universities (European Commission, 2015); universities and research institutes (URIs) have played a significant role in the development of science and technology capabilities of Beijing (Chen and Kenney, 2007). In addition, the Zhongguancun Science park, China's largest and most active high-tech economic zone is located in Beijing, which has played and still plays a leading role in the economic growth and development of STI in not only Beijing, but entire Mainland China as well (Guan et al., 2009).

1.2. Structure of the thesis

The Master thesis is organized as follows (Table 1). In Chapter 2 an overview of the literature will be given: Section 2.1 positions China in the global competitiveness & innovation context, briefly describes China's transition into an innovation-driven economy and gives an introduction to the Beijing context, while Section 2.2 analyses the Chinese National Innovation System and the role of government in the development of STI in China. In Chapter 3 research methods will be briefly discussed. It describes the aims of the study and the research questions, explains the methods used and lastly, provides an overview of the research challenges, the context and participants. Chapter 4 presents the results of the interviews including the perspectives of the Zhongguancun Science

Park, TusStar innovative incubator and its selected best cases of entrepreneurs, and the Beijing Makerspace. Finally, in Chapter 5 the lesson learned from this study are pointed out and discussed.

Introduction	**Introduction**

Theory	**Baseline analysis**
	• **China in the global competitiveness & innovation context**
	  ○ China in transition to the world's innovator
	  ○ Introduction to the Beijing Innovation context
	• **Analysis of the Chinese innovation system**
	  ○ Overview of the national innovation system in the global and Chinese context
	  ○ The role of government in S&T development
	  ○ Government S&T strategies & policies
	  ○ Government measures and incentives that foster innovation
	  ○ Analysis of the implementation of the Beijing innovation system

Methodology	**Methodology**
	• **Aims and research questions**
	• **Context and participants**
	  ○ Gaining access
	  ○ Participants
	• **Research method**
	  ○ Document analysis
	  ○ Interviews

Case Study	**Beijing case study: Zhongguancun - "China's Silicon Valley"**
	• **Perspective of the Zhongguancun S&T park**
	  ○ Facts and figures
	  ○ The perspective of the Zhongguancun Manager
	  ○ Ecosystem and stakeholders
	  ○ Resources and procedures
	• **Perspective of an innovative incubator: TusStar**
	  ○ Facts and figures
	  ○ Ecosystem and incubation
	  ○ Perspective of TusStar's entrepreneurs: Selected best cases
	• **Perspective of an innovative incubator: Beijing Makerspace**

Lessons learned	**Lessons learned**
Conclusion	**Conclusion**
Appendix	A. Questionnaire: Beijing Makerspace B. Support Letter of the S&T Office of the Austrian Embassy in Beijing C. Questionnaire: Zhongguancun Science Park D. Questionnaire: TusPark E. Questionnaire: TusPark's entrepreneurs

Table 1.: Structure of the Thesis (personal design).

2. Baseline analysis

This chapter gives an overview of the literature. Section 2.1: "China in the Global Competitiveness & Innovation Context" positions China in the global competitiveness & innovation context, briefly describes China's rapid transition into an innovation-driven economy and gives an introduction to the Beijing context, which is the main focus of the research, while Section 2.2 analyses role of government in the development of STI in China and gives an overview of the Chinese National Innovation System and the Beijing Innovation System.

2.1. China in the global competitiveness & innovation context

2.1.1. China in transition to the world's innovator

After the birth of the new, modern China, the People's Republic of China (PRC), the year 1978 was as a turning point for China's economy. Therefore, it is necessary to divide the two phases of the Chinese economy; the first from the establishment of the PRC in 1949 until 1978 (1949 - 1978), and the second after 1978.

In the first period (1949 - 1978), technological innovation, as well as all other aspects of the economy were planned by the central government, which were driven to meet their predefined goals. The government not only planned innovation, but also assigned the budget for it and as a result, innovation was entirely influenced by politics and governmental policies and measures. Consequently, there was no need for the innovators for risk-taking as they could not benefit from their innovations. Previous to 1970 and with the exception of the period between 1958 to 1961, the secondary (industrial) output was exceeded by the primary (agricultural) output, which was largely due to the weakness of China's industrial base, greatly incomplete infrastructure, system inefficiencies and political instabilities, however, this situation changed drastically after 1970. Furthermore, at that time the vast workforce was tied to the primary industry (agriculture) with limited or none possibilities to learn about technology, thereby hindering innovation and technological progress. Consequently, technological research and development received very little investment and started a long history of Chinese dependence on foreign technology (Shah et al., 2015). During this time state-owned enterprises (SOEs) represented an absolutely dominant market share in China. SOEs relished preferential treatment regarding policies and resource allocation that were extended by government regulations and policies on issues like raw materials, energy, equipment, etc. As a result, there was no need for SOE managers to make any strategic decisions or choices as they were only required to execute tasks allocated by the government and governmental agencies in the centrally planned system (Guan et al., 2009).

At the end of 1970s, China eventually recognized the ineffectiveness and the inadequate level of efficiency of a centrally planned economy. Hence, the government commenced a number of reforms of the economy, especially of its organizational systems in order to narrow the economic and technological gap between Western countries and China (Guan et al., 2009). In 1978, China started to open to the world economy and for foreign investments with Deng Xiaoping's economic reforms, also called the "Open door policy" (Fruin et al., 2012). Heavy emphasis on science and technology was put as progress in S&T was considered as one of the essential factors to promote socioeconomic growth and development. Furthermore, the structure of the industry changed after 1978, thereby significantly improving the proportion of the tertiary and secondary industries, which brought rapid technological and economic development. The labor force previously attached to the land was liberated by the increasing labor demands of the tertiary and secondary industries, which resulted in possibilities for learning new technologies and upgrading the skill level that directly contributed to the technological progress of the nation (Shah et al., 2015). Although these reforms enabled a greater access for foreign companies, many problems and barriers were present at that time; i.e. foreign companies couldn't exchange their Chinese currency earnings for hard currencies, handling problematic Chinese bureaucracy, etc., which lowered the attractiveness of investing in China. Furthermore, at that time in order for foreign companies to enter the Chinese market, a contractual joint venture had to be formed by the Chinese and foreign partners, in which the foreign partners usually supplied technology and sometimes piece of the capital, while the Chinese partner provided assets like labor, physical facilities, land and materials, thereby, mitigating the risks for foreign investors. Despite all the problems and barriers, China managed to become a world destination for low-cost manufacturing (Fruin et al., 2012). In addition, at the same time the first special economic zones were established in Southern China (Fruin et al., 2012) and during the times of technological progress people's basic needs were finally met, which enabled a large scale investments to promote innovation (Shah et al., 2015).

In the 1990s the focus started to shift from the traditional development, which was heavily depending on exports and investment in fixed-assets to a more higher-quality, knowledge-based growth driven by innovation (Fu, 2015). Selective financial support and tax policies were introduced to promote FDI related to the domestic industrial objectives, such as telecommunications and energy. Furthermore, due to the progressively favorable governmental policies, low labor costs and the high potential of China's growing market, many multinational enterprises (MNEs) were attracted in various industries, such as automotive, petrochemical, biotechnology, among all (Fruin et al., 2012). Investing in R&D gradually started to increase, exceeding 0.7% of GDP before 2000. In 2002 R&D finally reached over 1% of GDP for the first time in history and was growing steadily ever-since (Shah et al., 2015).

Today, China is the largest economy in terms of trade and the second largest in terms of GDP in the world. Despite the recent global economic recession which severely hit other industrialized economies, China managed to maintain a fast growth rate (Fu, 2015). This economic growth at a remarkable pace can be greatly explained due to the reforms over the last past decades and new regulations that have fostered the development of high-tech firms and loosening of prior policy pressures (Guan et al., 2009). However, China also faced a great deal of criticism over the years, because of its unsustainable growth model heavily based on foreign technology transfer and on imitation due to the lack of indigenous capabilities and creativity. Therefore, China has to take on considerable challenges in order to transition from imitation to innovation and the success of this transition will be essential for avoiding the middle-income trap and to spur a long-term sustainable economic growth. In fact, today, China is compelled to shift its current growth model based on long-existing, export-oriented low-cost manufacturing to a sustainable knowledge-intensive growth model with innovation as the driving force, due to the falling amount of excess unskilled workforce and since the environmental and resource constraints for sustainable growth are being considered increasingly important (Fu, 2015).

The state of innovation in China and the progress of its ongoing rapid transition into an innovation-driven economy can be assessed based on the aggregate of national statistics on innovation inputs and innovation outputs (Fu, 2015). Innovation inputs encompass components of the national economy which facilitate innovative activities, such as investments into R&D, human capital and infrastructure, while innovation outputs are the results of the national innovation activities (Cornell University, INSEAD and WIPO, 2014).

2.1.1.1. Innovation inputs

Inputs, such as financial and human resources, especially in R&D, contribute directly to the development of science and technology (S&T). R&D expenditure, which is a key indicator of one's innovation performance, has been constantly increasing at an outstanding rate in China (Fu, 2015). Gross Domestic Expenditure on R&D (GERD) has increased in China from RMB 34.9 billion in 1995 (Fu, 2015), rising to RMB 371.02 billion in 2007 and RMB 1184.66 billion in 2013 (Table 2). In comparison to other countries, in 2013 China's GERD was 191.2 billion USD, which accounted for the second largest R&D spending rate worldwide, behind USA which has continuously held first place with 453.5 billion USD in 2012 and in front of Japan in third position with 170.9 billion USD in 2013 (Figure 1) (Ministry of Science and Technology (MOST) of P.R.C., 2014). Although China's GERD has been increasing significantly every year since 1995, it will take time to catch up and close the substantial gap with the USA. Furthermore, another key indicator of one's innovation performance is R&D intensity, which is measured as a proportion of GERD to GDP (GERD/GDP) and expressed as a percentage. The R&D intensity has also increased remarkably in China since 1995; it was at a low of 0.57 % of GDP then, growing to 1.38 % in 2007 and 2.01 per cent in 2013 (Table 2) (Ministry of Science and Technology (MOST) of P.R.C., 2014).

	2007	2008	2009	2010	2011	2012	2012
GERD (100 million Yuan)	3.710,2	4.616	5.802,1	7.062,6	8.687	10.298,4	11.846,6
R&D intensity (%) GERD/GDP (%)	1,38	1,46	1,68	1,73	1,79	1,93	2,01

Table 2.: GERD in China 2007-2013 (personal design).

China experienced an exceptional increase in R&D intensity, however, compared with that of the OECD countries and other R&D-intensive nations, the R&D intensity in China is still low. China, with GERD/GDP of 2.01 per cent in 2013 was lagging behind the OECD average at 2.4 per cent (Fu, 2015) and behind leading R&D-intensive countries such as South Korea 4.15% (2013), Japan 3.49% (2013) and USA 2.81% (2012) (Figure 1) (Ministry of Science and Technology (MOST) of P.R.C., 2014).

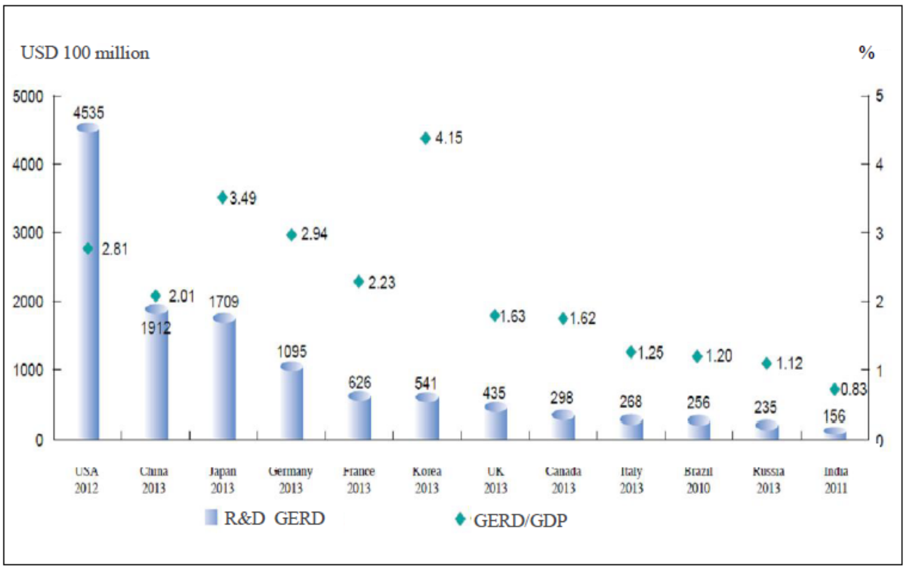

Figure 1.: Comparison of GERD in leading countries (Ministry of Science and Technology (MOST) of P.R.C., 2014)

In line with this view, China's National Guidelines for S&T Development designated a challenging objective for R&D investment; to reach 2 % of GDP by 2010 and 2.5 % or more by 2020. Although GERD almost tripled from 2007 to 2013, even despite the recession when R&D expenditures generally dropped in the entire world, however, the goal of attaining 2 % of GDP by 2010 was not met, therefore, rising the R&D intensity to 2.5 per cent by 2020 remains as a serious challenge. In order to sustain the rapid increase of R&D expenditure, strong financial support from multiple stakeholders is a vital driving force (Fu, 2015). In China, in 2013 the source of funds for GERD came from the following stakeholders: Business (74.6%), Government (21.1%), Abroad (0.9%) and Other (3.4%) (Figure 2) (Ministry of Science and Technology (MOST) of P.R.C., 2014). Based on these findings it is evident that the increase in R&D expenditure is mainly supported by enterprises, meaning that the business sector has become a significant player in China's innovation system. Furthermore, enterprise and government funding in 2013 amounted for 95.7 % of R&D spending in China, while foreign funding in R&D in China remains insignificantly low.

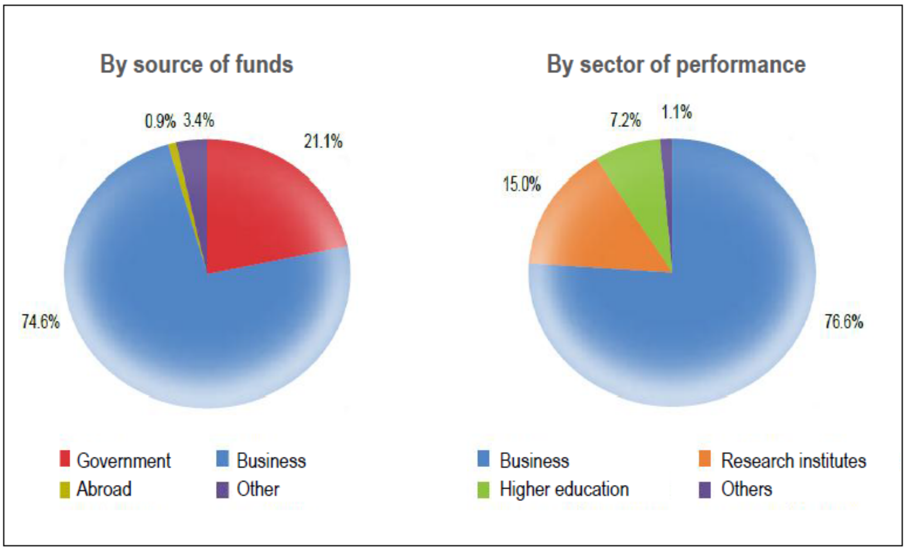

Figure 2.: GERD in China by source of funds and sector of performance (2013) (Ministry of Science and Technology (MOST) of P.R.C., 2014)

Since R&D encompasses three activities: basic research, applied research and experimental development, breaking down R&D expenditure by type of activity indicates main structural attributes of the innovation system (Fu, 2015). In 2013, GERD on experimental development represented by far the largest portion in China with 84.6 percent of total R&D expenditure, followed by applied research with 10.7 percent and basic research with 4.7 percent. Therefore, this distribution denotes that the largest portion of increase in R&D expenditure is due to heavy investments in experimental development. However, when GERD expenditures on these three aforementioned activities are examined from the perspective of the sector of performance, the cause of the dominant position that experimental development holds becomes clear (Figure 3) (Ministry of Science and Technology (MOST) of P.R.C., 2014).

Furthermore, an equally important input as R&D inputs are human resources, which are an essential building block in shaping an innovation pool. In addition, a great number of R&D personnel is necessary for a successful transformation to a knowledge-based economy in order to undertake the corresponding extensive increase in R&D activities. In line with this view, China had the second largest number of R&D personnel in the world since 2006, just after the United States (Fu, 2015) and in 2013, there were 3.532.800 (person-years) R&D personnel in China. Although the total number of R&D personnel in China is astonishing, even multiple times greater than in most countries; i.e. China had 4 times more R&D personnel than Japan in 2013, where 865.600 people were working in R&D. However, when measuring on a scale of R&D personnel per 10.000 labor force, the number becomes more real when put into this context. In comparison to leading

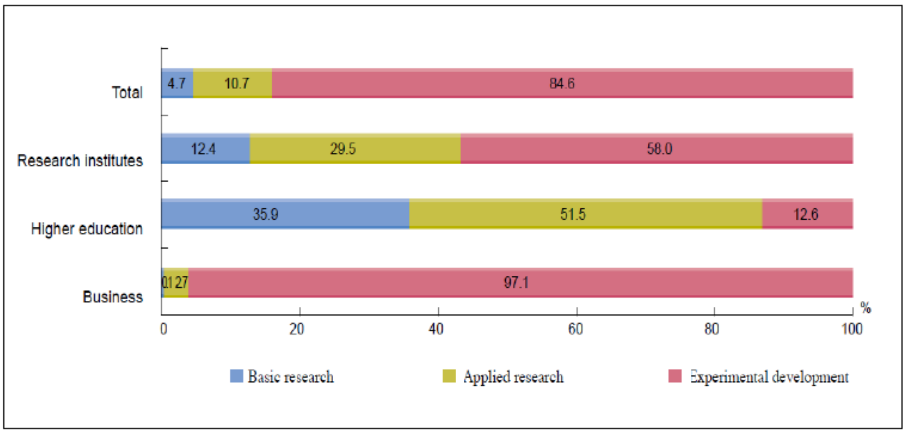

Figure 3.: GERD by type of activity (2013) (Ministry of Science and Technology (MOST) of P.R.C., 2014)

countries, such as Korea, Japan and Germany, which had 155, 132 and 142 R&D personnel per 10.000 labor force, respectively, China employed significantly less, only 45 R&D personnel per 10.000 labor force in 2013 (Figure 4).

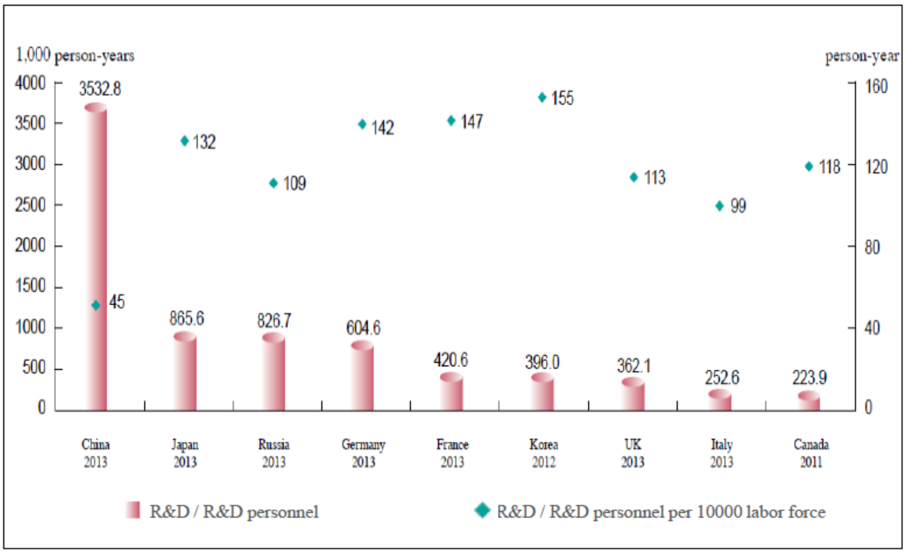

Figure 4.: R&D personnel in selected countries (Ministry of Science and Technology (MOST) of P.R.C., 2014)

Most of the R&D personnel in China were in the business sector (77.6%), followed by research institutes (10.3%), higher education (9.2%) and others (2.9%). Not only experimental development has a dominant share in GERD in China, but also in the number of R&D personnel (82.5%), accompanied by applied research (11.2%) and basic research (6.3%) (Figure 5).

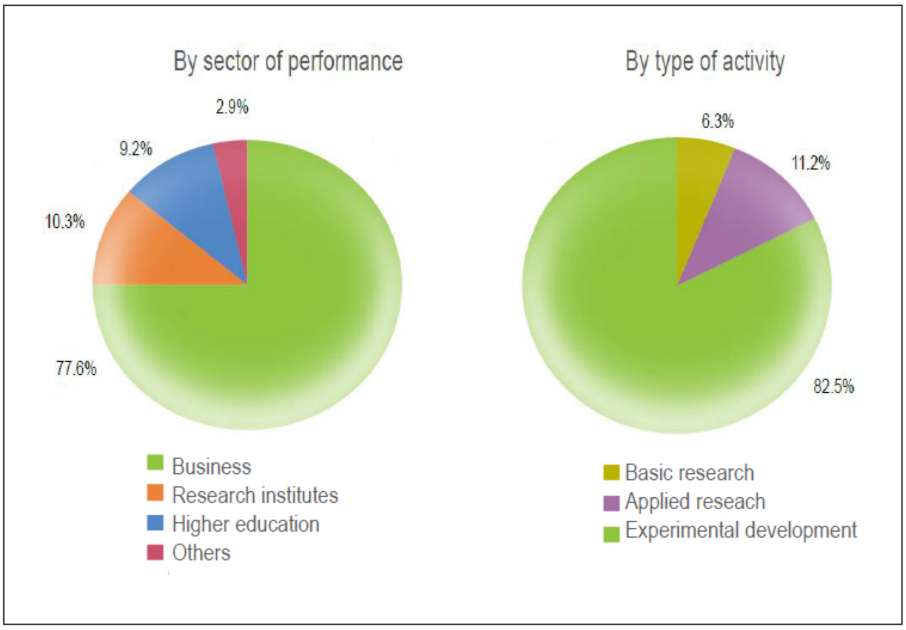

Figure 5.: R&D personnel by sector of performance and type of activity (2013) (Ministry of Science and Technology (MOST) of P.R.C., 2014)

Moreover, in 2013 regular institutions of higher education[1] in China enrolled 14.944.400 students and during the same year 3.199.700 students graduated from these institutions. In addition, in 2013, the aforementioned institutions enrolled 4.953.300 students in the engineering field of study and during the same year 1.058.800 students graduated in this field of study. The ratio of engineering graduates to total graduates was 33.09%, which together with science graduates (7.78%), covered more than 40% of graduates in all fields of study in China. Furthermore, in the same year 1.794.000 postgraduate students enrolled in PhD programs of regular institutions of higher education and research institutions in China, while there were 513.600 doctor degrees awarded from these institutions. When looking at the field of study, there were 648.200 enrollments and 176.400 graduates from the above-named postgraduate institutions in China, while the number of master & doctor degrees awarded in the field of study of engineering was 34.35% of all master & doctor degrees (Table 3). (Ministry of Science and Technology (MOST) of P.R.C., 2014)

[1]Refer to educational institutions, which recruit graduates from senior secondary schools through the National Matriculation Test. Such institutions are: full-time universities, colleges, independently established colleges, institutions of higher professional education, institutions of higher vocational education and others. (National Bureau of Statistics of China, 2014)

Item	Number of students in regular institutions of higher education by field of study (1.000 persons)		Number of postgraduate students in regular institutions of higher education and research institutions by field of study (1.000 persons)	
	Enrolments	Graduates	Enrolments	Graduates
Total	**14.944,4**	**3199,7**	**1794,0**	**513,6**
Philosophy	9,2	2,0	14,7	4,5
Economics	882,9	193,5	77,5	23,2
Law	535,4	122,7	121,4	40,4
Education	517,3	104,7	85,2	24,9
Literature	1480,0	355,7	93,5	31,6
History	70,8	15,8	17,8	5,3
Science	1076	248,8	184,0	50,0
Engineering	4953,3	1058,8	648,2	176,4
Agriculture	259,8	58,8	63,8	17,5
Medicine	1064,4	192,3	196,6	58,6
Management	2750,4	572,2	238,8	65,8
Military			0,9	0,2
Art	1344,7	271,5	51,5	15,3

Table 3.: Students in regular institutions of higher education and research institutions (personal design).

2.1.1.2. Innovation outputs

Apart from the growing trend in using innovation inputs, the same amount of attention is being given to the innovation performance as it is of great interest in evaluating the quality of the innovation. One of the most usually employed indicators for measuring innovation at an aggregated level is the amount of patent applications. (Fu, 2015)

In 2013 China's patent office, the State Intellectual Property Office of the People's Republic of China (SIPO), received 2.377.061 patent application from home and abroad for three kinds of patents: invention (825.136), utility model (892.362) and design (659.563) (Ministry of Science and Technology (MOST) of P.R.C., 2014), which was by far the highest number of patent applications received by a single IP office in the world. China has maintained this position since 2011 and its IP office witnessed the fastest yearly growth in fillings received; invention (+26.4%), utility model (+20.5%) and design (+0.3%) (World Intellectual Property Organization, 2014). In the same year SIPO granted 1.313.000 patents, which means that more than 50% of all patent applications were granted, of which were 207.688 inventions, 692.845 utility models and 412.467 designs. Of all the patents granted domestic accounted for 1.228.413, while foreign only for 84.587 (Table 4) (Ministry of Science and Technology (MOST) of P.R.C., 2014).

Moreover, China was ranked 1st in the world in all three kinds of patent applications in 2013: it had by far the highest number of invention applications (825.136), followed by the USA (571.612) and Japan (328.436); it accounted for nine-tenths of the world total utility model applications and for over half (53%) of design applications worldwide. When looking at the IP rights already in use in 2013, from more than 9.45 million patents in force, more than a million were in force in China. Furthermore, China made up for 85% of all the utility models in force, and out of

	2012			2013		
	Total	Domestic	Foreign	Total	Domestic	Foreign
Patent applications	**2.050.649**	**1.912.151**	**138.498**	**2.377.061**	**2.234.560**	**142.501**
Invention	652.777	533.313	117.464	825.136	704.936	120.200
Utility model	740.290	734.437	5.853	892.362	885.226	7.136
Design	657.582	642.401	15.181	659.563	644.398	15.165
Patents granted	**1.255.138**	**1.163.226**	**91.912**	**1.313.000**	**1.228.413**	**84.587**
Invention	217.105	143.847	73.258	207.688	143.535	64.153
Utility model	571.175	566.750	4.425	692.845	686.208	6.637
Design	466.858	452.629	14.229	412.467	398.670	13.797

Table 4.: Patent applications filed vs. patents granted by SIPO 2012-2013 (personal design).

approximately 3 million industrial design registrations that were in force, 1.2 million were in China. In addition, of all the 26.3 million trademarks that were active worldwide, China with 7.2 million, accounted for the most trademarks in force, followed by the US (1.8 million) and Japan (1.7 million). Moreover, in 2013, the top 10 IP offices accounted for the 60 % of the global trademark filing activities and since the beginning of 2000, China and the US were and still are the top two offices in the world. China with its 1.88 million class counts, followed by the US with approx. 486.000, accounted for more than a quarter of total trademark filings worldwide, while these also reported the largest yearly growth, +13.8% and +13.4%, respectively (Figure 6). (World Intellectual Property Organization, 2014)

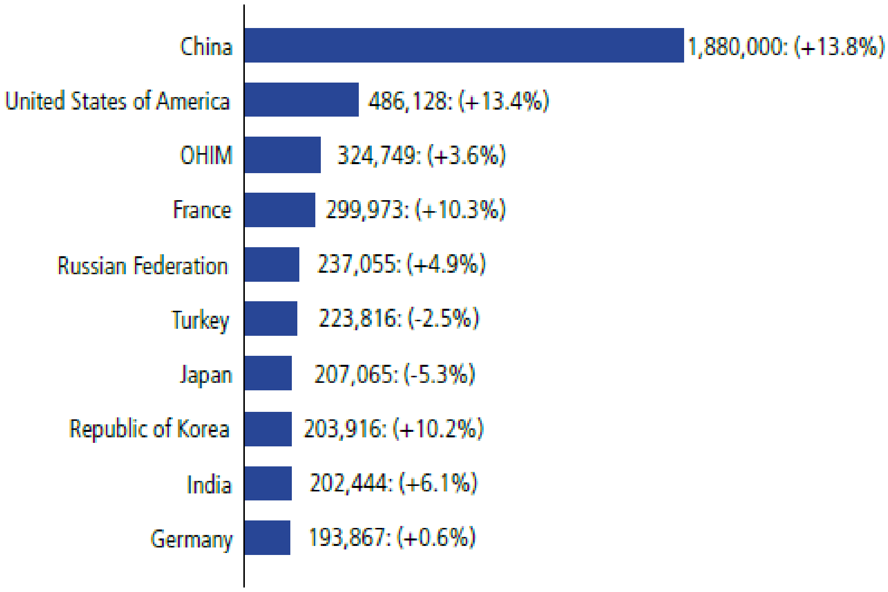

Figure 6.: Trademark application class counts in 2013 (World Intellectual Property Organization, 2014)

At the same time, about 205.300 of applications were filled globally under the Patent Cooperation Treaty (PCT), which eases the proceedings for multiple national patent filings by lowering the conditions necessary to submit a separate application in every jurisdiction where protection is looked for. Japan's Panasonic Corporation was the top PCT applicant in the world with 2.839 applications, followed by two Chinese telecommunications companies: ZTE Corporation in second place (2.309) and Huawei Technologies in third (2.110) (Figure 7). Panasonic and ZTE have shared the position of the world's top PCT applicant since 2009: Panasonic was at the top in 2009, 2010 and 2013, while ZTE in 2011 and 2012. (World Intellectual Property Organization, 2014)

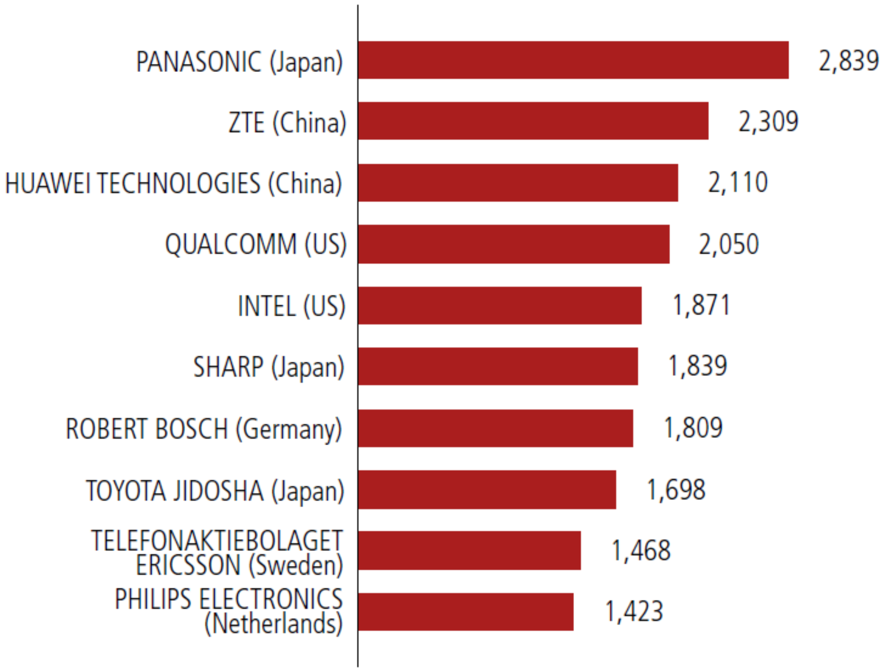

Figure 7.: Top PCT applicants in 2013 (World Intellectual Property Organization, 2014)

The higher education contributes twofold to the innovation development; firstly, by direct involvement in miscellaneous innovation activities and secondly, by ensuring a provision of future talent pools for innovation with its education mission (Fu, 2015). In 2013 there were 232.070, 163.688 and 68.501 Chinese S&T papers[1] indexed by SCI (Science Citation Index), EI(Engineering Index) and CPCI-S (Conference Proceedings Citation Index - Science), respectively. Furthermore, based on the number of S&T papers indexed by SCI, EI and CPCI-S, China was ranked 2nd in the world for both SCI and CPCI-S, just after the United States, however, for EI it was 1st in the world, far in front of the US (Table 5) (Ministry of Science and Technology (MOST) of P.R.C., 2014).

[1]Note: Hong Kong and Macau papers are included

Country	SCI		EI		CPIC-S	
	Papers	Rank	Papers	Rank	Papers	Rank
Total	**1.723.143**		**566.430**		**399.524**	
USA	474.110	1	103.390	2	11.121	1
China	**232.070**	**2**	**163.688**	**1**	**68.501**	**2**
UK	133.410	3	28.668	5	20.012	4
Germany	118.655	4	33.629	3	19.894	5
Japan	95.857	5	31.968	4	22.370	3
France	83.439	6	26.420	7	13.040	6
Italy	74.233	7	19.521	9	12.881	7
Canada	72.020	8	18.858	11	11.875	8
Korea	57.208	12	24.806	8	9.186	10
India	59.540	10	27.585	6	11.211	9
Russia	32.258	15	14.133	13	4.526	18
Brazil	44.052	13	8.955	16	6.241	14

Table 5.: STI papers indexed by SCI, EI and CPCI-S (personal design).

2.1.1.3. Outcomes and impacts

The outcomes of China's transformation into an innovation-driven economy are not only visible, but can be measured as well. China has produced remarkable results, which have placed it on the global innovation landscape. As it has been noted, China's patent office received by far the highest number of patent applications received by any single IP office in the world, a position China has maintained since 2011. Furthermore, China was ranked 1st in 2013 in all three kinds of patent applications as well as trademark filings worldwide. In addition, two Chinese companies, ZTE Corporation and Huawei Technologies, were the 2nd and 3rd largest patent application fillers under the Patent Cooperation Treaty (PCT) in the world.

Once heavy reliant on foreign technology, with a poor base of technology innovation and a long history of technology import, China worked hard to abolish its costly dependence on foreign technology. As a result, China had a positive balance between high-tech imports and exports (balance of trade) since 2004, which amounted to USD 4.1 billion at that time and has risen dramatically to USD 102.1 billion in 2013 (Figure 8) (Ministry of Science and Technology (MOST) of P.R.C., 2014).

Moreover, China has the second largest GERD in the world, just behind the US. Despite that China's R&D intensity as a percentage of GDP is lagging behind the OECD average and leading R&D-intensive nations, if China continues to advance at this rate, it will presumably reach the goal of 2.5% GDP by 2020 as defined in the National Medium- and Long-term Program for Science and Technology Development (2006-2020). In addition, China has the second largest number of R&D personnel in the world. Although many argue that China is not yet an innovation powerhouse, however, with all these key enablers in place and high government commitment, it is just a matter of time until it becomes one.

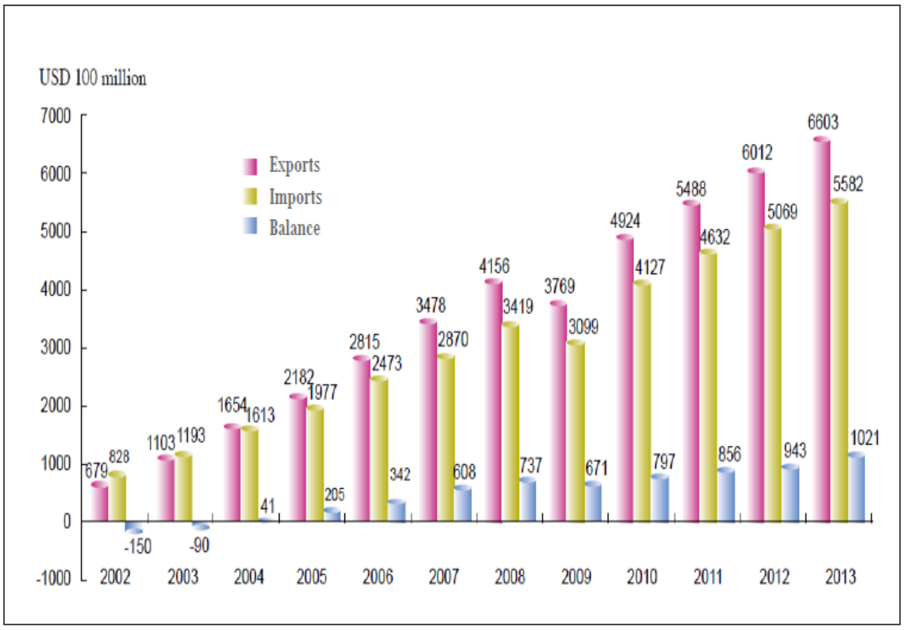

Figure 8.: Balance between high-tech imports and exports (2002 - 2013) (Ministry of Science and Technology (MOST) of P.R.C., 2014)

2.1.2. Introduction to the Beijing innovation context

China with its 22 provinces, five autonomous regions and four direct-controlled municipalities (Beijing, Tianjin, Shanghai and Chongqing) is not only too vast and diverse, but also too unevenly developed with each of its provinces and municipalities having distinct features and a substantial populace, therefore under these circumstances statistics of national averages can be extremely misleading (Fu, 2015). The aforementioned provinces, autonomous regions and municipalities are considered as Mainland China, while Hong Kong and Macau enjoy preferential treatment as Special Administrative Regions (SARs) which means that they are autonomous territories that are under the sovereignty of the People's Republic of China, however, are not a part of the Mainland China (European Commission, 2015).

One of the main characteristics of the Chinese innovation system, as well as many others, is a gap in the innovation performance of its regions and a large regional disparity in R&D. In 2012, investments in R&D were heavily concentrated in some cities and provinces, like Beijing, Jinagsu, Shandong and Guangdong, which accounted for 45% of the national R&D expenditure, while other regions were either less innovative or already lagging far behind. In addition, the highest R&D intensity in China was located in Beijing, which accounted for 6.28 % of GDP in 2000 and 5.95% in 2012. Furthermore, in 2012 the ratio of R&D intensity for the Beijing region was almost three times that of the national average, while the lowest that year was in Tibet, only 0.25 % of GDP, which was barely over one-eighth of the national average (Fu, 2015). Hence, the main focus of this study is on Beijing as it would be impossible to generalize the findings in Beijing on entire Mainland China.

Beijing, with the population of approx. 21.2 million (2013) is not only the political and cultural, but also the educational and S&T capital of China (National Bureau of Statistics of China, 2014). Beijing is the center of the university education system in China, as well as home to more research institutes than any other city in the country (Chen and Kenney, 2007). In addition, of all the Chinese cities, the largest amount of top-quality universities and research institutes (URIs) was concentrated in Beijing too, which have a strong capability to generate new knowledge (Guan et al., 2009). More exactly, Beijing is home to the two most prestigious universities in China, Tsinghua University and Peking University, as well as to the Chinese Academy of Sciences (CAS). CAS was established in 1949 and although it has institutes across entire China, the biggest and most prestigious ones are in Beijing. According to the Times Higher Education (2015), among the top 100 universities in the world, two were from China and both located in Beijing, Peking university and Tsinghua university, ranked 48th and 49th, respectively. In addition, Tsinghua University and Peking university were also among the 100 universities for engineering and technology in the world, positioned 23rd and 43th, accordingly. Although, there are 20 Chinese universities in the top 100 university rankings of the Asian region, Peking University in 4th place and Tsinghua University in 5th, are ranked not only the best universities in China, but among the best in the region as well. Unlike Shenzhen which two decades ago had no URIs and the companies built up their own R&D capacities by making use of foreign technology and attracting educated talent nation-wide, Beijing encouraged high-tech development by utilizing its rich URI resources, which played an important role in the development of innovation in Beijing. URIs in Beijing served not only as providers of human capital and research centers, but have also created spin-offs as well as established science and technology parks in order to commercialize their research and technologies (Chen and Kenney, 2007).

Beijing is one of China's leading economic and S&T regions and has also been recognized as China's most innovative region (Guan et al., 2009). In 2013, of all the regions in China, Beijing had the 3rd largest GERD in amount of RMB 118.5 billion, just after Jiangsu with RMB 148.74 billion and Guangdong RMB 144.35 billion. However, related to this context, it has to be taken into consideration that Guangdong and Jiangsu are entire provinces, while Beijing is only municipality - a city. Furthermore, there were 242.200 R&D personnel in Beijing, making it the 5th largest in terms of R&D personnel in entire China, after Guangdong, Jiangsu, Zhejiang and Shandong provinces, however, far in front of Shanghai with 165.800 R&D personnel. Local government in Beijing recognized the importance of S&T early on and in 2013, local government S&T expenditure in Beijing accounted for RMB 23.467 billion, behind Guangdong, Jiangsu and Shanghai with 34.494, 30.259 and 25.766 billion RMB, respectively. However, when looking at the S&T expenditure as a percentage of total local government expenditure, Beijing's local government with 5.6% was the second most R&D-intensive in China, just after Shanghai's 5.7%; both of them being more than 2.5 times of the national average (Table 6). (Ministry of Science and Technology (MOST) of P.R.C., 2014)

Region	R&D Expenditure (100 Million Yuan)	Local government S&T expenditure (100 Million Yuan)	Percentage of S&T expenditure in total local government expenditure	R&D personnel (1,000 person-years)
Total	11846.6	2715.31	2.3	3532.8
Beijing	**1185.0**	**234.67**	**5.6**	**242.2**
Shanghai	776.8	257.66	5.7	165.8
Shandong	1175.8	149.14	2.2	279.3
Zhejiang	817.3	191.87	4.1	311.0
Guangdong	1443.5	344.94	4.1	501.7
Jiangsu	1487.4	302.59	3.9	466.2
Hebei	281.9	49.76	1.1	89.5
Gansu	66.9	19.76	0.9	25.0
Tibet	2.3	4.17	0.4	1.2
Qinghai	13.8	8.39	0.7	4.8

Table 6.: Innovation inputs in selected regions (personal design).

Furthermore, Beijing played a vital role in the development of the innovation environment and S&T in China. During the initial phase of the transition, the S&T experience in Beijing was essential, since it influenced development of the innovation system throughout China (Guan and Yam, 2014). In addition, a substantial amount of elements of the national innovation policy have been formulated on the basis of the lessons learned and experiences obtained in the nation's capital, where Zhongguancun, China's most active high-tech zone is located (Guan et al., 2009).

The State Council of the P.R.C endorsed the founding of the Beijing New Technology Industrial Development Trial Zone in May 1988, which was the predecessor of the Zhongguancun Science and Technology Park. Thus Zhongguancun not only became China's first high-tech park, but also first of many to come Science and Technology Parks organized by the State Council. In march 2009, the State Council approved the construction of the Zhongguancun National Demonstration Zone and carried out a plan to make Zhongguancun a S&T innovation center with worldwide influence and recognition (Administrative Committee of Zhongguancun Science Park, 2015).

> *We will [...] gradually develop Zhongguancun in Beijing into a globally influential science and technology innovation center. Central Committe of the Communist Party of China (2011)*

This was later confirmed with the Development Plan Outline for Zhongguancun National Demonstration Zone (2011-2020), marking a new turning point for the development of Zhongguancun (Administrative Committee of Zhongguancun Science Park, 2015).

The predecessor of the Zhongguancun National Demonstration Zone, the Beijing New Technology Industrial Development Trial Zone, which was the first national high and new-tech industrial development zone in China, was originally located in today's Haidian (sub)park of the Zhongguancun National Demonstration Zone. It covers the area of 133.06 square kilometers and is in the proximity of the well-known universities and research institutions, like Peking University, Tsinghua

University and Chinese Academy of Social Sciences. During the transition over the last three decades, Haidian park has utilized the opportunities of China's transition into a market economy and has made great achievements, especially due to its advantageous innovation personnel and S&T resources. At the end of 2013, Haidian Park was home to more than half of all the Nasdaq-listed Chinese enterprises, as well as to 86 enterprises that have gone public. Furthermore, world's top 500 enterprises have setup more than 40 branches and R&D centers in the park. In addition, of all the Zhongguancun sub-parks, Haidian Park had the biggest concentration of international corporations in China. (Administrative Committee of Zhongguancun Science Park, 2015)

Today, Zhongguancun Science park also known as the "Z-park" or "China's Silicon Valley" is China's largest and most active high-tech economic zone. It is located in Beijing, which further confirms the significant role Beijing plays in the economic growth and development of science and technology in Mainland China (Guan et al., 2009). Zhongguancun with its sixteen sub-parks throughout the Beijing municipality, is the most extensive education, scientific and talent resource base in entire China. Since its establishment, Zhongguancun has been home to more than 20.000 high-tech enterprises, and to a new- and high-tech industrial cluster including biomedicine, energy and environmental protection, electronic information, aerospace, new materials, advanced manufacturing, R&D and service.

> *It boasts almost 40 colleges and universities like Peking University and Tsinghua University, more than 200 national (municipal) scientific institutions such as the Chinese Academy of Social Sciences and the Chinese Academy of Engineering, 67 state-level laboratories, 27 national engineering research centers, 28 national engineering and technological research centers, 24 university S&T parks and 29 overseas student pioneer parks. Administrative Committee of Zhongguancun Science Park (2015)*

In comparison to the other 114 national high-tech development zones located in other provinces, autonomous regions and municipalities throughout China, the innovation performance of Zhongguancun was by far the best. In 2013, it was the largest high-tech development zone in the number of housed enterprises and personnel engaged, but also in total income and exports in entire China. Zhongguancun was home to 15.455 enterprises, which employed almost 1.9 million (1.898.756) people. In addition, when comparing the total number of enterprises in all 114 national high-tech development (71.180), more than one fifth of all the enterprises were located in Zhongguancun. Furthermore, Zhongguancun alone, accounted for 15,3% of total income and 8,133% of total exports produced by all the national high-tech development zones together. (National Bureau of Statistics of China, 2014)

Around 13.000 high-tech start-ups were launched in Zhongguancun during 2014, which in comparison to 2013 was twice as much and represents a new record. Furthermore, during the same year, enterprises in Zhongguancun applied for a total of 43.793 patents, which is a 15.9% increase from the previous year and accounted for 31.7% of Beijing's total. Additionally, the enterprises in Zhongguancun generated a total revenue of 3,57 trillion yuan (USD 570.8 billion) in 2014, which is a year-on-year increase of 23.9 %. Total profits of the Zhongguancun enterprises were up 25.1 % in comparison to 2013 and reached 283.23 billion yuan in 2014, while the paid-in taxes peaked 186.73 billion yuan, a year-on-year rise of 23.9 %.

Zhongguancun not only inspires innovation and entrepreneurship, but is China's leading center for innovation and entrepreneurship. Therefore, the entrepreneurial ecosystem and atmosphere in Zhonguancun has increasingly attracted, not only more companies to the area, but also many skilled and talented students from Peking, Tsinghua and many other universities. Innovative incubators, together with maker organizations and angel investors have created a new business environment in Zhongguancun, which also enables a supporting entrepreneurial environment for micro and small businesses, and grassroots entrepreneurs as well. As a result, Zhongguancun is en route to become a science and technology innovation center with global influence and is expected to attract more than 200.000 science and technology entrepreneurs by 2020. Furthermore, the aim is to set up by the same time more than 80 innovative incubators, 500 "mass maker space", 10 entrepreneurial communities and 50 business service institutions overseas.

The largest Makerspace not only in China, but also in entire Asia, Beijing Makerspace, which was established in 2011, is also located in the Zhongguancun. It covers a vast area of 1,000 square meters and already has more than 300 members, ranging from IT engineers and programmers, to students and academics, to artists and designers, which all share a common interest: making things. Beijing Makerspace is a public service platform, DIY hub and an incubation base for Makers[1], that provides not only all the necessary tools to make ideas into reality, but is also a space to share ideas and knowledge, collaborate and get feedback. In addition the space has a 300 square meter prototype processing base and offers a wide range of tools, from high-tech devices and open-source hardware to 3-D printers and robots. (Administrative Committee of Zhongguancun Science Park, 2015)

2.2. Analysis of the Chinese innovation system

2.2.1. Overview of the national innovation system in the global and Chinese context

As previously described, innovation is universally considered as the principal driver of growth in contemporary capitalist economies. Furthermore, the premise that a capacity of a nation to acquire, absorb, disseminate, and implement modern technologies is tightly linked to its successful

1 The term Maker refers to people who turn innovative ideas into creative products due to their hobbies and interests. Administrative Committee of Zhongguancun Science Park (2015)

economic development, is embodied in its national innovation system (NIS) (Watkins et al., 2015). The concept of the National Innovation System (NIS) was established in the late 1980s and since then it has been constantly further developed (Guan and Chen, 2012). According to Lundvall (2007) the original concept of NIS was coined as a response to questionable policy strategies based on static standard economics and the necessity to create an alternative economic theory, and to give a different point of view on economic policy where knowledge acquisition and innovation were seen as essential processes behind economic growth and well-being. In addition, Lundvall (2007) stressed that the most significant resource in the present economy was knowledge, while the most significant process was learning.

> *The concept was intended to help develop an alternative analytical framework to standard economics and to criticize its neglect of dynamic processes related to innovation and learning when analyzing economic growth and economic development. (Lundvall, 2007, p. 96)*

Although numerous authors have utilized the notion of a NIS and many definitions of NIS exist, however, there is no widely accepted definition yet. Though, most of the definitions in use have a semantic core in common (Guan and Chen, 2012).

For example, a National Innovation System is defined as a network of policies, institutions and agents, which support and sustain technical and scientific advances. In addition, the industry and the government, together with URIs, which are essential in the production, acquirement, dissemination and application of knowledge, form the three core actors of a NIS (Chen and Kenney, 2007). Various authors have utilized the NIS approach to shed light on the mechanisms of knowledge production and implementation at national and/or regional levels, while the main focus of these studies is on the actors of innovative activities and the interaction among these actors (Xiwei and Xiangdong, 2007). Furthermore, the notion of a NIS is widely depicted as a set of national institutions that contribute to the creation and dissemination of new technologies and that supply the framework within which enterprises and the government derive policies to affect the innovation process (Watkins et al., 2015). From an universal point of view, a NIS emerges from the interaction between the embedded innovation environment which is represented by infrastructure and framework conditions connected to government intervention, and the knowledge innovation process (KIP). In regard to its physical structure, a NIS is a set of cooperating institutions/actors, such as industries, universities and governments which create and disseminate knowledge innovation. Furthermore, these aforementioned actors formulate the national innovation production framework within which governments shape and undertake policies and measures to affect the innovation process (Guan and Chen, 2012). Therefore, the NIS concept emphasizes that comprehending the linkage between the actors engaged in innovation is the key to enhance the innovative performance of a nation. In this respect, the innovation process is the outcome of a complex set of relations between the actors creating, disseminating and implementing different types of knowledge, both intangible and tangible (Samara et al., 2012).

The NIS approach stressed out the significance of systemic cooperation in the innovation process (Samara et al., 2012). Due to the enormous contribution of the existing literature related to the NIS concept, policymakers were enabled to apply systematic thinking about innovation at the national level instead of linear thinking, which promotes a demand-side orientation in innovation policy. In addition, systematic thinking is a more holistic system perspective on innovation centered on the interdependencies between several organizations, institutions and agents (Guan and Chen, 2012). NISs in various nations have already been analyzed which produced a rich set of diverse participating organizations and institutions and their networks of interconnections (Samara et al., 2012). In line with this view, evaluating the efficiency of innovation helps both to clarify how to improve the efficiency by identifying areas of weakness and to recognize the leading practitioners in innovation for benchmarking (Guan and Chen, 2012).

In the NIS context, the government is a key constituent as governments can serve as coordinators and drivers to compensate for the weaknesses of enterprises, as well as streamline the functions and structure of NIS to support national innovation initiatives (Gao, 2015). Therefore, the role of government in innovation has been of great interest to innovation policy and strategy researchers, as well as policymakers worldwide since devising consistent innovation policies is essential for the development of the nation and regions in general, since national and regional innovation policies can contribute to or obstruct economic and innovation development (Guan and Yam, 2014). Regulatory infrastructure established by the government and its underlying laws and regulations in particular, give the needful assurance that the enterprises necessitate in order to invest innovation. Therefore, innovation is greatly impacted and influenced by the institutional environment, since poor institutional rules can lead to rent-seeking and corruption, thereby hindering innovation (Shah et al., 2015).

In order to catch up in innovation, the governmental support has been proven to be crucial for the late-coming nations, which is also true for the case of China. In relation to the catching up context, it is important to note that most indigenous national innovation initiatives in these developing and newly industrializing countries often lacked funds, therefore required governmental interventions, which in turn formed technological progress. Therefore, in the context of the national innovation systems, governments play a key role as coordinators and main drivers to compensate for the shortcomings of the companies. In addition, a further role of government can be seen to rationalize the functions and structures of the national innovation system in order to support national and regional innovation initiatives (Gao, 2015). There are various ways in which a government can promote innovation and aid domestic enterprises to gain innovation capabilities, such as by using tax incentives, government procurement, governmental financial support of projects to increase the motivation to innovate (Shah et al., 2015), as well as, by establishing Science and Technology (S&T) parks, investing in R&D, driving technology standardization, etc. Like many other developing countries, China also had a weak foundation of technology innovation and quite a long past of importing foreign technology, consequently, the government had to take a leading role in the standardization of such an enormous and complex technology system. An example of such case would be the development of the wireless system in China, which was supported by national R&D project funding of the Chinese government (Gao, 2015).

Since the beginning of China's opening up to the world, the reform of the national S&T system has achieved significant breakthroughs and considerable progress whilst forming close links with the economy, with the aim of reinforcing technological innovation, transformation and industrialization of S&T performance, organizational realignment and undertaking a series of major reformatory measures. However, at that time the existing S&T system in China remained incapable of fulfilling the demands of the economic and S&T development and that of the socialist market economy due to the low innovation capability of the enterprises, which are yet to become the main players in technological innovation; the compartmentalization of the S&T sector, which yielded low overall performance level and both duplication and dispersion of endeavors; the S&T innovation capability of the public sector remains weak in particular; at the macro level, the management of S&T is dreadfully uncoordinated, with the S&T resource allocation and assessment system failing to meet the demands for the new development of S&T and mandate shift of the government; and lastly, the mechanisms for promoting pioneering activities and innovation, as well as for rewarding outstanding personnel are yet to be completed, therefore, heavily undermining the construction of the national innovation capacity.

The guidelines for strengthening the reform of S&T system are specified as follows: foster the fully-fledged development of a national innovation system (NIS) embodied with Chinese characteristics; focus on the efficient distribution of S&T resources and their broad integration; establish an enterprise-led technological innovation system, which involves the integration of academia, industry and research, in order to considerably improve the building of an unique Chinese NIS and immensely upgrade the indigenous innovation capability of the nation. The S&T system reform will aspire to achieve the next major objectives:

1. Supporting and Encouraging Enterprises to Become the Main Player in Technological Innovation

2. Deepening Institutional Reform and Establishing a Modern Research Institute System

3. Advancing the S&T Management System Reform

4. Vigorously Pushing Forward the Construction of a National Innovation System with Chinese Characteristics

However, due to the scope of this section, full attention will only be given to number 4: "Vigorously Pushing Forward the Construction of a National Innovation System with Chinese Characteristics". The goal of reinforcing the reform of the S&T system is to improve and intensify the establishment of a national innovation system.

The national innovation system is a government-led public system which gives full play *to the basic role of the market in resource allocation while letting various innovation players forge close links and interact with one another. (State Council of P.R.C., 2006, p. 52)*

Presently the building of the "National Innovation System with Chinese characteristics" is fully underway, which is to stress as follows:

1. Construct an enterprise-led technology innovation system including universities, research institutes and enterprises, because only when the system is run by enterprises, it can provide market orientation for technology innovation and efficiently combine the strengths of universities, research institutes and enterprises to improve national competitiveness. In addition, enhance the S&T resources allocation among the three stakeholders, while dramatically improving the capability of enterprises in technology innovation and sustaining innovation, as well as creating new services for universities and research institutes customized to the needs of technology innovation activities in enterprises.

2. Facilitate the cooperation and sharing of resources between universities and research institutes by creating a mobile, open, collaborative and competitive operational mechanism at the core. Furthermore, enhance the building of a public good scientific research system and develop a number of world-class research universities, basic science and frontier technology bases.

3. Set up a national defense S&T innovation system that emphasizes the mixture of defense and civilian needs by making defense S&T part of the civilian operations, in order to reinforce the establishment of an environment where world-class civilian S&T personnel offer services to S&T innovation related to defense and where the S&T achievements of the defense can be rapidly transformed into civilian applications.

4. Develop regional innovation systems (RISs) with various strengths and characteristics and build corresponding innovation capacity in a coordinated and consistent fashion. In addition, reinforce the reform of local S&T systems with the help of research institutes, universities and national high-tech parks in order to improve the support of S&T innovation for the local social and economic development. Also, deepen the development of S&T capacity in the western and central regions of the country, whilst seriously reinforcing the establishment of grassroots S&T systems at the county (city) level.

5. Develop a network of S&T intermediary service organizations in various forms, while fully capitalizing the benefits of the significant roles played by research institutes, universities and social organizations in supplying S&T intermediary services. Furthermore, S&T intermediate service organizations shall be led in the direction of standardization, professionalism and scale. (State Council of P.R.C., 2006)

Government interventions can have a considerable impact on the economy and the implications are especially far-reaching in the developing nations where financing and credit are both challenging to receive, markets are obscure, bureaucracies more grave and the government intervention itself is more widespread than in developed nations (Shao et al., 2015). In line with this view, the central government plays an essential role in fostering regional S&T development by mustering and coordinating national resources. China's twenty-two provinces, four municipalities, five autonomous regions and two special administrative regions are all under the leadership of the central government and have identical systems of governance, while each region has a regional government that administers local economic development and innovation, as well as S&T, education, finance and taxation departments that manage governmental functions. In addition, regional governments are responsible for the regional policy making, which are in accordance with the national policies, in a way that are copied to each region and then adjusted to its specific requirements. In example, once the Five-year National Plan for S&T Development is issued, the responsibility of every region is to devise a Five-year Regional Plan for S&T Development. Regional plans usually correspond to national plans, however, they are permitted to have their own policy measures. On the national level research policies stress investment into research, while the regional research policies, which are designed and implemented by the regional S&T and Education Commissions, are mainly focused to establish research infrastructure, foster technology commercialization and attract talented human capital. Although regions have to compete for funding and national resources, developed regions are more independent as they possess more local resources, while the less developed ones are more dependent on the appropriation from the central government (European Commission, 2015).

A rather important intervention by the central government was the decision to choose several Special Economic Zones and implement them. Within these Special Economic Zones clusters of creative entrepreneurial activity have emerged, which are often referred as the regional innovation systems (RIS). Inspired by the Silicon Valley in the USA, China has created three clusters of economic zones situated in Yangtze River Delta (Shanghai–Jiangsu–Zhejiang region), Pearl River Delta (Guangzhou–Shenzhen–Hong Kong region) and Bo Hai Rim (Beijing–Tianjin–Hebei region), however, the Silicon Valley, unlike China's clusters, arose without any intervention and interference of the government (Someren, Taco C. R. van and Someren-Wang, 2013). Central and local governments have supported and encouraged all three regions with a number of preferential policies, which have been implemented in these areas to foster more favorable technical, industrial and economic opportunities for development in order for these areas to become the engine driving the economy of the rest of the nation. Although the founding of these economic development areas has successfully boosted the national economy, it has resulted in an unintentional consequence of provoking serious economic disparities between regions. In addition, the GDP in these Special Economic Zones accounted for more than 40% of the total national GDP in China, while the average GDP growth rate was around 18% in comparison to the 5% in other areas (Shao et al., 2015).

As previously noted China has accomplished significant economic performance since its reform and has leaped in just three decades from an underdeveloped country to becoming the world's fastest-growing and second largest economy (Guan and Yam, 2014). In line with this view, China as a major emerging economy has witnessed considerable development during these past three decades not only of its financial sector, but of the technological sector as well. However, despite of this remarkable progress on a national level, the impact varies across various administrative regions and is nevertheless unequal. In addition, this uneven evolution produced vigorous variations in terms of both financial and technological characteristics throughout the country's provinces, municipalities and autonomous regions (Hsu et al., 2013). These characteristics resulted in a gap in the innovation performance among China's geographical regions and a National Innovation System with a large regional disparity of R&D as its noteworthy feature (Fu, 2015). Furthermore, the regional disparities in China are quite broad because of the vast and diverse territorial units, which vary considerably in culture, industrial composition, natural, financial and human resources (European Commission, 2015).

In 2000, the highest R&D intensities were found in Beijing, followed by Shanghai and Jiangxi, while western and southern China were clearly less innovative with scarce R&D expenditures. The coastal and eastern regions heavily benefited from the export-oriented industrialization and opening policy as they managed to catch up at an exceptional pace, particularly in Guangdong and Zhejiang provinces; i.e. Guangdong with R&D expenditure below RMB 800 thousand in 2000, has become one of the most R&D-intensive provinces in China with more than RMB 123 billion in 2012. In addition, Zhejiang, Jiangsu and Shandong provinces have witnessed identical remarkable increases, while inland China was catching up at a moderate rate, however, the western parts in particular, remain less innovative and are lagging behind. As a result, in the east and coastal regions, including Beijing, Guangdong, Shanghai, Zhejiang and Jiangsu, the enterprise funding plays a leading role in sustaining R&D activities, while the government funds are mostly absorbed by the central and west provinces (Fu, 2015). In line with this view, the central government has endorsed a strategy of letting some regions develop before others and thus implemented preferential policies favoring coastal areas, which had better human capital and physical resources than the rest of the county. For instance, although only 2.2% of the Chinese population lived in the eastern seaboard region, this region achieved a level of economic performance comparable to some developed economies, while provinces are less economically developed as further one goes to the west, with GDP income per capita even below the average of developing countries (European Commission, 2015).

2.2.2. The role of government in S&T development

2.2.2.1. A brief overview of the state structure of the People's Republic of China

A brief overview of the state structure of the People's Republic of China is given in order to understand the specifics of the Chinese context, the role of the government and its underlaying mechanisms responsible for the development of STI, as the People's Republic of China is still one of the few remaining socialist states in the world. The fundamental system of the People's

Republic of China is the socialist system and the state is under the people's democratic dictatorship. As a single-party state, the country is run by the Communist Party of China (CPC), which is the party in power in the entire country and has both local and central organizations. The CPC is an unified entity structured corresponding to the principle of democratic centralism and its program and constitution (The Constitution of the Communist Party of China). The Central Organizations of the CPC and the primary organs of state power are the National People's Congress (NPC), the President and the State Council.

The National People's Congress (NPC) of the P.R.C is the supreme organ of state power. The NPC is in session once annually and is constituted of deputies chosen from the provinces, autonomous regions, municipalities directly under the Central Government, as well as, of deputies elected from special administrative regions (SARs) and People's Liberation Army. Furthermore, all the country's minority nationalities have suitable representation as well. The permanent body of the NPC is the Standing Committee of the National People's Congress, which has the term of office for five years. The NPC and its Standing Committee are entitled with the right and power of decision-making, legislation, electing and removing. More exactly, only the NPC can amend the Constitution and oversee its enforcement, elect and assign members to central state organs, pass and alter basic laws determining criminal offenses, civil affairs, state organs and other matters, and lastly specify major state issues, such as examining and endorsing the report on the plan for national economic and social development and on its implementation.

The Head of the State of the People's Republic of China is the presidency, consisting of the President and Vice-President of the P.R.C, which are elected by the NPC and which have the same term of office as the NPC and cannot serve more than two consecutive terms. In addition, although the presidency as the head of the state is an independent organ of the state, it itself does not resolve state matters, rather executes its power in accordance with the NPC and its Standing Committee. Furthermore, the president, in pursuit of the determination of the NPC and its Standing Committee engages in activities involving State affairs, proclaims statutes, assigns or removes the Premier, Vice-Premiers, State Councilors, Ministers in charge of ministries or commissions, Secretary-General of the State Council and the Auditor-General; issues orders of special pardons, etc., while the Vice-President of the P.R.C assists the President in his work.

The state administrative organs of the P.R.C contain central and local administrative organs. Local administrative organs are regarded as local people's governments at four different levels: the provinces, autonomous regions and centrally administered municipalities; cities and prefectures; counties and townships. The central administrative organ is the Central People's Government, better know as the State Council, which is the supreme organ of State administration; the executive body of the supreme organ of state power. The State Council consists of the following members: Premier, the Vice-Premiers, the State Councilors, the Ministers in charge of ministries and commissions, the Auditor-General and the Secretary-General. The State Council reports on its work and is accountable to the NPC or to its Standing Committee when NPC is not in session. The term of office of the State Council is the same as that of the NPC and the Premier, Vice-Premiers and

State Councilors, which cannot serve more than two consecutive terms. The Premier is overall responsible for the work of the State Council, while the ministers take on responsibility for the work done by their ministries and commissions. The State Council is empowered with the rights to: pass administrative measures, issue administrative regulations and enact the orders and decisions according to the Constitution and other relevant laws; deliver proposals to the NPC or its Standing Committee; to steer and conduct economic matters and urban and rural development; to manage and guide the affairs of *education, science*, public health, culture, family planning and physical culture; etc. (National People's Congress of the P.R.C, 2013)

As mentioned before, the State Council is the highest State Administrative Organ in China. It issues important documents for Science, Technology and Innovation (STI), which are currently the main guiding policies, such as:

- The National Medium- and Long-term Program for Science and Technology Development (2006-2020)
- The Twelfth Five-Year Plan for National Economic and Social Development of the People's Republic of China (2011-2015)
- The Thirteenth Five-Year Plan for National Economic and Social Development of the People's Republic of China (2015-2020) (in the making)

2.2.2.2. National Medium- and Long-Term Program for Science and Technology Development (2006-2020)

> *The guideline is a summary of China's practice and experience in S&T development for more than a half century, and an important choice for realizing the great renaissance of the Chinese nation. (State Council of P.R.C., 2006, pp. 10–11)*

An outline for the National Medium- and Long-Term Program for Science and Technology Development was prepared by the State Council in compliance with the request commissioned by the 16th National People's Congress (NPC) of the P.R.C, to formulate an outline based on the fully-fledged establishment of a well-to-do society and speeding up the drive of socialist modernization.

The outline considers the first 20 years of the 21st century as a period of significant strategic importance for the progress of S&T, as well as social and economic development of the nation. The outline sets forth the plan to strive aspire for the thriving development of the scientific and technological enterprise in order to achieve the objectives of the fully-fledged establishment of a well-to-do society and ensure the support of S&T for constructing a harmonious socialist society by applying the direction given by the theory of Deng Xiaoping and by implementing the concept of scientific development and the strategy of revitalizing the nation by the means of education, science and talented people; proceedings from the national circumstances and adopting a people-based approach; and finally intensifying reforms and step up opening up to the world.

> *Facts have proved that, in areas critical to the national economy and security, core technologies cannot be purchased. If our country wants to take the initiative in the fierce international competition, it has to enhance its indigenous innovation capability, master core technologies in some critical areas, own proprietary intellectual property rights, and build a number of internationally competitive enterprises. (State Council of P.R.C., 2006, p. 11)*

In addition, S&T talents are of crucial importance for enhancing indigenous innovation capability. The primary and principal task is to establish an environment favorable for attracting and developing S&T personnel, particularly high-quality talents, granting the full scope to the creativity and enthusiasm to the bulk of S&T personnel in order to ensure a continuous flow of S&T talents and that the best ones are put forward. Relentless efforts are to be made to establish a vast, high-quality and well-organized S&T labor force consistent with the social and economic development, as with the work of the national defense in order to assure a knowledge and talent base for the national S&T development.

> *The guiding principles for our S&T undertakings over the next 15 years are: indigenous innovation, leapfrogging in priority fields, enabling development, and leading the future. (State Council of P.R.C., 2006, p. 10)*

Indigenous innovation makes reference to enhancing the national innovation capability by improving original innovation, integrated innovation and re-innovation on the basis of absorption and assimilation of imported foreign technology. Although mere import of foreign technology without stressing absorption, assimilation and re-innovation is destined to impair national indigenous R&D capability, which as a consequence broadens the gap with the advanced nations, China imported an enormous of foreign equipment and technology since it started to reform and open up to the world, which, however, played a significant part in fostering the economic development of the nation and increasing the general level of the industries.

> *This calls for placing the strengthening of indigenous innovation capability at the core of S&T undertakings. The Party and government have long advocated and paid close attention to indigenous innovation. To press ahead with the modernization drive under conditions of opening to the outside world, we must earnestly study and draw on all the fine achievements of human civilization. (State Council of P.R.C., 2006, p. 11)*

Leapfrogging in priority fields refers to choosing and focusing efforts on those key areas of reasonable advantage and strength connected to the national economy, people's well-being and national security, in order to aspire for breakthroughs and carry out leaping developments. Enabling development is a try to strive for breakthroughs in key technologies, which are in a desperately required for a coordinated and sustainable social and economic development. Leading the future sets fourth a vision of utilizing basic research and frontier technologies, which will in turn drive new market demand and create new industries expected to lead prospective economic and social development.

> *In a word, the improvement of indigenous innovation capability must be made a national strategy that is implemented in all sectors, industries, and regions so as to drastically enhance the nation's competitiveness. (State Council of P.R.C., 2006, p. 11)*

The overall objectives of the national development of S&T (2006-2020) are to:

- Clearly increase indigenous innovation capability and the level of S&T in order to powerfully support the establishment of a well-to-do society.
- Enhance the in-depth strength of basic research and frontier technology development.
- Achieve a series of S&T achievements with global impact.
- Join the ranks of innovative countries and as a result become a world S&T power by the middle of the 21st century. (State Council of P.R.C., 2006)

In addition, the outline calls for the fulfillment of the succeeding objectives in major S&T areas over the 15 years.

- Harness core technologies in information industry and equipment manufacturing, which are crucial for the national competitiveness.
- Raise the levels of the technological capability of manufacturing and information industries to the corresponding global level.
- Accomplish technological breakthroughs in energy conservation, clean energy and energy development.
- Produce a contingent of world-class researchers and scientists.
- Ensure S&T support for creating an environment friendly society and resource sparing.
- Develop world-renowned universities and research institutes and highly-competitive industrial R&D centers in order for the rather extensive national innovation system (NIS) of Chinese characteristics to take form.

- Accomplish innovative achievements with high impact in mainstream science development.
- Progress frontier areas, such as materials, space, information, biology to achieve world advanced levels. (State Council of P.R.C., 2006)

  By 2020, the nation's gross expenditures on R&D (GERD) are expected to rise to 2.5% or above of the gross domestic product (GDP) with the rate of S&T contribution to the economy reaching 60% or above, and dependence on imported technology reduced to 30% or below, and the annual invention patents granted to Chinese nationals and the international citations of scientific papers moving into the top five countries. (State Council of P.R.C., 2006, p. 12)

The general deployment of the outline specified China to take the sequential S&T endeavors:

- Implement special major project, which are aligned with the national goals, and will enable filling up blanks or leaping development. The outline identifies 16 of such special major projects.
- To react to challenges of the future, progressive use of basic research topics and frontier technologies is to be made in order to provide persistent innovative capability as well as to lead future social and economic development. The outline selects 27 frontier technologies in 8 technological fields, prioritizes 18 fundamental scientific issues and suggests the implementation of four major scientific research programs.
- Intensify the reform of the S&T system by refining policies and measures of great relevance, raising investments in S&T, reinforcing the development of S&T talents, and fostering the establishment of a national innovation system (NIS) to ensure dependable assistance for China to become an innovation-driven society.
- In accordance to the national tangible needs and conditions, an amount of priority areas is to be defined, major technological obstacles and challenges to be overcome as to increase the overall S&T support capability of the nation. The outline determines 11 areas of high priority for social and economic development among the 68 priority topics with explicitly defined objectives. (State Council of P.R.C., 2006)

Moreover, strategic priorities are selected in accordance with the overall power of the nation, global S&T development trends and pressing demand for establishing a well-to-do society.

The outline covers the aforementioned key areas and is divided into the following chapters: Main Areas and Priority Topics; Major Special Projects; Frontier technologies; Basic Research; Reform of the S&T System and the Construction of a National Innovation System; Major Policies and Measures; S&T Input and S&T Infrastructure Platforms; and lastly Talented Workforce Buildup.

1. *Main Areas and Priority Topics*. Main areas make reference to such industries and sectors, which are both crucial to economic and social development and national security, and are in urgent necessity of S&T support. The priority topics defined withing the main areas are in a dire need of technology clusters, which have solid technical foundations, clearly defined aims and auspicious outlooks for breakthroughs in short-term. The outline identifies 11 such main areas: energy, water and mineral resources, the environment, agriculture, manufacturing industry, transportation sector, information industry and modern service industry, population and health, urbanization and city development, public security and national defense; and in total 68 priority topics for these 11 main areas.

   > *The nation's S&T development shall be planned and deployed according to the principle of coordinated arrangement and advancement, with due consideration to priority areas and topics, so as to provide full and forceful support for addressing urgent issues in economic and social development. (State Council of P.R.C., 2006, p. 13)*

2. *Major Special Projects*. In line with the national objectives and with specifying priority topics within the main areas, a number of major special projects are identified, which include strategically essential products, major engineering projects and crucial common technologies. Furthermore, these major special projects are created to aspire breakthroughs by taking the advantage of the market economy and the socialist system in allocating resources, and are anticipated to fill the strategic gaps of the country, while facilitating S&T progress in lagging areas and leapfrogging development in general productivity. The major special projects are to carry out national objectives and have to be completed by putting together resources and achieving breakthroughs in core technologies within a designated duration of time, hence are a top priority in the national S&T development. A wide range of strategic domains are covered by the major special projects such as information and biotechnology; major urgent challenges regarding the environment, resources, energy and public health; dual-use technologies and ultimately defense technologies. The outline has specified the following 16 major special projects: high-end generic chips and basic software; the next generation broadband mobile telecommunication; high-end numerically controlled machine tools and basic manufacturing technology; super large-scale integrated circuit manufacturing technology and associated techniques; core electronic devices; high resolution earth observation systems; large advanced pressurized water reactors and high temperature gas-coolant reactor nuclear power stations; major new drugs; prevention and treatment of major infectious diseases such as HIV/AIDS and viral hepatitis; large passenger aircrafts: new genetically modified varieties; water body contamination control and treatment; development of large oil-gas fields and coal-bed methane; manned space flights; and lastly the moon probe.

3. *Frontier technologies* denote the extensive high-tech innovation capability of the nation and make reference to great groundbreaking, visionary and experimental technologies in the domain of high-tech. In addition, the frontier technologies form a significant foundation on

which emerging industries can develop and high-tech can originate. Frontier technologies are chosen based on the criteria if they: have a groundbreaking role in developing and forming new industries in the future; are part of the direction in which the world high-tech frontiers are developing; are favorable to industrial technology enhancement and to carrying out leapfrogging development; and are endowed with a strong R&D base and talented personnel. Under the aforementioned criteria 8 frontier technologies are to be deployed: biotechnology, information technology, advanced materials technology, advanced manufacturing technology, advanced energy technology, marine technology, lasers technology and aerospace technology; with in sum 22 topics within these 8 frontier technologies in an effort to increase competitiveness and national high-tech R&D capability, as well as to lead the future of S&T development.

4. *Basic research* represents an essential source for high-tech development and for nourishing innovative personnel, a base for constructing a progressive culture, and an internal means of propulsion for the future S&T development through complete comprehension of natural phenomena, uncovering nature's laws and obtaining new knowledge, methodology and principles. The development of basic research should be in line with the principle of integrating the fulfillment of national objectives with the promotion of free research. Furthermore, basic research activities are to oblige the law of scientific development, esteem the exploratory spirit of the scientists and focus more on the long term benefit of science with stable support, creative deployment and dynamic readjustment according to future scientific development trends. The outline sets forth deployment in four major areas, including basic and major scientific research activities that correspond to disciplinary development, scientific frontiers and major national strategic demands. The identified four major scientific research programs are as follows: protein studies, quantum regulation studies, nanometer studies, growth and reproduction studies, which are bound to considerably increase the international competitiveness of the nation, improve its sustainable development and carry out leapfrogging development in selected fields.

5. *Reform of the S&T System and the Construction of a National Innovation System* was covered as part of the subsection 2.2.1.

6. *Major Policies and Measures* will be covered as part of the subsection 2.2.4.

7. *S&T Input and S&T Infrastructure Platforms.* S&T inputs and basic facilities form a physical foundation for S&T innovation, an essential prerequisite and fundamental assurance for sustainable S&T development.

> *Today's S&T input is literally an investment in the future national competitiveness. (State Council of P.R.C., 2006, p. 59)*

Since the era of opening up and reform, China has witnessed a constant increase in S&T

input, in order to fulfill the major needs in greater development of S&T and in the fully-fledged establishment of a well-to-do society, however, in comparison to the developed and developing nations, the overall and intensity of national S&T input remains inadequate, with a weak S&T infrastructure and unreasonable aspects in the investment structure.

> *Given the fact that both developed and emerging industrialized nations around the world have made the increase of S&T input a strategic measure to raise their national competitiveness, our country should respond to the trend and need for enhancing the nation's indigenous innovation and core competitiveness by drastically increasing its input in S&T activities and strengthening the construction basic S&T facilities, so as to ensure the fulfillment of the missions defined in the Outline. (State Council of P.R.C., 2006, p. 59)*

8. *Talented Workforce Buildup*. Since innovation is embedded in S&T personnel and human resources constitute the most essential strategic resource, it is of great importance to uphold the strategy of constructing the national capacity with talented personnel and enable the support of human resource for the implementation of the outline. (State Council of P.R.C., 2006)

2.2.2.3. The Twelfth Five-Year Plan for National Economic and Social Development of the People's Republic of China (2011-2015)

The Twelfth Five-Year Plan for National Economic and Social Development of the People's Republic of China (2011-2015) was formulated based on the Proposal of the Central Committee of the Communist Party of China (CPC) for Formulating the Twelfth Five-Year Plan for National Economic and Social Development. The plan primarily unfolds the strategic aim of the state, steer the conduct of market players and shed light on the focus of the work of government. Moreover,

> *It is a grand blueprint for our country's economic and social development over the next five years; an action plan for the people of all our country's ethnic groups; and an important basis for the government to fulfill its duties in economic regulation, market supervision, social administration and public service. (Central Committe of the Communist Party of China, 2011, p. 0)*

The Twelfth Five-Year Plan sets forth a broad range of main goals in order to respond to the global developments and the impacts of the global financial crisis, to meet the aim of creating a moderately prosperous society in all aspects by 2020 and to take into account future trends and conditions.

> *The Twelfth Five-Year Plan period is crucial for building a moderately prosperous society in all respects, depending reform and opening up, and accelerating the trans-*

> *formation of the pattern of economic development, so we must profoundly understand and accurately grasp the new changes and new characteristics in the domestic and international situations, continue to grasp and make the most of this important period of strategic opportunities, and strive to initiate a new phase of scientific development. (Central Committe of the Communist Party of China, 2011, p. 2)*

Some of the major goals for the five-year period of the The Twelfth Five-Year Plan are the following:

- Accomplish stable and rapid economic development.
- Significantly increase the efficiency and quality of the economic growth.
- GERD should account for 2.2 % of GDP.
- GDP should grow annually on average at a rate of 7%.
- Continuously deepen opening up and reform.
- Increase education retention rates to 93%.
- Constantly improve the lives of people, while maintaining the population at 1.39 billion.
- Achieve relevant progress in reforming key links and major areas, like taxation and finance, banking, factor prices and monopoly industries, etc.
- Heavily increase the level of education and S&T.
- Pick up the pace of transformation of government functions and raise the administrative efficiency and government credibility. (Central Committe of the Communist Party of China, 2011)

The Twelfth Five-Year Plan is structurally organized in 16 parts and 62 chapters, which comprehensively address a broad range of topics. However, not all of the parts and chapters are directly relevant for this Master thesis and are beyond the scope of this study, therefore, only focus on part 7 will be given: Be Innovation-Driven: Implement the Strategies of Reinvigorating the Country Through Science and Education and Strengthening the Country Through Human Resources, which heavily emphasizes the importance of innovation and the development of an innovative country.

> *We will comprehensively implement the country's medium- and long-term plans for science and technology, education and human resources; greatly increase our scientific and technological innovation capabilities; accelerate educational reform and development; make the most of the advantages in human-resources; and promote*

> *the development of an innovative country. (Central Committe of the Communist Party of China, 2011, p. 122)*

In addition, Part 7 is further divided into the following three chapters: Chapter 27: Increase Scientific and Technological Innovation Capabilities, Chapter 28: Accelerate the Educational Reform, and Development and Chapter 29: Cultivate a Large Contingent of High Quality Personnel. Although chapters 28 and 29 are not as directly related to S&T development as chapter 27, they lay the necessary groundwork for chapter 27 to work and that is education and human resources, which, as previously has been noted, are an important innovation input.

Chapter 28: Accelerate the Educational Reform and Development is divided into four sections[1] and highlights the importance of making education widely available, reforming and raising the quality of all levels of education, which are essential for developing indigenous talents and high quality personnel necessary for STI, emphasized in chapter 29.

> *We will comprehensively implement the Party's education policy, safeguard the lawful rights of citizens to education, and provide education that satisfies the people. We will promotes the scientific development of education and increase the degree of modernization in education in accordance with the requirements of giving high priority to the development of education, focusing on educating the whole person, carrying out reform and innovation, promoting fairness, and raising quality. (Central Committe of the Communist Party of China, 2011, p. 128)*

Chapter 29: Cultivate a Large Contingent of High Quality Personnel consists of three sections[2], which stress the importance of experts and high-quality innovation personnel that are critical for increasing indigenous innovation capability and a fundamental prerequisite for building an innovative country.

> *We will strenuously implement the strategy of using talent to strengthen the country; uphold the guidelines of serving development, giving high priority to human resources, regarding their utilization as fundamental, making innovations in mechanisms, having highly talented people take the lead, and seeking overall development; and strengthen the development of skilled personnel in every area required for modernization in order to guarantee the supply of talent for accelerating the transformation of the pattern of economic development and achieving scientific development. (Central Committe of the Communist Party of China, 2011, p. 133)*

---

[1] Section 1: Coordinate the Development of All Types of Education at All Levels; Section 2: Vigorously Promote Educational Equality; Section 3: Comprehensively Promote Well-Rounded Education; Section 4: Deepen Reform of the Education System. (Ministry of Science and Technology (MOST) of P.R.C., 2014)

[2] Section 1: Stress the Cultivation and Training of Innovative Scientific and Technological Personnel; Section 2: Promote the Balanced Development of Various Contingents of Personnel; Section 3: Create an Environment Favorable to the Emergence of Outstanding Talent. (Ministry of Science and Technology (MOST) of P.R.C., 2014)

However, due to the scope of the work full attention will be primarily given to chapter 27, which is directly related to the efforts of the Chinese government to develop and upgrade S&T and Innovation in China.

> *We will uphold the principles of carrying out independent innovation, making significant progress in key areas, supporting development, and leading the way into the future; accelerate the development of a national innovation system; make great efforts to raise enterprise innovation capabilities; promote the transformation of scientific and technological achievements into actual productive forces; and give impetus to having economic development driven more by scientific and technological innovation. (Central Committe of the Communist Party of China, 2011, p. 123)*

Chapter 27 is comprised of the subsequent sections:

- *Section 1: Promote Major Scientific and Technological Breakthroughs* sets forth the goal of embracing the trend of S&T progress and making future-driven arrangements for basic research and research in cutting-edge technologies, as well fostering the close integration of S&T development with industrial improvement and upgrading. In addition, major scientific discoveries and the development of new disciplines are to be encouraged, while striving to take the high ground in the fields of life sciences, space sciences earth sciences and nanotechnology. Lastly, the implementation of major national scientific and technological projects is to be speed up and major breakthroughs are to be accomplished in the areas of equipment manufacturing, modern agriculture, energy resources, environmental protection, information networks, new materials and public safety and health.

- *Section 2: Accelerate the Establishment of a Technological Innovation System Led by Enterprises* accentuates the development of an innovation system which is enterprise-led, where orientation is given by the market and the endeavors of enterprises and URIs are incorporated, by fostering the development of strategic alliances between enterprises involved in innovation, universities and scientific research institutes; reforming the management system for science and technology in order to facilitate an efficient integration and allocation of society's science and technology resources; focusing on promoting and assisting innovation factors in enterprises, increasing the government resource support to enterprises, stimulating innovation in SMEs and large enterprises to increase R&D investment in order to be sure that enterprises are engaged in technological innovation, invest in R&D and utilize the results from innovation. Lastly, speed up the formation of regional innovation centers, address the essential roles of innovation demonstration zones, national innovation cities and new- and high-technology development zones and develop Beijing's Zhongguancun into science and technology innovation center with global influence.

- *Section 3: Accelerate the Construction of Science and Technology Infrastructure* underlines the construction of a solid national S&T infrastructure, national science centers and national (key) laboratories; the strengthening of sharing mutual complementarity and efficient utilization of this infrastructure; reinforcing S&T platforms, such as developing a platform for basic research, cutting edge and generic technology in order to enhance indigenous innovation capabilities and the ability to improve imported technologies. In addition to the aforementioned, this section also emphasizes the thorough implementation of the Action Plan to Increase the Population's Understanding of Science for popularizing science among general public.

- *Section 4: Strengthen Support Policies for Scientific and Technological Innovation* highlights strengthening the support policies for S&T and innovation, such as taxation, fiscal and financial policies in order to support enterprise innovation and the industrialization of scientific research results; reforming the management system for research funding while maintaining a consistent increase in government S&T funding and investments in basic research; implementing intellectual property rights (IPR) strategy and improving all aspects related to intellectual property rights (IPR), such as laws on IPR, law-enforcement's related to IPR, develop a respectable market for trading technology property rights and foster the integration and promotion of technical standards with independent IPR. Besides, the section calls for improving the integrity of scientific research and upgrading the evaluation and reward system for S&T achievements as well. Moreover, the section further emphasizes on focusing efforts in order to construct scientific and technological innovation capabilities by implementing the following:

  - *Major science and technology projects* on core electronic devices, high-end general chips and basic software, ultra large-scale integrated circuits manufacturing technology, next-generation wireless broadband mobile communications, etc.

  - *Key science and technology programs* such as National Basic Research Program of China (Program 973), the National High Technology Research and Development Program of China (Program 863), the National Key Technologies R&D Program and the National Natural Science Fund, as well as major scientific research programs into protein, quantum control, nanotechnology, growth and reproduction

  - *Scientific Research Facilities* - construct major national S&T infrastructure, including a free-electron laser and the spallation neutron source

  - *Knowledge innovation projects* to set up science centers for mathematics, condensed matter physics, space, oceans, etc. and establish R&D centers for clean energy, small satellites and notion of space, green and intelligent manufacturing and technology for deep prospecting on land and at sea

  - *Technological innovation projects* in order to improve enterprise technology centers, innovative enterprises and strategic alliances in industrial technology innovation; build national engineering centers and engineering laboratories for carbon fiber composites, digital home networks and new-energy vehicles, and promote the 100 most innovative enterprises. (Central Committe of the Communist Party of China, 2011)

2.2.3. Government S&T strategies & policies

Starting in the 1980s, China began to reform its science and technology system through a series of policies and programs. Ever since China has had an extremely centralized research system administered and organized by the central government with hierarchical decision making related to S&T. The administration mechanism of China's national S&T system, the National Steering Group for S&T and Education in the State Council, was established in 1998. The group is headed by the Prime Minister and coordinates all activities in connection to innovation, education and research (European Commission, 2015). The main goals of the group are to: research and examine major policies and national development strategy for education, science and technology; coordinate significant relationships between various governmental departments, local governments and the central government, concerning education, science and technology; consult about and assess the important programs and tasks related to education and S&T. The group consists of nine members: Ministry of Science and Technology (MOST), Ministry of Education (MOE), National Development and Reform Commission (NDRC), Ministry of Finance (MOF), Ministry of Industry and Information Technology (MIIT), Ministry of Agriculture (MOA), Chinese Academy of Sciences (CAS), Chinese Academy of Engineering (CAE) and lastly the National Natural Science Foundation of China (NSFC) (Figure 9). All these group members, except the Ministry of Environment Protection and the Ministry of Health, are directly involved in the formulation and implementation of the national S&T program and policies (Table 7) (Xiwei and Xiangdong, 2007).

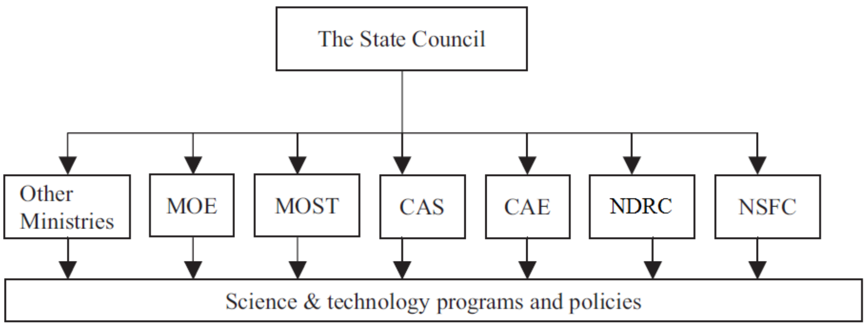

Figure 9.: National Steering Group for S&T and Education in the State Council (Xiwei and Xiangdong, 2007)

The Ministry of Education (MOE) is responsible for formulating strategies, policies and plans for the development and reform of education; drafting relevant regulations and rules, as well as monitoring their execution; overall planning, steering and coordination of all kinds of education at every level; fostering a versatile development of compulsory and righteous education; taking care and managing of total funds for education. In addition to being responsible for all the aspects connected to education, MOE also serves as an important base for research. There are several several important roles that MOE plays; directs and plans the research in social sciences, natural sciences and philosophy by institutions of higher education; steers the erection and development of the S&T innovation in institutions of higher education; coordinates and stimulates the institutions of higher education to contribute in developing the national innovation system and take part in the State's key science and technology development projects and programs; manages the informatization of education, as well as encourages the integration of teaching, production and research (Table 7). (Ministry of Education (MOE) of the P.R.C., 2015)

China Academy of Science (CAS), founded in 1949, is China's highest ranked academic institute in natural sciences and its supreme S&T advisory body. In addition, CAS is a national comprehensive research and development center in natural sciences and high technology. CAS is responsible for fundamental S&T national research projects in order to drive national technological innovation (Table 7). (Xiwei and Xiangdong, 2007)

China Academy of Engineering (CAE) is the highest academic and research institutes in engineering and China's most respected advisory institution in the engineering community. The duties of CAE are to introduce and execute studies of strategic importance, consult on decision-making for national key issues in engineering and technological sciences, and foster the development of engineering and technological sciences in China for the benefit and welfare of the society (Table 7). (Chinese Academy of Engineering, 2015)

National Natural Science Foundation of China (NSFC) is an important constituent of the group, as it financially supports basic research and applied basic research, discovers and promotes scientific talents, fosters science and technology and carries out social and economic development of China. Furthermore, NSFC puts together and propagates the Guide to Programs for basic and applied basic research, collects research proposals from universities and/or institutions nationwide, prepares peer reviews and evaluation sessions in order to select the best proposals to grant. NSFC developed cooperation with science foundations and relevant scientific organizations in other countries and regions and takes part in active international scientific cooperation and exchange (Table 7). (National Natural Science Foundation of China, 2015)

In addition, the National Development and Reform Commission (NDRC) is responsible for developing long-term economic development strategies and policies focusing on the social and economic aspects of S&T. Ministry of Finance (MOF) helps to develop fiscal policies for encouraging R&D activities, particularly in enterprises and formulates governmental procurement procedures and criteria. While the Ministry of Industry and Information Technology (MIIT) and the Ministry of Agriculture (MOA) administer R&D activities connected to the industrial sectors, which includes IT and agriculture, respectively. (European Commission, 2015)

Ministry of Science and Technology (MOST) plays a vital role in designing S&T policies and programs. MOST is solely liable for drafting multiple S&T plans and programs, like Key Technologies R&D Program, National Basic Research Program, etc., but also teams up with other organizations, departments and ministries in assessment, scheme demonstration, acceptance and policy making of major S&T projects, as well as consults on big changes. MOST tends to carry out socio-economic growth through the coordination of basic research, frontier technology research, research on social service, key and common technology. The missions of the MOST are the following: to take the leading role in drafting and implementing S&T development plans and policies, related laws and regulations, national S&T Programs, as well as plans and policies on science popularization and above all guarantee for their implementation. In addition, MOST devises and executes plans on innovative bases, national laboratories and research conditions in order to facilitate construction of infrastructure and sharing of resources; draws up and oversees S&T plans of all kinds; directs the national high-tech industrial development zones; stimulates demonstration and application of technological invention and scientific discovery, as well as helps enhance innovation capacity of enterprises; and lastly takes care of and manages budgeting, accounting, and the supervision of S&T funds (Table 7). (Ministry of Science and Technology (MOST) of P.R.C., 2015)

Name	Roles	Goals	Activities
Ministry of Science and Technology (MOST)	Liable for drafting multiple S&T plans and programs, such as Key Technologies R&D Program, National Basic Research, etc. Teams up with other organizations, departments and ministries in assessment, scheme demonstration, acceptance and policy making of major S&T projects. Takes care of and manages budgeting, accounting and the supervision of S&T funds.	Take the leading role in drafting and implementing S&T development plans and policies, related laws and regulations, national S&T Programs. Carry out socio-economic growth through the coordination of basic research, frontier technology research, research on social service, key and common technology. Help enhance innovation capacity of enterprises.	Devise and executes plans on innovative bases, national laboratories and research conditions in order to facilitate construction of infrastructure and sharing of resources. Direct the national high-tech industrial development zones. Stimulates demonstration and application of technological invention and scientific discovery.
Ministry of Education (MOE)	Responsible for formulating strategies, policies and plans for educational development and reform. Draft relevant regulations and rules, and monitoring their execution.	Fostering a versatile development of compulsory and righteous education. Formulate strategies, policies and plans for educational development and reform.	Overall planning, steering and coordination of all kinds of education at every level. Taking care and managing of total funds for education. Participate in the State's key S&T development projects and programs.
Chinese Academy of Sciences (CAS)	Highest ranked academic institute in natural sciences. China's supreme S&T advisory body.	Drive national technological innovation. Support nationwide S&T development and deliver S&T advice.	Responsible for fundamental S&T national research projects.
Chinese Academy of Engineering (CAE)	Highest academic and research institutes in engineering. China's most respected advisory institution in the engineering community.	Foster the development of engineering and technological sciences in China for the benefit and welfare of the society	Introduce and execute studies of strategic importance. Consult on decision-making for national key issues in engineering and technological sciences.
National Natural Science Foundation of China (NSFC)	An important constituent of the group; it supports financially basic research and applied basic research, discovers and promotes scientific talents, fosters S&T and carried out social and economic development of China.	Develop cooperation with science foundations and relevant scientific organizations in other countries and regions. Take part in active international scientific cooperation and exchange.	Supports financially basic research and applied basic research. Discovers and promotes scientific talents.

Table 7.: Most important constituents of the National Steering Group for S&T and Education in the State Council (personal design).

Many major S&T policies and programs have been introduced since the early 1980s. An overview of the most prominent ones is given underneath (Table 8).

- *National High-tech R&D Program (863 Program)* was established in March 1986, in order to speed up China's high-tech development and to be able to face global challenges of the new technology revolution and intense competition. The 863 Program is one of the most important programs and still continues to play a vital role. Since its establishment it has boosted the general R&D capacity, high-tech development, socio-economic development and national security in China. The program is devoted to addressing advanced, strategic and progressive issues related to high-tech, which are the key to the future development of the nation. In addition, the program has taken a leading role in the future development of emerging industries by utilizing, progressing an implementing proprietary high technologies (Table 8).

- *National Key Technologies R&D Program* was initiated in 1982 and is the first national S&T program in China, which aims to confront the major S&T issues in national economic and social development. Since its establishment the program has not only improved the national S&T capability and spurred sustainable development of the society, but also made exceptional contributions to the technical modernization and enhancement of traditional industries, as well as formation of new ones. The program addresses key technical issues, while focusing on R&D and the application of generic and key technologies for public good, strengthening re-innovations and integrated innovation, and lastly raising industrial competitiveness and aspiring to achieve breakthroughs in key technologies (Table 8).

- *National Basic Research Program of China (973 Program)* was formulated by the State Science and Education Steering Group in 1997 based on the thought that

  > *Basic research is a driving force for the progress of human civilization, a source and backbone of S&T and economic development, a precursor of inventions and new technology, and a cradle of S&T talents. Continuous fast socio-economic growth imposes increasingly higher demands on basic research while many scientific issues press for solutions derived from in-depth basic research. Significant breakthroughs from basic research often trigger remarkable changes in economic and social sectors. Ministry of Science and Technology (MOST) of P.R.C. (2015)*

  The goal is to mobilize S&T talents of China to carry out innovative research on major issues such as information, energy, materials, resources and environment, agriculture, etc.in order to construct a sound S&T base for sustainable socio-economic development of the nation (Table 8).

- *National Science and Technology Infrastructure Program* aims to reinforce, adjust and enhance the S&T capacity of various kinds of national S&T research centers, as well as to supply shared conditions and resources for technical development and scientific research in order to strongly support national S&T development.

- *Environment Building for S&T Industries* is a major constituent of the national S&T plan in the Five-year Plan period with the main objectives to reinforce policy for environment establishment, foster regional economic development, promote the development of small and medium-sized S&T enterprises (S&T SMEs), improve technical exchanges and services, strenuously develop S&T intermediaries and lastly construct a solid environment for the industrialization and commercialization of S&T findings. (Ministry of Science and Technology (MOST) of P.R.C., 2015)

- *Resolution on the reform of S&T system* was put forth by the government in 1985 with two objectives: firstly, to upgrade the general management of the R&D system, including promoting the fluidity of the research personnel, and secondly to incorporate S&T into the economy by establishing a flexible operating system.

- *Torch program* was introduced in 1988 to foster the establishment of high-tech enterprises. The program aims to mitigate regulations, attract foreign high-tech enterprises by ensuring support for establishing facilities, and promote the founding of indigenous high-tech enterprises in special high-tech zones throughout China, which are established in the close vicinity to URIs in order to encourage linkages between enterprises and the researchers. Between 1991 and 2003, 53 national high-tech zones were establish across China, while the principal industries in these high-tech zones were biotechnology, new materials, new energy technologies and information technology (IT) (Table 8).

- *National Science and Technology Achievements Spreading Program* took off in 1990 with the goals of deploying technological achievements, commercialization of research from academia and encouraging technology transfer.

- *National Engineering Technology Research Center Program* was established in 1991 to enforce a measure of transparency into the system by the means of peer review of both institutional performance and proposed projects.

- *Climbing program* was formed in 1992 to speed up the national basic scientific research.

- *Endorsement of UAEs (URI-affiliated enterprises)* was launched in 1992 to facilitate industry and university linkage.

- *Super 863 program* started in 1996 and focuses on achieving breakthroughs in key areas and commercialization of these results.

- *The Guideline for Developing National University Science Parks* was started in 2000 and is of great importance as it aims to foster the development of university science parks.

- *Decision on Accelerating S&T Progress* planned in 1996, implemented in 1999 with the objective to transform government research institutes and promote their linkage to the industry. (Xiwei and Xiangdong, 2007)

- *211 Program* is a major human resources program, which was initiated in 1995 and got its name after the plan to establish 100 internationally competitive universities in the 21st century. Since universities are an essential player in China's S&T system, not only in creating S&T personnel, but also in taking part in various R&D activities, the program allocates funding to chosen universities in order to build up their research capabilities and train high-quality research personnel (Table 8).

- *Spark program* was introduced in early 1986 primarily focusing on the rural areas in China. The aim of the program is to support the development of agricultural technologies and encourage their application in the rural areas, as well as to support enterprises wiling to engage in R&D in the rural areas of the nation (Table 8). (European Commission, 2015)

Name	Started in	Role	Goal	Impact
National Key Technologies R&D Program	1982	Addresses key technical issues. Focuses on R&D and the application of both generic and key technologies for public good. Strengthens re-innovations and integrated innovation.	Confront major S&T issues in national economic and social development. Raise industrial competitiveness and aspire to achieve breakthroughs in key technologies.	Improved national S\&T capability. Made exceptional contributions to the technical modernization and enhancement of traditional industries and to the formation of new ones.
National High-tech R&D Program (863 Program)	1986	Addresses advanced, strategic and progressive issues related to high-tech. Takes a leading role in the future development of emerging industries by utilizing, progressing an implementing proprietary high technologies.	Speed up China's high-tech development in order to be able to face global challenges of the new technology revolution and intense competition.	Boosted the general R&D capacity, high-tech development, socio-economic development and national security in China.
Spark program	1986	Support enterprises wiling to engage in R&D in rural areas of the nation.	Facilitate the development of agricultural technologies and encourage their application in the rural areas.	Fostered technological advances and development in China's rural area.
Torch program	1988	Fosters the establishment of high-tech enterprises and high-tech zones.	Mitigate regulations; attract foreign high-tech enterprises. Promote the founding of indigenous high-tech enterprises in special high-tech zones.	53 national high-tech zones established between 1991 and 2003.
211 Program	1995	Allocates funding to chosen universities in order to build up their research capabilities and train high-quality research personnel.	Establish 100 internationally competitive universities in the 21st century.	Two Chinese universities already among the 100 top universities in the world (Tsinghua and Peking University).
National Basic Research Program of China (973 Program)	1997	Foster the development of basic research.	Mobilize S&T talents of China to carry out innovative research on major issues, i.e. information, energy, materials, resources and environment, etc. Construct a sound S&T base for a sustainable socio-economic development of the nation.	Emphasizes to increase the focus on basic research which was in 2013 as low as 4.7% in China. Achieve significant breakthroughs from basic research which often trigger remarkable changes in economic and social sectors.

Table 8.: Selected prominent S&T programs in China (personal design).

In addition to the major S&T programs, many laws and regulations have been established by the government since the 1980s, in order to reinforce and support the development of S&T, including: "The Law for Promoting Commercialization of S&T Achievement", "The Technology Contract Law", "The Law for Agriculture Technology Diffusion", "Regulations on the IPR Management of Government-Funded Projects", "The Statute for Computer Software" (Xiwei and Xiangdong, 2007), as well as "The Trademark Law", "The Copyright Law", "The Patent Law", "The Product Quality Law of the People's Republic of China", "The Law of the P.R.C on Science and Technology Progress", "The Law of the People's Republic of China on Popularization of Science and Technology", "The Regulations on the Protection of Layout-Designs of Integrated Circuits", etc. (Ministry of Science and Technology (MOST) of P.R.C., 2015).

2.2.4. Government measures and incentives that foster innovation

Government support for enterprise innovation by the means of regulatory provisions, relevant policies and financial incentives is almost identical in both developed and developing nations. Among the broadly adopted measures and instruments are providing skilled S&T personnel, drawing financial support to innovative enterprises, issuing supporting S&T policies, setting up S&T parks, providing services of industrial advisory and coordinating the relationships between university/research institutions and the industry. (Guan and Yam, 2014)

The outline of National Medium- and Long-Term Program for Science and Technology Development (2006-2020) includes various S&T policies and measures, which are devised to confront major salient problems and inconsistencies that the nation was facing and are to be improved and aligned to the changing conditions and the progress in the implementation of the outline. In order to guarantee for the implementation of the goals defined by the outline, system and mechanism issues need to be taken care of and efforts are to be undertaken to devise more efficient policies and measures. All policies and measures are to enhance and foster indigenous innovation capability; support social and economic development by the means of science and technology; stimulate the creativity and eagerness of the S&T personnel; and fully utilize both foreign and domestic S&T resources; the outline calls for nine of the following measures to be implemented during the 15-year period:

1. Financial and Taxation Policies Encouraging Technological Innovation at the Enterprise Level.

2. Strengthening assimilation and absorption of imported technologies, and re-innovation.

3. Government Procurement Favoring Indigenous Innovation.

4. Intellectual Property Rights Strategy and Technology Standards Strategy.

5. Financial Policies Encouraging Innovation and Pioneering.

6. Accelerating the Industrialization of High Technologies and the Diffusion of Advanced Appropriate Technologies.

7. Perfecting the Mechanism for Combining Defense and Civilian Sectors, and Making Defense Part of the Civilian Sector.

8. Expanding International and Regional S&T Cooperation and Exchanges.

9. Improving Scientific and Cultural Literacy of the Entire Nation and Building a Social Environment. Conducive to S&T innovation. (State Council of P.R.C., 2006)

2.2.5. Analysis of the implementation of the Beijing innovation system

Regional innovation capabilities and their development have been of key importance for building competitiveness in both developing and developed economies. In addition, regional systems can cover the local nature of innovation much better than other broader geographical systems (Fu, 2015). As knowledge and technology are not only the key drivers of competitiveness at a national level, but also at regional and company levels, therefore, they play a crucial role in sustaining the economic development of regions and longterm survival of enterprises. Therefore, regional players in S&T and regional innovation policies within the regional innovation system (RIS) perform a decisive role in establishing adequate context for the creation and transfer of knowledge and technology (Lau and Lo, 2015).

> *Regional innovation system (RIS) is a set of networks between public and private agents that interact and give mutual feedback in a specific territory by taking advantage of their own infrastructure to adapt, generate and extend knowledge and innovation (Lau and Lo, 2015, p. 100)*

As previously stated, Beijing is the political, economic, and cultural center of China. In addition, Beijing is also the S&T and educational capital of China (Chen and Kenney, 2007). It is truly one of China's largest innovation hubs and home to Zhongguancun Science Park (ZGC), known as the "China's Silicon Valley", China's largest and most active S&T park (Guan et al., 2009), which was established in 1988 to promote the commercialization of knowledge produced by URIs to enterprises (European Commission, 2015). Also Beijing's high-technology industrial cluster located in Zhongguancun is the main representative of the high-technology industry clusters in China (Shah et al., 2015). It has played and still plays a vital role in the development of STI in China (Guan et al., 2009). Furthermore, with the constant influx of multinational enterprises over the past years, Beijing is not only a domestic R&D hub, but has become a global R&D center (European Commission, 2015). Moreover, Beijing is an essential component of the Bo Hai Rim cluster (Beijing, Tianjin, Shandong province and Hebei province), which alongside the Pearl River Delta and Yangtze River Delta clusters is one of the most innovative regions in China. According to Someren, Taco C. R. van and Someren-Wang (2013), these clusters are referred as regional innovation systems (RIS).

Nowadays, universities are broadly considered as a vital player in the national and regional innovation systems because of their role related to competitiveness, innovation and socio-economic development. Moreover, universities are broadly considered as a major contributor to the creation of innovation and progress in basic scientific research, and have miscellaneous roles including educating, creation of knowledge in the form of patents and scholarly publications, public space provision and problem-solving activities (Fu, 2015). In addition, universities and research institutes (URIs) played a considerable role in the development of a great number of high-technology regions, which is also true in the case of Beijing (Chen and Kenney, 2007). Beijing, being the center of the Chinese university education system is home to the Chinese Academy of Sciences and 172 universities, therefore is China's richest area in technical talents and research resources (European Commission, 2015). Beijing takes advantage of its abundant URI resources to foster high-tech development, since URIs in Beijing serve not only as core research centers and providers of human capital, but also have formed science parks and produced spin-offs to commercialize their technologies and research. In line with this view, Beijing universities have established tight relationships with the industry by the means of joint projects, training and professional consulting (Chen and Kenney, 2007).

3. Methodology

This chapter briefly discusses research methods used in this study. Firstly, it describes the aims of the study and the research questions it tries to answer. Secondly, an overview of potential challenges in gaining access related to conducting research in the Chinese context is given. Lastly, the context and the participants of the study are explained, as well as the methods used, including data analysis and interviews.

3.1. Aims and research questions

This study aims to:

1. Investigate the Chinese government's strategies for business environment improvement and entrepreneurship innovation climate development.

2. Investigate government measures and incentives which foster innovation.

3. Explore the functionality, stressfulness, efficiency and sustainability of the Chinese innovation support system in the Beijing area.

The study seeks to answer the following research questions:
RQ1: Which measures and incentives foster innovation and how can an entrepreneurial/innovative climate be developed/encouraged?
RQ2: How can a country improve from an innovation underachiever to a fast follower or innovation leader and gain global visibility in a relatively short period of time?

3.2. Context and participants

The research was conducted during a semester abroad as an international foreign student exchange at the Beijing University of Technology (Beijing Ligong Daxue) in the duration of 5 months and under the KUWI scholarship, offered by Graz University of Technology (TU Graz) and intended for a short-term academic stay at a foreign institute for conducting research/writing Master's and PhD theses.

The research context is set in China's capital, Beijing, since China is not only too vast and diverse, but also too unevenly developed with each of its provinces and municipalities having distinct features and substantial populaces (Fu, 2015). As already noted, Beijing, with the population of approx. 21.2 million (2013) is not only the political and cultural, but also the educational and S&T capital of China (National Bureau of Statistics of China, 2014). Beijing is one of China's leading economic and S&T regions (Guan et al., 2009), and has played a vital role in the development of the innovation environment and S&T in China (Guan and Yam, 2014). In addition, Beijing is home to the Zhongguancun Science park also known as the "Z-park" or "China's Silicon Valley", which is China's oldest, largest and most active high-tech economic zone and also the main focus of my research (Guan et al., 2009).

3.2.1. Gaining access

When conducting research in the Chinese context, one must be prepared to face a number of potential obstacles and difficulties. During the duration of the research in Beijing the following difficulties were encountered.

- *Internet.* There were several issues related to the Internet. First of all, one must be aware that browsing the Internet in China is hindered by the "Great Firewall of China", which blocks most of the "western" websites, content and services; for example Google and all its services are unavailable in China. Access to these websites, which one took for granted before, don't work without the use of a Virtual Private Network (VPN) software. Secondly, Internet bandwidth is usually slower than in European countries, while the connection was breaking often and the use of VPN made browsing even slower. Lastly, campus Internet was not provided by the Beijing Institute of Technology and needed to be paid for. Despite, the fact that the campus Internet need to be paid for, the bandwidth was slow, the quality of service was poor with many connection issues and frequent error messages. Connecting to the campus Internet has not occurred from the first attempt during the 5 month stay.

- *Language barrier.* Although, Beijing has become internationalized over the years with many foreigners living there, the language barrier nonetheless still persists. Firstly, related to the aforementioned Internet problems, the entire login page of the campus Internet homepage and all the corresponding error messages were only in Mandarin Chinese. Secondly, although the homepage of the Library of the Beijing Institute of Technology has a link to an English version, however, when the link is clicked, the Mandarin Chinese version is reloaded or in other words the English version is nonexistent. Despite the fact that only a few employees among the librarian staff spoke English, the only reason why searching online databases and borrowing books was possible, is because of English speaking librarian staff, their willingness to help and kind assistance. In addition, the English speaking librarian staff were of great support and assisted manifold with searching for the missing literature, browsing numerous online databases, borrowing and returning books. Thirdly, some of the documents issued by various government agencies and even some of the official websites of government organizations that have previously been used by researchers in their references, do not have English versions, i.e. website of the Ministry of Education, Science and Technology or Annual Report of Science and Technology Development of China, etc.

- *Availability of documents and contact information* was especially a challenge. As mentioned before some of the documents issued by various government agencies and some of the official websites of government organizations are only available in Mandarin Chinese, while the English versions of some of these documents are not published as frequently as the Mandarin Chinese ones. In addition, even if some of the websites of government agencies/organizations have English versions, these versions are usually outdated and the content is not kept up-to-date, which is definitely not the case with their Mandarin Chinese counterparts; an example of such websites are websites of the Ministry of Science and Technology (MOST), China Association for Science and Technology (CAST) and many others. Some of the government organizations don't have contact e-mail addresses where one can send his or hers inquiries, for example MOST. On the other hand, three e-mails were sent to the e-mail addresses found on CAST's (outdated) English website, which were returned with errors "The following addresses had permanent fatal errors. Error: no valid recipients". In addition, all the e-mails sent to inquire about the possibility of conducting interviews, and e-mails to MOST and CAST to inquire about missing primary sources of information received no replies. Furthermore, a number of documents which were only available in Mandarin Chinese versions were missing and would have been of great significance to the research, such as *Annual Report of the State Programs of the Science and Technology Development (MOST)*, *Annual Report of Science and Technology Development of China (MOST)*, *Report of Regional Innovation Capabilities of China*, *Zhongguancun Area National Innovation Model 2014 Yearbook*, *National S&T Programmes Yearbook*, consequently, these documents had to be substituted by secondary source of information.

Despite all the challenges of conducting research in the Beijing context and missing literature, the research was successfully concluded and interviews were conducted due to the help of many supporters of this Master thesis to whom a great debt of gratitude is own.

3.2.2. Participants

A total of six interviews have been conducted in this study; three of the participants belong to relevant stakeholders related to STI in Beijing, therefore each gives a different perspective on the development of STI in Beijing (participants 1-3), while other three participants were entrepreneurs and owners of startup companies (participants 4-6). To ensure confidentiality, the names of the participants were withheld, and except participants 5 and 6, all other participants were of the female gender, while all the participants were Chinese nationals, citizens of the P.R.C.

Participant 1 works for the Beijing Makerspace, which is located in Haidian district, in the heart of the Zhongguancun S&T park. The Beijing Makerspace is the largest Makerspace not only in China, but entire Asia. Due to the growing importance of the Maker movement in the world and in China as well, the Beijing Makerspace was certainly worth visiting and including in this Master's thesis. More exactly, participant 1 is in charge of the Maker academy, a department of the Beijing Makerspace focused on the Maker education, offering workshops and classes to various age groups. The interview took place at the Beijing Makerspace, which is located on the 4th Floor of the Zhongguancun Dream Laboratory on No.1 Zhongguancun St in Haidian District in Beijing.

Participant 2 works for the Division of International Exchanges and Cooperation of the Administrative Committee of Zhongguancun Science Park, which is part of the People's Government of Beijing Municipality. Zhongguancun Science Park is the focal part of the research and the Administrative Committee of Zhongguancun Science Park, although does not have the administrative power over the Zhongguancun Science Park, it is responsible for all the preferential policies and measures park has to offer, as well its internationalization. The venue of the interview was in a meeting room on the 7th floor of Tower C on No.73 Fucheng Road in Haidian District, Beijing, where the office of the Administrative Committee of Zhongguancun Science Park is located.

Participant 3 works for the Enterprise Development Department at the TusStar (TusPark Business Incubator Co., Ltd.) innovative incubator, which is located in the Tsinghua science Park in Beijing's Haidian district. TusPark is one of the most famous science parks in the Zhongguancun Science Park, as well as a world-class university science park and the largest single university science park in the world, which were more than enough reasons to include it in this Master's thesis. During the visit to the TusStar interviews with the three aforementioned entrepreneurs have been conducted (participants 4-6), whose companies have been incubated between two months and a year and a half in the TusStar Incubator of Mobile Internet. Participant 4 is the CEO of Randian which is an O2O (Online-to-Offline) web application based on HTML 5 intended for users to find coaches for sports online. Participant 5, is the co-founder of Holonet Security a startup focusing on cloud computing security for enterprises, while participant 6 is the CEO of ZhongDu Technology, a travel-related startup. The interviews were held in TusPark's Tower C where the TusStar Incubator of Mobile Internet is located.

3.3. Research method

The research method is based on the qualitative approach, which includes document analysis and interviews.

3.3.1. Document analysis

Various primary and secondary sources of information have been analyzed. Primary sources were mostly documents issued by the Chinese government or its affiliated agencies/organizations, including plans, reports and statistics. Literature overview includes a range of primary sources of information, such as:

- *The twelfth five-year plan for national economic and social development of the People's Republic of China (2011-2015)*
- *The National Medium- and Long-Term Program for Science and Technology Development (2006-2020)*
- *China Statistical Yearbook 2014*
- *China Science & Technology Statistics Data Book 2014*

In addition, numerous official websites of the Chinese government, its ministries, agencies and organizations are included in the literature overview as well, like:

- *Administrative Committee of Zhongguancun Science Park*
- *Chinese Academy of Engineering (CAE)*
- *State Council*
- *Ministry of Education (MOE)*
- *Ministry of Science and Technology (MOST)*
- *National Natural Science Foundation of China (NSFC)*
- *National People's Congress of the P.R.C*

3.3.2. Interviews

A semi-structured interview style was applied to all the interviews with a predefined questionnaire for guidance. Participants 1-3 each had a unique questionnaire as each of them works in a different organizations, therefore each questionnaire was entirely adjusted to each of the organizations. On the other hand, the same questionnaire was used for participants 4-6 since they had more in common such as that they are all entrepreneurs, owners of startup companies and all incubated in the TusStar Incubator of Mobile Internet. Four questionnaires in total were composed and these questionnaires were printed out and distributed at the beginning of each interview. All the questionnaires used in the interviews can be found in the Appendix.

The duration of the interviews with participants 1-3 was between one and two hours, while the interviews with the entrepreneurs were shorter and lasted up to 30 minutes. All the interviews were recorded, and then later transcribed and processed. In addition, the interviews were conducted in English, except with participant 6, who understood English, but could not speak it well, therefore participant 3 needed to act as a mediator and Mandarin Chinese - English translator. Although this was not a big problem, it made the interview slightly more difficult to conduct and changed its dynamics, while certainly some of the information was lost in the translation, however, it was an interesting experience nonetheless.

The visit to the Beijing Makerspace and the interview were arranged personally through "Wechat", which is the most popular messaging app in China. Although two e-mails with inquiries were sent and no replies received, an answer on Wechat was received quickly and they were more than happy to grant a visit. All the contacts of the Beijing Makrespace were found on their official website. Later participant 1 explained that the e-mail address to which the inquiries were sent, is only checked by the owner of the Beijing Makerspace and that they did not know that any e-mails were sent previous to my visit. The questionnaire consisted of 15 questions regarding the Beijing Makerspace including the following topics: facts and figures, operation, organizational aspects, the business model, offered services and events, etc. In addition, especially important topics were whether the support from the government was important for the success of the Beijing Makerspace and the state of the Maker culture/culture of entrepreneurship in Beijing/China (Appendix A).

Organizing an interview with the Administrative Committee of Zhongguancun Science Park was the hardest part. Two rounds of e-mails were sent to two different e-mail addresses of the Administrative Committee of Zhongguancun Science Park. The e-mail addresses of the Administrative Committee of Zhongguancun Science Park, were found on their official website, however, the e-mails sent received no replies, which required further actions. An interview with paticipant 2 was arranged by firstly personally calling a contact number of the Administrative Committee of Zhongguancun Science Park found on their official website. Although the person who answered the phone spoke only Mandarin Chinese, a phone number of the international office of the Administrative Committee of Zhongguancun Science Park managed to be obtained regardless of the language barrier. Secondly, the number of the international office of the Administrative Committee of Zhongguancun Science Park was called and the purpose explained, however, the speaker that worked for the international office of the Administrative Committee of Zhongguancun Science Park did not completely understand the purpose of the phone call and thought the inquire is about the visit to the exhibition center of the Zhongguancun Science Park. As the purpose to the speaker was unknown, a new e-mail address was given to send the inquiry, which was the e-mail of the participant 2. An answer was received within a day from participant 2 and the visit granted. In the meanwhile, due to the initial lack of success with arranging the interviews, the help from the S&T Office of the Austrian Embassy in Beijing was sought, who needed two weeks to process the inquiry (Appendix B). The interview took place within these two weeks, before the S&T Office processed the inquiry, however, during the interview, participant 2 said that she had also been contacted from the S&T Office of the Austrian Embassy in Beijing, which was unknown at that time, but to whom a great deal of gratitude is given for their kind assistance.

The questionnaire consists of 3 parts: *Basic facts and figures on the Zhongguancun Science Park*, *Facts on the Administrative Committee of the Zhongguancun Science Park* and *Advantages and benefits for residents of the Zhongguancun Science Park* (Appendix C). *Basic facts and figures on the Zhongguancun Science Park* consists of seven questions mostly related to statistics, which couldn't be find on the official website of the Administrative Committee of Zhongguancun Science Park nor in the China Statistical Yearbook 2014, such as number of employees (full-time, short-termers, external coworkers, etc.), the total area ZGC covers in km2, the owners/stakeholders of the ZGC S&T Park, etc. *Facts on the Administrative Committee of the Zhongguancun Science Park* are covered by 13 questions and a wide range of topics related to the Administrative Committee of the Zhongguancun Science Park, their work and duties, and the Zhongguancun Science Park itself. Lastly, *Advantages and benefits for residents of the Zhongguancun Science Park* refer to the benefits one would get to set his or hers business in the Zhongguancun Science Park, for example measures and incentives for STI that are offered on a park and sub-park level, available sources of financing (i.e. government incentives, risk capital: angel investments, VC, etc.), etc.

The interviews at TusStar with participant 3 and participants 4-6 were arranged by participant 2, who joined the meeting as well. First the interview with participant 3 took place, followed by participant 4, while the interviews with participant 5 and participant 6 due to unfortunate timing were held simultaneously, which made their conducting more difficult as attention to a single interviewee could not be given and as mentioned before, the communication with participant 6 was carried out through participant 3 and participant 2, who acted as simultaneous translators and facilitators. The questionnaire for participant 2 was made of two parts: *Basic facts and figures on the TusPark Science Park* and *Facts on the TusStar Incubator* (Appendix D). *Basic facts and figures on the TusPark Science Park* inquired about the basic information about TusPark such as its ownership, management and organization, how it is related to the Z-park and statistical data such as no. of companies in the park, no. of startups incubated, no. employees and researchers, etc. While the *Facts on the TusStar Incubator* covered fourteen questions, among the most important topics were: what the prerequisites for being incubated in TusStar are, what benefits TusStar offers in comparison to other innovative incubators in the Z-Park, what services/mechanisms it provides to its residents, how they foster a culture of innovation/entrepreneurship and collaboration, and how students are encouraged to become entrepreneurs, etc. The questionnaire for TusStar's entrepreneurs consisted of 12 questions, while the following were the main topics: basic info about their company and work, reasons and motivation for starting a startup company and for incubation at TusStar, services that TusStar provides that they especially found useful, services missing in the park that they consider to be useful, and obstacles/challenges that their companies faced or are facing at the moment (Appendix E).

The results of the interviews are presented in the following chapter 4.

4. Beijing case study: Zhongguancun - "China's Silicon Valley"

In this chapter the results of the interviews are presented. Section 1 to Section 4 give a perspective on the Zhongguancun Science Park from the view of Participant 2 who works for the Administrative Committee of Zhongguancun Science Park. In Section 5 Participant 3 gives an overview of the TusPark and its innovative incubator TusStar, while Section 6 covers the selected best cases of TusStar's entrepreneurs. Lastly, Section 7 looks at the Beijing Makerspace and the Maker Movement in China through the perspective of Participant 1.

4.1. Perspective of the Zhongguancun S&T park

4.1.1. Facts and figures

The origins of the Zhongguancun National Innovation Demonstration Zone (Z-Park) go back to the "Zhongguancun Electronics Street" in the early 1980s. During more than two decades of development the Z-Park has expanded to 16 districts and counties across Beijing, covering an area of 488 squared kilometers. Due to the continuous accomplishments in innovation, the Z-Park has become a superior industrial functional area spreading across Beijing's multiple administrative districts, China's most dynamic hub for entrepreneurship and innovation, and a origin of strategic emerging industries in China. As previously stated, there are 114 national high-tech zones in China, including the Z-Park. However, of all the companies located in these 114 national high-tech zones in China, the companies in the Z-Park accounted for 15.3% of the total revenue generated in 2013. In 2014, there were more than 16.000 enterprises in Z-Park qualified as high-tech companies with a total revenue of RMB 3.570 trillion or approx. USD 600 Billion, which is an increase of 17.2% in comparison to the previous year. In addition, in the same year there were around 2500 companies with revenue above RMB 100 million, 440 with revenue above RMB 1 billion and 65 with revenue more than 10 billion. Compared to 2013 when over 6.000 new companies have been established in ZGC, in 2014 a record number of 13.000 new businesses were registered and started making, however, these have not been authorized as high-tech companies yet. By June 9 2015, there were as many as 275 public companies in Z-park; 99 of them are listed on overseas markets including NASDAQ (36), NYSE (21), Hong Kong Stock Exchange (34), in Singapore (3), in Japan (2), on AIM Britain (1), in Canada (1), in Germany(1). Furthermore, in 2014, 23 new enterprises went public on NASDAQ (4), NYSE (2), Hong Kong Stock Exchange (6) among the all. In addition, most of the Z-Parks's foreign companies are from the USA, Europe and Japan, while approximately 300 Fortune 500 enterprises have set up headquarters in the park, contributing around 40% to the total revenue.

As Z-Park is the birthplace of strategic emerging industries, high-tech enterprises have established a cluster of emerging industries, which corresponds to the strategic positioning of the Beijing Municipality and have achieved major breakthroughs in the fields of strategic new technologies including high-end LCD display, 4G mobile communications and mobile Internet, advanced equipment and processes for integrated circuit manufacturing, bio-health, etc. There are in total six highly competitive industry clusters: next generation Internet, satellite application, mobile internet and new-generation mobile communication, biology and health, environment protection and energy conservation, while an increase in start-ups has been witnessed, especially in the areas of new-generation mobile Internet and next-generation Internet. In addition, Z-Park takes the leading role in China in terms of patent applications and approvals, creation of both international and domestic technical standards and until now Z-park's enterprises have led to the establishment of 144 international standards, 1.828 industry standards, 2.778 national standards and 146 regional standards.

One of the main missions of the Z-Park is to create a high-end pool of both domestic and overseas talents by employing a "talent-led and innovation-driven" development pattern where top talents play an essential role in facilitating innovative development. In addition, Z-Park is densely populated with scientific and technological talents and in 2014 the high-tech enterprises in the park employed 1.898 million people including: 747.000 graduates, 183.400 post-graduates and 18.400 PhDs. Due to the first-class talent pool that already exists in the park, Z-Park is able to lure more and more talents. In line with this view, in 2013 the Z-park mustered approx. 9.000 foreign employees, 18.000 overseas returnees, more than 2.000 foreign-funded enterprises and 260 foreign R&D institutions. Many of the Z-Park's talents have become successful and highly influenced entrepreneurs both home and abroad, such as Liu Chuanzhi from Lenovo, Robin Li from Baidu, Lei Jun from Xiaomi Tech, etc. In addition, Z-Park is also attracting international talents of high-caliber, for example, the former Global Vice President of Google, Hugo Barra, joined Xiaomi Tech; Zhang Yaqin, former Chairman of Microsoft Asia-Pacific R&D Group joined Baidu, etc.

Z-Park has actively collaborated with many globally well-know science parks; it has developed long-term collaborative relationships with ten global areas of innovation including Canada Ottawa Innovation Centre and Sophia Antipolis; and as a member of the International Association of Science Parks (IASP) hosted the 2015 IASP World Conference, which demonstrate the increasing international influence of the Z-Park.

The State Council has approved the *Development Plan Outline for Zhongguancun National*

Demonstration Zone (2011-2020) in which the strategic position for future innovation development and objectives haven been specified, with a general objective to develop Z-Park into an innovation hub and high-tech industrial base with a global influence by 2020. (Participant 2)

4.1.2. The perspective of the Zhongguancun Manager

Like most things in China, Z-park is completely state-owned and the Administrative Committee of Zhongguancun Science Park, which is part of the People's Government of Beijing Municipality, governs the companies within the park and all its sub-parks. The Administrative Committee is responsible for issuing policies for all the enterprises in the science park, however, has no administrative power, therefore the work of the Administrative Committee is completely service oriented, offering a pallet of services to the residents of the park. The only shareholder of the Z-park is the government, while its main stakeholders are URIs and the industry. In addition, privately owned S&T parks are completely rare in China, while some of the science parks are owned by universities or research institutions, which given that China is a socialist country, are as a result state owned as well; a great example of a university science park would be Tsinghua University Science Park (TusPark), which is a world-class university-based high-tech park and by far the best one in China. The Administrative Committee consists of different departments, each covering its own policy area and is responsible for issuing policies in its respectable area, such as marketing, finance, HR/talents, etc. The department where participant 2 works is the international division, which takes care of foreign companies in the park, as well as offers a wide range of services to companies with international ambitions such as financial support for internationalization through "go global" special funds; financial support for going to international exhibitions and for exporting, etc. In addition, the international division organizes classes with experts for the companies wanting to enter another market, while, Z-park's international offices all over the world, help and support companies from the Z-park to set up offices or research institutions in these countries abroad. An additional goal of international offices is to gather/recruit talents worldwide, so that these talents would either join existing companies in the Z-park or set up their own businesses there.

Although government support was definitely a key success factor for Z-Park to become China's leading innovation hub as new STI strategies/policies/programs issued by the government would always firstly be implemented and tested in Zhongguancun before extending them to the rest of China, therefore, Z-Park plays a leading and pioneering role in China. However, according to participant 2, there were several more reasons for Z-Park's success. First of all, since Z-Park is located in the nation's capital it was able to attract an abundance of many good resources both domestic and foreign (talents, capital, etc.). Secondly, it has shaped a unique entrepreneurial ecosystem consisting of six elements, which was undoubtedly an essential foundation for success. Thirdly, all its famous residents and industry leaders made it more attractive than other science and technology parks and also helped to attract resources such as capital and talents. Lastly, and according to participant 2 of greatest importance, is that what both Shanghai and Hong Kong are missing - angel investments. Both Shanghai and Hong Kong are focused on large companies and MNEs and rely on the banking sector as a source of finance, therefore are heavily lacking small-scale finance. Although both of these cities are endowed with many universities like Beijing, which also play an important role in the local ecosystem, participant 2 sees the comparative advantage of Beijing in angel investments in particular. As mentioned before, active angel investment agencies in Beijing accounted in 2014 for 80% of total in China, which is an essential source of financing for micro businesses and SMEs whose development Beijing heavily encourages. In addition, finance related to technology of all sizes is booming in Beijing and these types of finance and availability of capital play a vital role in Beijing. (Participant 2)

4.1.3. Ecosystem and stakeholders

The Z-Park assimilates both Chinese and international technologies, talents, capital and other entrepreneurial elements, thereby forming a unique entrepreneurship ecosystem, which consists of six elements.

1. *Industry leaders*. Z-park's industry leaders are constantly fostering and developing new startups, which are classified into various categories based on the working background of the founder, i.e. *Baidu catagory* and *Lenovo catagory*. These industry leaders play a special role in facilitating entrepreneurship, as well as attracting talents and resources to the Z-park.

2. *Universities and research institutions (URIs)*. Beijing has 14 leading national universities, which is more than in any other city in China and 260 national research centers. In addition to being origins of talents, URIs are incubators of original ideas and technology as well.

3. *Angel investors and venture finance*. Since the development is determined by innovation and innovation is driven by capital, angel investors are a key link in the entrepreneurship ecosystem. In addition, the Z-park is China's most active area for angel investments and its active angel investment agencies accounted in 2014 for 80% of total in China, while their cases represented more than 60% of total cases in China. The Zhongguancun angel investment guiding fund cooperates with 14 sub-funds (i.e. Gobi Partners, ZhenFund, etc.), which has the total volume of capital RMB 1307.84 million and RMB 161.5 million committed capital.

4. *Innovative incubators*. Z-Park has a great variety of innovative incubators with different models and entrepreneurial services. Innovative incubators signify in China a type of incubation where in addition to the mere workspace, a combination of offline and online services is offered to the ones incubated such as coaching, team building, product launching, technology research, financing (micro loans, angel investments, VC, etc.), mediating in finding partners, employees; etc. So far 37 incubators have been recognized as innovative

incubators by the Administrative Committee of Zhongguancun Science Park, while the number of incubators that have not been acknowledged as innovative exceeds one hundred in Beijing. In addition, among all the support from the Administrative Committee innovative incubators also receive financial support, more exactly usually between RMB 500 thousand and RMB 1 million yearly, or in some cases even more.

5. *Culture of entrepreneurship*. Many entrepreneurs fail and unlike in some countries, where failure is seen as an embarrassment which prevents people to become entrepreneurs, Beijing encourages a culture of entrepreneurship with failure as its constituting part. Since the culture in Beijing encourages entrepreneurship and accepts failure, the entrepreneurs even if they fail, go again and again until they succeed. However, this movement has appeared recently in China and was heavily influenced and advertised by the CPC, President, State Council and especially by the Premier Li Keqiang who emphasized that starting a business is not a privilege of the upper classes, but of everyone with a good idea regardless of his or hers background. In Z-Park, there are three main startup forces: executive entrepreneurship, serial entrepreneurship and student/post-1990s generation entrepreneurship, which have become a standard practice and that is the culture. Serial entrepreneurship accounted for 37 % of the three in total, of which 89% have created new start-ups and 33% have merged or received financing. Also, student entrepreneurship plays an important role as well and according to the data collected from 20 incubators, more than 500 university graduates have founded start-ups within the two years after their graduation. In addition, the Z-Park was home to 11 entrepreneurs in 2012, 10 in 2013 and 13 in 2014, which were featured on the famous Forbes list China "30 under 30".

6. *Talents are the main force in entrepreneurship*.

The entrepreneurial ecosystem in the Z-Park, which was formed by the aforementioned six elements described above, has driven the entrepreneurs in China into a new era. It exhibits three major symbols:

1. *Universities have become a hub of entrepreneurs*. Many famous universities in Beijing including Peking University and Tsinghua University actively perform all sorts of entrepreneurial activities, while many of these entrepreneurs are students, teachers and university alumni.

2. *Serial and post-1990s generation entrepreneurship have been Zhongguancun's main driving force*. Many elite post-1990s entrepreneurs keep on leading the wave of China's post-1990s entrepreneurs, while in 2014 there were 13 entrepreneurs from Zhongguancunon on the Forbes China "30 Under 30" list, which is by far the largest number of all the domestic regions.

3. *A new entrepreneurial ecosystem is shaped and dominated by innovative incubators, angel investors and geeks*. Many innovative incubators have emerged in the Zhongguancun,

which are best represented by Innovation Works, 36Kr, Beijing Makerspace and Garage Cafe, therefore Z-Park has crated a new type of business, a so-called entrepreneur services industry.

Z-Park has turned into a driver of economic development in Beijing and plays a leading and demonstrative role in the process of establishing a sophisticated and superior economic structure in Beijing. The added value created by Z-Park's high-tech industries was more than RMB 422.7 billion in 2013, which was a 15.9% increase. These high-tech industries are responsible for 21.7% of total value added in Beijing, contributing at a rate greater than 30% to the economic growth in Beijing and accounted for more than 50% of the total exports in Beijing by achieving exports of USD 33.62 billion, which is a year-on-year growth of 28.5%. Furthermore, one of the main characteristics of the Z-Park is its headquarter economy as headquarter enterprises have produced more than 40 percent of all the revenue generated in the Z-Park. For example, 277 software companies including Baidu and Yonyou have established both their global R&D centers and headquarters in the Zhongguancun Software Park. (Participant 2)

4.1.4. Resources and procedures

Z-park offers various preferential policies to its residents, including taxation, financing, attracting human resources, etc.

Enterprises in Z-park that have been recognized as high-tech enterprise enjoy tax deductions of 10 %, therefore instead of paying 25% of value-added tax (VAT), only 15% of VAT has to be payed, which is an enormous saving, especially when looked at yearly basis from the perspective of the largest companies in the park, such as Lenovo, Baidu and Xiaomi. Since October 1 2014, small-scale VAT taxpayers including enterprises and non-enterprise units, whose monthly sales do not exceed RMB 30.000 are granted a temporary exempt from value-added tax. In addition a similar temporary exempt from business tax is also granted to the enterprises and non-enterprise units, which are taxpayers of the business tax with turnover between RMB 20.000 and 30.000.

The scientific financing system consists of 6 mechanisms including risk compensation; multiple cooperation between the bank, the government and the enterprise; integration of investments, security and loan centered around VC; credit incentives; continuous support; and market selection focused on key points; which are realized through 10 channels: angel investments, guarantee finance, VC, IPO, petite loans, credit, loan and trade financing, finance lease, M&A and agency stock transfer.

Since top talents play an essential role in fostering innovative development, the talents service system was set forth in order to develop a talent zone, which is heavily supported by fifteen Ministries. Various talent programs have been established in order to attract foreign talents as well as Chinese nationals studying/working abroad. Among all, the following programs need to be singled out: the "1.000 Talent Program", which has attracted more than 3.000 talents from abroad of which 904 to Beijing and 705 to Z-Park; the "Overseas Talent Program" attracting 511 talents in total, 306 to Z-Park; the "High-end Talent Program"; the "U30 Talent Program" (under 30 years of age talent program); and "Overseas Returnees Start-Up Fund". Supporting policies for developing, attracting and retaining talents include:

- Distribution of Major Projects
- Import Tax
- Overseas Stock Ownership and "Return-to-Invest"
- Talent Training
- Exchange Settlement
- (Part-Time) Residence and Immigration
- Scientific Funds Management
- Settlement
- Housing
- Funding
- Medical care
- Spouse Settlement

(Participant 2)

4.2. Perspective of an innovative incubator: TusStar

4.2.1. Facts and figures

Tus-Holdings Co.,Ltd. was founded in 2000 from the former Tsinghua University Science Park (TusPark) Development Center established in 1994 and is a large integrated enterprise affiliated to the Tsinghua University, while Tus-Holdings is fully responsible for developing, building and managing TusParks, Tsinghua University Science Parks. During the past two decades of constant development, Tus-Holdings has gained a rich experience in developing and managing university science parks and has actively facilitated the organic interaction between the regional economy and innovative resources. In addition, Tus-Holdings has been establishing a successful innovation system nationwide with the science park as the main carrier. Nowadays, its radial network already exceeds 20 regions and cities, thereby becoming a new force of the innovation system in China. Furthermore, Tus-Holdings has directly invested in and controls more than 200 enterprises with more than RMB 30 billion of total assets under its management. The business model of Tus-Holdings is an innovation trinity of "Industry + Finance + Real Estate", which sets forth an overall objective of the Tus-Holdings to become a Chinese leader and an international model in technology service industry. TusPark under the motto "Limited Space for Unlimited Dream" is a key platform for transferring technological accomplishments of the Tsinghua University and organically expanding its social functions. The mission of the TusPark is to serve as a platform for entrepreneurship and innovation, to provide opportunities and to become a bridge between the economy and technology.

As Tus-Holdings' top-of-the-line product, TusPark Beijing is presently the biggest single university science park in the world and has developed into an essential platform of the Tsinghua University to foster regional innovation and to be of service to the society. Beijing TusPark is situated in the southeast corner of Tsinghua University and in the heart of the Zhongguancun Science Park, covering an area of 25 hectares with a building area of 770,000 squared meters, accommodating more than 600 enterprises and institutions of all types. TusPark is part of the Zhongguancun Science Park and shares a great deal of support from the government, the Administrative Committee of Zhongguancun Science Park, such as preferential policies, the "Zhongguancun Guiding Fund", utilizes some of Z-Parks unique resources gathered worldwide (international offices and cooperation, PR, etc.). However, since the Administrative Committee of Zhongguancun Science Park is just a policy area and does not have the administrative power to govern TusPark, therefore TusPark has its own autonomy and is self-operating, more exactly it is managed and operated by TusHoldings, while Tsinghua University is a 45% shareholder. Furthermore, under the guidance of development theories and its main principles "Congregation, Polymerization, Focalization and Achievement", it has truly become a world-class university science park with the most complete innovation system in Beijing, offering the most comprehensive innovation service system in the Zhongguancun Science Park. Beijing TusPark was essential for the later expansion of TusParks across China, because of the lessons learned and experiences gained during two decades of constant development, making TusPark Beijing into a role-model.

The results of the continuous development of the TusPark in Beijing can be seen in the following facts and figures:

- It is the first "Grade A" national university science park in China authorized by the Ministry of Science and Technology (MOST) and Ministry of Education (MOE)

- More than 1000 entering enterprises
- Annual revenue over RMB 60 billion
- Yearly tax around RMB 4 billion
- 600 high-tech enterprises
- 30 thousand research talents
- R&D investments more than RMB 3 billion
- Over a 1000 patent applications annually
- 13 incubated companies that have gone public

(Participant 3)

4.2.2. Ecosystem and incubation

Moreover, TusPark offers a stepwise approach to incubation, which includes the following incubation modes, except steps 5 and 6 that are intended only for large companies:

1. *Tsinghua Dream Course* is a new program of entrepreneurship and innovation launched by TusPark and Tsinghua University School of Economics and Management. It aims to select students and help them to start their own companies. Since July 2014, it has taken place four times with in total of 73 teams. Half of the teams have started their own businesses, while more than 10 teams have received funding. The total amount of investments awarded exceeded RMB 30 million.

2. *Tsinghua X-lab* was started by Tsinghua University School of Economics and Management with 14 other departments and is an education practice platform for entrepreneurship, innovation and creation offered to the students of Tsinghua University. Under the heavy support of the Tsinghua Entrepreneur and Executive Club (TEEC) and TusPark, more than 300 projects have been registered with more than 5000 students and schoolfellows taking part in the entrepreneurial activities, while 16 companies have already received investments.

3. *TusStar Plan* is a cultivating plan started by Tus-Holdings intended to attract projects worldwide through the intubation style of "incubating services + entrepreneurship training + angel investment + public platform" in order to develop world-class enterprises. Until July 2014 8 TusStar incubators have been established, in which more than 300 new start-ups have

been incubated, and over 200 startup trainings and 50 joint investment activities have taken place.

4. *TusStar Camp* was started by TusPark and is held once a year as an extensive plan for public entrepreneurship and angel investment, as well as a showcase of TusPark's innovation service ability. In addition, it is a major matchmaking event where TusStar's residents can present their projects in front of numerous investors and thereby attract investments. Prior to July 2014 the number of teams enrolled in TusStar Camp exceeded 1000 and more than 200 investors with billions of RMB in funds were attracted.

5. *Diamond project* was established in September 2006 by TusPark which follows the main principles "Congregation, Polymerization, Focalization and Achievement" in order to produce enterprises with cutting-edge technologies and industry leading positions. The project chooses prospective enterprises from TusPark and previous to July 2014 5 groups of 36 diamond companies have been picked, of which 9 have gone public, 5 have merged and many have begun or finished share reform.

6. *Listed companies*. During the past 20 years TusPark 13 companies have gone public like Sumavision Technologies, Highlander Data, Spreadtrum Communications, while Eben, Smartdot and 3 other companies have been merged.

Tsinghua Dream Course is only offered to the students of Tsinghua University, for Tsinghua X-lab, at least one member of the team must be a Tsinghua University student, schoolfellow or alumni, while for TusStar Plan and TusStar Camp teams from allover China can apply. Participant 3 said that currently in China entrepreneurship is heavily promoted by the government, so students and professors are inspired to devote themselves to become entrepreneurs and start companies. Dream Course plays an important role in encouraging students to become entrepreneurs at Tsinghua University. Furthermore, Dream Course is different from other courses in a way that there are a limited number of places for students, which have to go through evaluation and interviews, thereby only the most promising students are filtered out and chosen. In addition, there are even some entrepreneurship courses, practices and exams available as regular university courses at Tsinghua. Graduates of Tsinghua University who want to start their own businesses are entitled to various benefits, for instance all services related to company registration (including waiver of company registration fees) are for free within the first year of graduation, while a 50% discount is given during the second year after graduation. As a result, 40% of the entrepreneurs in the TusPark are students, graduates and schoolfellows from Tsinghua university.

TusStar innovative incubator program was established by Tus-Holdings to solicit entrepreneurial projects which either have technology-based business model or leading innovation technology. TusStar reviews and then picks superb entrepreneurs with excellent business models offering them "incubation service + entrepreneurship training + angel investment + open platform" as well as other means of support. It plans to find and support innovative projects; to train the prominent talents in entrepreneurship; promote technological entrepreneurship and innovation; supply outstanding enterprises for the "Diamond Plan"; and lastly foster "world-class enterprises". By July 2014 there were already 4 TusStar professional incubators in Beijing covering an incubation area of 10 thousand square meters: TusStar Incubator of Mobile Internet, TusStar Incubator of Nanotechnology, TusStar Incubator of Internet Finance and TusStar Incubator of Energy Conservation and Environmental Protection, while each of them primarily focus on one industrial sector, however, through different models:

- Collaborating with one or up to few leading companies, i.e. China Mobile, Huawei, Tsinghua Solar, etc.
- Obtaining government support, such as of the New Materials and New Energy Office of Beijing Science and Technology Commission.
- Cooperating with the university research institutions (URIs), for example, Tsinghua PBC (People's Bank of China) School of Finance.

TusStar incubators access various resources such as industries, universities, governments, research institutes, etc. to support startups to carry out "Congregation" and "Polymerization" in their proprietary industry areas, as well as "Focalize" and "Achieve" a group of remarkable enterprises by utilizing 20 years of experience and the incubation model "incubation service + entrepreneurship training + angel investment + open platform". TusStar's incubation services have been continuously updated during the years of operating and therefore TusStar offers a one-stop incubation services built on an Open Service Platform and established innovative entrepreneurial environment consisting of eight elements: industry, university, government, finance, research, intermediary, media and trade. TusStar's Open Service Platform includes the following platforms.

1. *Financial service platform* depends on the TusPark Financial Group. The incubator has established an integrated system with credit operations, direct investments, investment-banking business, as well as comprehensive financial services, which provide holistic financial services to S&T innovation-oriented enterprises.

2. *Angel investment platform* during its 20 years of work in incubation investments it has accumulated a remarkable experience in gathering resources, offering entrepreneurial services and attracting investors. It not only provides supporting funds for startups, but also overall equity financing services for all types of incubation, such as seed investments, angel investments, consulting for merger investment, etc., as well as focuses on value-added services related to investments, in example, business model design, equity financing, etc.

3. *Intellectual-property platform.* The State Intellectual Property Office (SIPO) has authorized TusPark among the first as a "Communication Station for Company Patent Work". In addition, the incubator further integrates industrial resources and professional institutions in

order to offer extensive intellectual property services for its residents.

4. *Covert and taxation platform.* This platform helps new startups with new business registration, taxation and fiscal management, various administrative affairs, etc. in order to save company's time and let them focus on their work, therefore enhancing their competitiveness.

5. *Training and education platform* incorporates management training resources in order to offer management training and reeducation to the enterprises. Moreover, the incubator offers weekly, monthly and yearly trainings. For example among the all are, "Common lecture on policy, technology and management" every Thursday afternoon; "Connecting Investors to Excellent Entrepreneurs" every Friday afternoon, while "A Club for the Peers of Entrepreneurs", which facilitates the exchange of ideas between entrepreneurs takes place once monthly; and "TusStar Demo Day" which is a showcase of remarkable incubation results and matchmaking between entrepreneurs and investors, are organized once quarterly.

6. *Human resource platform.* The incubator assists companies in recruiting talents by posting information to major hunting sites; organizing job fairs on campus; human resource policy seminars for enterprises, etc.

According to participant 3, the biggest advantage of TusStar in comparison to the other innovative incubators in the Zhongguancun Science Park are the resources from the Tsinghua University. Tsinghua University, not only serves as a vast pool of entrepreneurs and talents, but is also essential for knowledge and technology transfers. Tsinghua University is a well-known example in entire China and the government encourages other cities in China to learn from Tsinghua university, its entrepreneurs, innovators and entrepreneurial environment, so that they can develop their own entrepreneurial environments in their provinces and cities. Although from the policy aspect TusStar shares the same policies with other innovative incubators in the Zhongguancun Science Park, TusStar is a business incubator focusing on incubation and seed investment. Unlike other innovative incubators which offer incubation to companies that they have invested in, TusPark offers incubation to every company regardless if they have or haven't invested in it. TusStar first incubates a company, then evaluate its performance and their prospects for future growth, and then decides afterwards whether to invest in the company or not. Sources of financing/investment depend on each case, however, TusStar offers various types of investments to the incubated companies depending on its development stage such as venture capital, angel investments, micro loans.

During the past 20 years, there were many enterprises incubated, some of which have become successful enterprises. For example, Sumavision (Beijing Sumavision Technologies Co., Ltd) is the leading system integrator and provider in the radio and television digital field in China; Highlander (Highlander Data Technology Co., Ltd) is a leading Chinese marine electronics and naval defense information technology company; ChineseAll (ChineseAll Cultural Development Co., Ltd), is a pioneer in Internet publication and the leading domestic communication agency for copyrighted digital content; etc. (Participant 3)

4.2.3. Perspective of TusStar's entrepreneurs: Selected best cases

4.2.3.1. Participant 4: CEO of Randian

Randian is a startup company incubated at TusStar Incubator of Mobile Internet. Their product is an O2O (Online-to-Offline) web application based on HTML 5. Randian helps to connect users with coaches of various sports, who can organize a class for the user or even come to their office or home (depending on the sport of course). Therefore Randian can be seen as a "rent-a-coach" platform for people to learn or practice sports. They are currently focusing on gym, running and yoga, however, plan to expand their offer to cover all feasible sports. The idea for the company is mostly based on the hobby of participant 4 and on her personal interests as she loves sports and is a sporty type. Randian is already her third startup, while participant 4 established her first startup during her graduate year. When participant 4 was asked what motivated her to become an entrepreneur instead of settling for a secure job and a regular paycheck, she responded the following:

> *I think it's just my way. I like creating and building new things. I love freedom, I love my team and doing something with my friends. (Participant 4)*

In only 2 months since the company was established, it has already managed to get incubated at TusStar, receive funding of several million RMB and go to the market with their product. In addition, Randian has mustered in this short-term period a team of nearly 20 full-time employees, some of which were her classmates at Tsinghua University where she majored in software engineering, while others have even quit their jobs at Baidu to join her startup. According to participant 4, TusStar has helped her to start her own company in various ways by giving her office space; helping her with legal such as new business registration, taxation and fiscal management, various administrative affairs; providing angel investment from TusStar; offering entrepreneurship training and training related to her project, etc. Although TusStar offers a comprehensive set of services, participant 4 experienced difficulties in finding employees and team members, which was time consuming and everything had to be done by herself as it was not covered in TusStar's existing services. In addition, participant 4 says that despite the presence of many universities in Beijing, it is hard to find a person fit for the job and faithful, someone with high potential, since most of the students and graduates want to join a big company rather than a startup. However, participant 4 said that the presence of other companies in TusPark, especially large ones and MNEs, does not affect her business regardless of the fact that the larger companies can pay more and therefore pick the best talents, participant 4 believes that startups have something that big companies cannot offer, which is why some of her employees quit their well-off jobs at a large company such as Baidu.

participant 4 found out about TusPark at the university when she was a graduate student and the main reason why she chose TusPark/TusStar among the many innovative incubators in the Zhongguancun Science Park is because she graduated from Tsinghua, while there are several additional reasons, such as it is very convenient with a comprehensive set of services for entrepreneurs; she lives nearby and given the vast size of Beijing, living near where you work can be considered as a luxury; the "human touch", as she can ask for help and advice, and even if the incubator does not have someone among the staff who could help, they will find an expert to help her.

As for the future plans, participant 4 hopes to achieve every entrepreneur's dream that her company becomes famous and goes public. In addition, as Randian is collaborating with Baidu at the moment her big wish is that one day on the homepage of Baidu's mobile website a link to Randian would be on it. (Participant 4)

4.2.3.2. Participant 5: Co-founder of Holonet Security

Participant 5 is the co-founder of a startup company called Holonet Security, which focuses on cloud computing security for enterprises. The company was established a year and half ago and was the first company incubated at TusStar Incubator of Mobile Internet. Participant 5 has more than 20 years of work experience in network security, of which more than 10 years in the Silicon Valley where he worked for major IT security companies. Participant 5 explains that he worked for network security companies for a long time and that he has decided to start his own company in order to pursue his professional interests. However, this company is different from many other startup companies in China because it is not focused on the vast Chinese market, rather on the market in North America, primarily the US. Participant 5 clarifies the rationale is that in China working in cloud computing security implies that the government is the biggest customer and not the enterprises. Holonet Security is run by participant 5 and his partner; his partner is located in the Silicon Valley where he focuses on doing marketing for the company, while participant 5 is the head of operations in Beijing. The motive why Holonet Security established operations in Beijing is because of the need of a technical-intensive environment with many engineers and since there are numerous engineering universities in Beijing, some of which even well-renowned, Beijing was an obvious choice.

The reason why participant 5 has selected TusStar merely because he graduated from Tsinghua University, although he says that should not be a good enough reason for someone to choose TusStar, rather its qualities which differentiate it from other innovative incubators in Beijing. Participant 5 had a previous experience with startups before, which he described as horrible as he needed to do everything by himself including: finding an office, finding investments, hiring people and assembling a team, etc., which occupied more than 60% of his time, therefore he couldn't focus on his core business. Unlike his previous startup experience, TusStar lets him focus 100 % on his business, since they provide (almost) everything else for him. In addition, TusStar provided many benefits for participant 5, including office space and various services such as finance, even some services related to human resources, etc. However, participant 5 states that there are 3 most important things for every startup: 1. Team, 2. Marketing and 3. Capital, but has not received many help with these three priorities from TusStar. Participant 5 has identified the following missing services which are in line with the three priorities of every startups: help with hiring students and graduates from Chinese universities, how to offer internships and get interns, how to hire and retain people in general, especially young people; help with marketing, clients and introducing to other companies; assistance with finding capital, etc. Participant 5 hopes that TusStar will extend its current set of services and that these aforementioned missing services TusStar will have in the future. Although in his line of work, the minimum requirement are engineers with at least 2 years experience in the industry and he cannot depend on new graduates from Tsinghua University nor any other university, however, he believes that TusStar is missing services related to Tsinghua University and it should be more easier to access its resources, especially its human resources. Furthermore, Participant 5 notes that sometimes it is not easy to get a reply from TusStar when one has a specific question. Interview 2 has experienced an issue at TusStar, although not as big, but nonetheless important for his business and that is the issue of Internet bandwidth and connectivity. He has raised this issue 3 months ago, however nothing happened and the Internet connection still breaks from time to time. Participant 5 has a clear vision what he needs to do, his market position is quite clear, his product definition is well-known, but does not have the necessary resources to finish his work. Moreover, participant 5 is especially lacking quality engineers and prior to the interview has spent almost 2 hours interviewing potential employees. Participant 5 adds that human resources are not an individual problem, but a problem shared by all startups and small companies.

As a last question participant 5 was asked if he could point out the differences between the Silicon Valley and TusStar based on his experience. Participant 5 explains that these are completely different. First of all, unlike the Silicon Valley, TusStar was formed by government intervention and the entrepreneurship culture is endorsed and heavily influenced by the government as well. Participant 5 adds that in China incubators are at an early stage and still a lot needs to be done. Secondly, according to participant 5 the incubators in Silicon Valley offer a limited number of spaces for startups, which are heavily focused on the generation of new value and creation of novelty, therefore the incubator can provide specialized services to every company and give them the attention the companies need. In addition, in his opinion, it is a matter of quantity vs. quality and he thinks that TusStar cannot offer the same quality of service to its 600+ companies as the incubator in the US which is focused on a smaller number of startups. Lastly, although many have tried to copy the environment and the culture from the Silicon Valley, he believes that it cannot be disseminated in any other contexts. (Participant 5)

4.2.3.3. Participant 6: CEO of ZhongDu Technology

Participant 6 is the CEO of ZhongDu Technology, a travel-related startup founded one and a half years ago and also incubated at the TusStar Incubator of Mobile Internet. When participant 6 was asked what motivated him to become an entrepreneur and join China's entrepreneurship movement, participant 6 replied that he was working for various companies during the past 20 years, while his last employer was China's Internet giant Sohu.com, where he worked as a manager, and that he wanted to be the boss of his own company and pursue his personal interests by doing what he really wants instead of working for others.

Participant 6 has chosen TusStar for several reasons. First of all, he graduated from Tsinghua University. Secondly, the headquarters of his last employer Sohu.com is also in TusPark, which made him well aware of TusStar and its benefits. Secondly, participant 6 believes that both the environment and the culture in the TusPark are perfect. Lastly, TusPark is very famous and well recognized in China, and is among the best and most popular science parks in Beijing. In addition, participant 6 is of the opinion that TusStar can provide more professional services than any other innovative incubator in the Z-park and that TusStar provides enough services to his company. As a result, he can focus merely on his work, while TusStar does everything else, thereby helping to cut time-to-market. Although, participant 6 thinks that TusStar offers a comprehensive set of services and many of which have been provided to his company, however, he misses one service in particular and that is help with human resources, such as finding/hiring employees. Participant 6 explains that it has become hard to find a student eager to work for his company and faithful to the job as most students in China look for employment in large companies and MNEs as soon as they graduate. Participant 6 clarifies that this phenomenon is related to the Chinese cultural background and the common belief that large companies offer secure jobs and a clear future, unlike SMEs and startup companies. Even if his startup would pay graduates more and even give some other benefits that large companies do not give, the students would nevertheless choose to work for a large company instead. In addition, as more high-tech companies are setting businesses in Beijing, the salary level has gone up and giants like Lenovo, Baidu, Xiaomi, Ali, etc. as well as other MNEs can offer higher salaries and therefore pick the most promising talents first, making it even more difficult for startups. (Participant 6)

4.3. Perspective of an innovative incubator: Beijing Makerspace

> *Maker spaces, providing modern facilities in a low-cost environment with the onus on efficiency to encourage public entrepreneurship, play a significant role in fueling the economy and creating jobs. Premier Li Keqiang at a State Council executive meeting on Jan 28, 2015. State Council of P.R.C. (2015)*

The State Council is appealing for mass entrepreneurship and innovation to create a new era of the Chinese economy. China is transforming its pattern of development for innovation to become the main driver of economic development and for the Maker economy with the "Mass Maker Spaces" to be in the center of it all. The "Mass Maker Space" is referred in China as a specific economic platform, which is heavily encouraged by policy makers to foster more innovation hubs, venture capitals and entrepreneurship to propel innovation in China. Premier Li Keqiang, President Xi Jinping and the State council, have all heavily promoted the "Mass Maker Space" as a new platform for innovation and fostered the maker culture nationwide by pushing forward valiant reforms and providing supportive policies and measures for their development (State Council of P.R.C., 2015). In line with this view, participant 1 confirms that Makers are very popular now in China, especially because of the Premier Li Keqiang. Premier Li Keqiang encourages Makers in particular and visited the Innovation Street in Zhongguancun some weeks prior to the interview, where among all the Beijing Makerspace is located, to see how the entrepreneurs and Makers are doing. Although the concepts of makers and entrepreneurs are often mixed in China, nonetheless what the government really wants is for more people to start their own businesses, which will in turn open new jobs for people (in urban areas).

> *Before, not everyone had the guts to start their own business. Maybe only graduates from really good schools, someone with a lot of savings or someone who has really good connections could have their own business. This was the original stage. Nowadays, they call on the people called "the roots of the grass", people that don't have money, that don't have good connections and that even don't have good education and are pushing those kind of people to start their own businesses. Because everyone can have a dream. (Participant 1)*

In addition, as mentioned before, the Premier heralds a new age of creativity, which he has also expressed during the visit to the Zhongguancun's Inno Way, or Innovative Street, on May 7 2015.

> *Entrepreneurship is not the privilege of a small group of people, but the choice of many people. In fact, the general public know better than us about what people need, and that is exactly the essence of public innovation. The spirit of innovation includes credibility, which is an integral part of doing business. State Council of P.R.C. (2015)*

Furthermore, according to participant 1 the culture plays an important role in fostering entrepreneurship in China, as the Chinese people have their "face". The "face" makes reference to one's individual perception of prestige or dignity in social contexts. Their face is money and it is the main thing everyone believes in, therefore one's face can universally be measured with money. As a result, money plays as a strong incentive and is a way of differentiation from others. For example, having startups is such a way to differentiate from others and stick out of the crowd, especially for children who want to present themselves differently, as adults. People having startups at an age of 15 or 16 is nothing new in China as these younger generations are not afraid of failure and are determined to keep on trying until they succeed. In addition, participant 1 points out that older generations were more worried about how to get a job and earn money to feed their families, while the new generations, ones born after 1990s do not worry about such things because parents support them for a long time. Consequently, it is much easier nowadays for people to have their own businesses at a really young age. Although, these younger generations believe that they can easily get a job somewhere, which sometimes is not true, they still possess that kind of confidence.

Nowadays there are numerous Makerspaces all over China with each one of them having distinct features and characteristics. Besides the Beijing Makerspace which is the largest in Asia, according to participant 1 there are two other Makerspaces in China worth mentioning: "The new factory" in Shanghai and "Chaihuo" in Shenzhen. Although, new Makerspaces are popping up across China every day, but differences between Makerspaces exists. For example, "The new factory" Makerspace in Shanghai is run by a small group of Makers who focus heavily one events for the public and charge a high price for such events. Apparently they already have a large Maker community in Shanghai, so people are willing to pay a lot of money to join their events. Another interesting example of a Makerspace in China, which employs a completely different approach is the "Chaihuo" Makerspace in Shenzhen. Chaihuo Makerspace is the first Makerspace in Shenzhen and was created and sponsored by the component manufacturing company Seeed Studio, which is why it attracts many DIY enthusiast and entrepreneurs. The company Seeed Studio provides the Makerspace with everything necessary in order to encourage Makers to come to the space and create new things, so that they can use their components and put them on the market. Moreover, since Shenzhen is an important manufacturing hub, the Shenzhen Government is putting a lot of effort into Makerspaces, investing plenty of money and creating preferential policies for Makers as they want to attract more Makers making things, so that the entire supply chain in Shenzhen can be utilized. An example of a such preferential policy is giving incentives for establishing Makerspaces in Shenzhen, which includes RMB 5 million for creating the Makerspace and the office space/rent, an additional RMB 1 million if the Makerspace has reached a certain standard and RMB 3 million for the equipment and furnishing. However, the government is not naive and first you need to prove, build the space and demonstrate that it works, then the funds are given. In addition, if the Makerspace would have many teams incubated and real projects, even more money would be awarded by the government. The premier Li Keqiang visited the Chaihuo Makerspace in Shenzhen, Guangdong province on Jan 4 2015, emphasizing its significance.

> *Your innovative thoughts and products have shown the dynamics of entrepreneurship that will provide the enduring power of economic growth in the future. State Council of P.R.C. (2015)*

Today, there are already many Makerspaces in Beijing, however, the Beijing Makerspace, which was established in 2011 is one of the first Makerspaces in both Beijing and China. The Beijing Makerspace was started by a group of enthusiasts calling themselves "Makers", working in a garage/storage place on the outskirts of Beijing and has grown into the largest Makerspace in China, but also the largest in entire Asia as well. It is a membership based organization, which is privately owned by several founders and investment companies. It is a place for people to work on their hobby projects, to learn new skills and expertises, and work on individual or group projects which can later be incubated at the Makerspace. Membership fees of RMB 100 per month, RMB 200 per quarter or RMB 1000 a year need to be payed for people to join, which are a real bargain, given that this humble price includes the use of all the tools and equipment in the facility including the workshop, laser cutter, various 3D printers, etc., having his or hers own space and a locker, borrowing books in the Makerspace library, having discounts on paid events, getting technical support and even some of the materials. Beijing Makerspace already has more than 300 members that pay membership fees and over 10.000 subscribers on newsletters and wechat. In addition, they have a base of around 1.000 people that don't have projects but join events, classes and workshops from time to time depending on their interests. However, one of the main reasons why their membership fee is so cheap is to attract more people to join, especially young creative people necessary to create a large Maker base, which is currently lacking in the Makerspace. They regularly host free events opened to the public, free of charge, such as inviting famous company founders to talk about their companies, which are usually interesting for the public or free workshops to lure new people in. According to participant 1, every of these events attract at least 200 people, some of which will either become new members or will follow/subscribe, thereby helping to spread the word.

Besides the classic services related to incubation like accounting, legal, financing, PR and media support, the Beijing Makerspace offers access to supply chains in Shenzhen for manufacturing/production, education and technical support, funding by crowdsourcing through kickstarter and indiegogo with whom they have established good relationships. However, the Beijing Makerspace can accommodate and incubate groups up to 5 members, once the project becomes bigger with more group members, they move out and choose a real office. In addition to being a creative space and offering the aforementioned services to their members, the Beijing Makerspace organizes various events and provides Maker education through the Maker academy operated by participant 1. The events organized by the Beijing Makerspace are numerous and attract all kinds of people, such as Maker camps; Open days, when they invite the public to see what the Makerspace is all about; Critical lab, a workshop for children to teach them how to make things by combining new techniques in education and new technologies; Maker academy, which offers regularly classes on weekends to all age groups with topics varying from iOS and android application development, learning how to use 3D printers to Arduino boards; Hackathons, usually sponsored and supported by companies, which set a challenge/problem and the contestants have 48 hours to solve it. So far they have organized three major hackathons sponsored by Intel, Lenovo and Haier. The biggest event of the year is the Maker Carnival, which is the largest Maker fair in Beijing and also one of the largest in China, intended for Makers and innovators to present their work. the Maker Carnival was Launched in 2012 and has entered its third year. It takes place once a year on October 2nd-3rd at the famous 798 art district in Beijing. During these two days last year the Maker Carnival has attracted more than 100.000 people.

As for the business model of the Beijing Makerspace, participant 1 explains that they are currently at the Makerspace 3.0 stage and that they have changed their business model several times over the years, this being the third time. Since there is a high demand for Makerspaces in China and the Beijing Makerspace has received many requests from people all over China wanting to open Makerspaces in their towns and cities, the company is selling its Makerspace franchises, which is one source of revenue. The Beijing Makerspace is only the headquarters of the company, while there are several other Makerspaces across China in Tianjin, Qingdao, Shanghai and Hong Kong. Some of these Makerspaces were opened by the company itself, while some of them are franchises opened by local governments or companies. The company sells the plan how to set up a Makerspace and their consulting services to the client. In addition, all the events that the Makerspace offers are branded and the client needs to pay to use them. Additional sources of revenue include events, Maker education, memberships and incubations, consulting/organizing classes for companies and schools, and selling kits/products produced by the Makers. However, challenges to make the Makerspace sustainable and profitable still exist. Although the space offers everything necessary for the Makers, as noted before, they are lacking a consistent large Maker community, or in other words they need people to come in and make things regularly. As members usually leave once they get a job or once their project grows, a big community of Makers is essential to spur sustainability and in turn profitability for the shareholders, which have invested a lot of money, to gain returns on their investments. The Beijing Municipal government has recognized the importance of the Beijing Makerspace and has given them various awards and big titles such as "a creative new type of incubator". Although Government support is not essential for the Beijing Makerspace, it has played an important role. The entire Zhongguancun area belongs to the government and the building in which the Makerspace is located as well. Therefore, the 1.000 square meter space in which the Beijing Makerspace is currently located, was given by the government for free, but only for 3 years. After these 3 years are over, the Makerspace will have to pay the rent, which is a way of encouraging them to become profitable. Before the government used to give money in advance and people usually did not do any work, as a result, nowadays the government first expects results and then rewards them, which is also true for the case of the Beijing Makerspace as well. Usually when the Makerspace does a project, organizes an event etc., some money would be awarded from the government after their successful completion as incentives/bonuses with which they can cover parts of the costs. The Beijing Makerspace cannot fully depend on the government, but can get reimbursed for some of the expenses they have. In addition, in order to receive any further funding from the government, the government needs to see that the Makerspace is working and creating profit.

In addition, quite a few of today's successful companies were started at the Beijing Makerspace, among these are Emie, PICOOC, ROLI, Intartic, IKair and probably the most well-known company is ANTVR with its product ALL-IN-ONE Universal Virtual Reality Kit that offers crystal clear virtual reality gaming and viewing experience, was funded on kickstarter[1] and has achieved international success. (Participant 1)

[1] https://www.kickstarter.com/projects/805968217/antvr-kit-all-in-one-universal-virtual-reality-kit?lang=en

5. Lessons learned

In this chapter the lessons obtained from the research on the Beijing context will be presented and discussed.

5.1. China

There are numerous lessons one can learn from China's transition, however, one has to also take into consideration the uniqueness of the Chinese context as after all China is a single-party state and one of the last remaining socialist countries in the world. Therefore, one has to bare in mind these limitations, however, the lessons learned from this study highlight the concrete measures the Chinese government and institutional environments in Beijing have taken to foster innovation, which are, nevertheless, also applicable in other contexts and could thus serve as a role-model for countries on the wrong side of the innovation divide. In this respect, the study hopes to make a contribution to the understanding of strategic innovation development by focusing on a context which has made significant progress towards an innovation-driven economy.

In the mid-1990s China started to transition from the traditional development, which was heavily depending on exports and investment in fixed-assets to a more higher-quality, knowledge-based growth driven by innovation (Fu, 2015). From that time a national policy of indigenous innovation was embraced with intent to assist the Chinese enterprises to have a strong-point in key technologies. Indigenous innovation makes reference to enhancing the national innovation capability by improving original innovation, integrated innovation and re-innovation on the basis of absorption and assimilation of imported foreign technology. Although mere import of foreign technology without stressing absorption, assimilation and re-innovation is destined to impair national indigenous R&D capability, which as a consequence broadens the gap with the advanced nations, China imported an enormous amount of foreign equipment and technology since it started to reform and open up to the world, which, however, played a significant part in fostering the economic development of the nation and increasing the general level of the industries (State Council of P.R.C., 2006). However, ever since China has worked extensively to eliminate its costly dependence on foreign imported technology by forming a national technology infrastructure. (Gao, 2015) Nowadays, China is in an ongoing transition into an innovation-driven economy. The outcomes of China's transformation into an innovation-driven economy are not only visible, but can be measured as well. China has produced remarkable results, which resulted in its placement on the global innovation landscape. Today, China is the largest economy in terms of trade and the second largest in terms of GDP in the world. Despite the recent global economic recession which severely hit other industrialized economies, China managed to maintain a fast growth rate (Fu, 2015). This economic growth at a remarkable pace can be greatly explained due to the consistent reforms over the last past decades and new regulations that have fostered the development of high-tech firms and loosening of prior policy pressures (Guan et al., 2009). Progressively favorable governmental policies, low labor costs and the high potential of China's growing market, attracted many multinational enterprises (MNEs) and FDIs in various industries, such as automotive, petrochemical, biotechnology and many other (Fruin et al., 2012).

As previously mentioned, the role of government in innovation has been of great interest to policymakers and innovation policy/strategy researchers worldwide (Guan and Yam, 2014) as regulatory infrastructure established by the government and its underlying laws and regulations in particular, give the needful assurance that the enterprises necessitate in order to invest innovation. In other words, innovation is greatly impacted and influenced by the institutional environment, since poor institutional rules can lead to corruption and thereby could hinder innovation (Shah et al., 2015). Moreover, governments together with the industry and URIs form the three core actors of a NIS (Chen and Kenney, 2007). In most developing and newly industrializing countries indigenous national innovation initiatives often lacked funds, therefore required governmental interventions. Government interventions can have a considerable impact on the economy and the implications are especially far-reaching in the developing nations where financing and credit are both challenging to receive, markets are obscure, bureaucracies more grave and the government intervention itself is more widespread than in developed nations (Shao et al., 2015). In the context of the national innovation systems, governments play a key role as coordinators and as main drivers to compensate for the shortcomings of the companies. As a result technological progress was often formed by government interventions. Correspondingly, governmental support has been proven to be crucial for the late-coming nations in order to catch up in innovation, which is also true for the case of China (Gao, 2015).

There are various ways in which a government can promote innovation and aid domestic enterprises to gain innovation capabilities, such as by using tax incentives, government procurement, governmental financial support of projects to increase the motivation to innovate (Shah et al., 2015), establishing Science and Technology (S&T) parks, investing in R&D, driving technology standardization, etc. Like many other developing countries, China also had a weak foundation of technology innovation and quite a long history of importing foreign technology, hence, the government had to take a leading role in the standardization of such an enormous and complex technology system. An example of such case would be the development of the wireless system in China, which was supported by national R&D project funding of the Chinese government (Gao, 2015).

However, a principal characteristic of the Chinese governmental system is an extremely centralized government and therefore highly centralized decision making. The central government plays an essential role in fostering S&T development by mustering and coordinating national resources. China's twenty-two provinces, four municipalities, five autonomous regions and two special administrative regions are all under the leadership of the central government and have identical systems of governance, while each region has a regional government that administers local economic development and innovation (European Commission, 2015). The primary organs of state power in China are the National People's Congress (NPC), the President and the State Council, which hold all the power in China. The State council, which is the highest State Administrative Organ in China, is empowered with many rights, for instance, passing administrative measures, issuing administrative regulations, etc, however, in relation to STI, it can be considered as most relevant of the three aforementioned organs as it manages and guides the affairs of education and science among all (National People's Congress of the P.R.C, 2013). More precisely, the administration mechanism of China's national S&T system is the National Steering Group for S&T and Education in the State Council, which coordinates all activities related to innovation, education and research (European Commission, 2015).

The main findings of the study have shown that governmental support has played a leading role in the development of STI in China. Specifically, the role of the government in development of STI has been manifold and the government has been central in:

- Issuing important plans and guiding policies documents for STI such as the National Medium- and Long-term Program for Science and Technology Development (2006-2020) and the Twelfth Five-Year Plan for National Economic and Social Development of the People's Republic of China (2011-2015), which are currently the main guiding policies in force (State Council of P.R.C., 2006).

- Coordinating significant relationships between various governmental departments, local governments and the central government, concerning education, science, technology and innovation (European Commission, 2015).

- Passing, amending and altering laws and regulations to reinforce and support the development of STI, including the Trademark Law, the Copyright Law, the Patent Law, the Law of the People's Republic of China on Popularization of Science and Technology and many other (Ministry of Science and Technology (MOST) of P.R.C., 2015).

- Establishing S&T parks. Including the Z-Park, there are already 114 national high-tech zones in entire China (Participant 2).

- Issuing various S&T programs such as the National High-tech R&D Program (863 Program), National Key Technologies R&D Program, National Basic Research Program of China (973 Program), Torch program, 211 Program, Spark program, etc. (Ministry of Science and Technology (MOST) of P.R.C., 2015).

- Implementing measures to enhance and foster indigenous innovation capability like Government Procurement Favoring Indigenous Innovation, Intellectual Property Rights Strategy and Technology Standards Strategy, Financial Policies Encouraging Innovation and Pioneering, and so on (State Council of P.R.C., 2006).

- Promoting a culture of innovation and entrepreneurship in order to "fuel" the next era of China's economic growth (State Council of P.R.C., 2015).

As previously stated, the National Medium- and Long-term Program for Science and Technology Development (2006-2020) and the Twelfth Five-Year Plan for National Economic and Social Development of the People's Republic of China (2011-2015) are currently the principal guiding policies in power.

The Twelfth Five-Year Plan for National Economic and Social Development of the People's Republic of China (2011-2015) is a master plan of China's economic and social development over the 12th five-year period, which is crucial for building a moderately prosperous society in all respects, depending reform and opening up. The Twelfth Five-Year Plan sets forth a broad range of main goals in order to react to the global developments and the implications of the global financial crisis, to meet the objective of creating a moderately prosperous society in all aspects by 2020 and to consider future trends and conditions. Some of the major aims for this five-year period are to: increase education retention rates to 93%; heavily enhance the level of education and S&T; raise GERD to 2.2 % of GDP; increase GDP annually on average at a rate of 7%; constantly improve the lives of people, while maintaining the population at 1.39 billion, among all. While the plan comprehensively addresses a broad range of topics with its 16 parts and 62 chapters, Part 7: Be Innovation-Driven: Implement the Strategies of Reinvigorating the Country Through Science and Education and Strengthening the Country Through Human Resources, which heavily emphasizes the importance of innovation and the development of an innovative country, is directly relevant for this Master thesis and the scope of this study (Ministry of Science and Technology (MOST) of P.R.C., 2014).

The National Medium- and Long-term Program for Science and Technology Development (2006-2020), considers the first 20 years of the 21st century as a period of significant strategic importance for the progress of S&T, as well as social and economic development of China. The plan is based on the fully-fledged establishment of a well-to-do society and speeding up the drive of socialist modernization, while the primary and principal task is to establish an environment favorable for attracting and developing S&T and revitalizing the nation by the means of education, science and talented people. The overall objectives of the national development of S&T (2006-2020) are to: clearly increase indigenous innovation capability and the level of S&T in order to powerfully support the establishment of a well-to-do society; enhance the in-depth strength of basic research and frontier technology development; achieve a series of S&T achievements with global impact; join the ranks of innovative countries and as a result become a world S&T power by the middle of the 21st century. In order to meet these ambitious goals, the plan sets forth the deployment of the following S&T endeavors: implement 16 special major project, which are aligned with national goals, and which will enable filling up the blanks or leaping development; 11 areas of high priority for social and economic development comprising of 68 priority topics with explicitly defined objectives are determined in accordance to the national tangible needs and conditions; 27 frontier technologies in 8 technological fields are selected, 18 fundamental scientific issues are prioritized and the implementation of four major scientific research programs is suggested in order to react to the challenges of the future; intensify the reform of the S&T system by refining policies and measures of great relevance; raise investments in S&T; reinforce the development of S&T talents; and lastly and especially important, foster the establishment of a national innovation system (NIS) to ensure dependable assistance for China to become an innovation-driven society.

> *The national innovation system is a government-led public system which gives full play to the basic role of the market in resource allocation while letting various innovation players forge close links and interact with one another. (State Council of P.R.C., 2006, p. 52)*

Although, the reform of the national S&T system has achieved significant breakthroughs and considerable progress since the beginning of China's opening up to the world whilst forming close links with the economy, in order to reinforcing technological innovation, transformation and industrialization of S&T performance, organizational realignment and undertaking a series of major reformatory measures. However, at that time the existing S&T system in China was incapable of fulfilling the demands of the economic and S&T development. Therefore, the plan calls for strengthening the reform of the S&T system which are specified as follows: foster the fully-fledged development of a national innovation system (NIS) embodied with Chinese characteristics; focus on the efficient distribution of S&T resources and their broad integration; establish an enterprise-led technological innovation system, which involves the integration of academia, industry and research, in order to considerably improve the building of a unique Chinese NIS and immensely upgrade the indigenous innovation capability of the nation.

Presently the building of the "NIS with Chinese characteristics" is fully underway, which is to stress the following:

1. Construct an enterprise-led technology innovation system including universities, research institutes and enterprises.

2. Facilitate the cooperation and sharing of resources between universities and research institutes.

3. Set up a national defense S&T innovation system that emphasizes the mixture of defense and civilian needs.

4. Develop regional innovation systems (RISs).

5. Develop a network of S&T intermediary service organizations in various forms.

Nevertheless, China with its 22 provinces, five autonomous regions and four direct-controlled municipalities (Beijing, Tianjin, Shanghai and Chongqing) is not only too vast and diverse, but also too unevenly developed with each of its provinces and municipalities having distinct features and a substantial populace (Fu, 2015), therefore, one of the main characteristics of the Chinese innovation system, is a gap in the regional innovation performance and a large regional disparity in R&D (Shao et al., 2015). A rather important intervention by the central government was the decision to choose several Special Economic Zones and implement them (Someren, Taco C. R. van and Someren-Wang, 2013). Or in other words, the central government has endorsed the strategy of letting some regions develop before others and implemented preferential policies favoring coastal areas, which had better human capital and physical resources than the rest of the county (European Commission, 2015). Within these Special Economic Zones clusters of creative entrepreneurial activity have emerged, which are often referred as the regional innovation systems (RIS). Inspired by the Silicon Valley in the USA, China has created three clusters of economic zones situated in Yangtze River Delta (Shanghai–Jiangsu–Zhejiang region), Pearl River Delta (Guangzhou–Shenzhen–Hong Kong region) and Bo Hai Rim (Beijing–Tianjin–Hebei region), however, the Silicon Valley, unlike China's clusters, arose without any intervention and interference of the government (Someren, Taco C. R. van and Someren-Wang, 2013). Central and local governments have supported and encouraged all three regions with a number of preferential policies, which have been implemented in these areas to foster more favorable technical, industrial and economic opportunities for development, in order for these areas to become the engine driving the economy of the rest of the nation. Although the founding of these economic development areas has successfully boosted the national economy, it has resulted in an unintentional consequence of provoking serious economic disparities between regions. In addition, the GDP in these Special Economic Zones accounted for more than 40% of the total national GDP in China, while the average GDP growth rate was around 18% in comparison to the 5% in other areas (Shao et al., 2015). Furthermore, despite the fact that only 2.2% of the Chinese population lives in the eastern seaboard region, this region achieved a level comparable to some developed economies in terms of economic performance, while the provinces become less economically developed as further one goes to the west, with GDP income per capita well below the average of the developing countries (European Commission, 2015).

5.2. Beijing

Due to the conditions mentioned above, the main focus of this study is set on Beijing as it would be impossible to generalize the findings in Beijing on entire Mainland China. As already mentioned, Beijing, with the vast population of 21.2 million (2013) is not only the political and cultural, but also the educational and S&T capital of China (National Bureau of Statistics of China, 2014).

Beijing is the center of the university education system in China and is home to the Chinese Academy of Sciences and 172 universities (European Commission, 2015), therefore, universities and research institutes (URIs) have played a significant role in the development of STI capabilities of Beijing (Chen and Kenney, 2007). Nowadays, universities are broadly considered as a vital player in the national and regional innovation systems because of their role related to competitiveness, innovation and socio-economic development. Moreover, universities are broadly considered as a major contributor to the creation of innovation and progress in basic scientific research, and have miscellaneous roles including educating, creation of knowledge in the form of patents and scholarly publications, public space provision and problem-solving activities (Fu, 2015). Unlike Shenzhen which two decades ago had no URIs and the companies built up their own R&D capacities by making use of foreign technology and attracting educated talent nation-wide, Beijing encouraged high-tech development by utilizing its rich URI resources, which played an important role in the development of innovation in Beijing. URIs in Beijing served not only as providers of human capital and research centers, but have also created spin-offs and established science and technology parks in order to commercialize their research and technologies. In addition Beijing universities have established tight relationships with the industry by the means of joint projects, training and professional consulting (Chen and Kenney, 2007).

Furthermore, the local government in Beijing recognized the importance of S&T early on, and as a result Beijing was and still is one of the most R&D-intensive regions in China. In 2013, S&T expenditure as a percentage of total local government expenditure was 5.6%, which was the second most R&D-intensive in entire China, just after Shanghai's 5.7% and more than 2.5 times of the national average (Ministry of Science and Technology (MOST) of P.R.C., 2014).

Beijing played a vital role in the development of the innovation environment and S&T in China. During the initial phase of the transition, the S&T experience in Beijing was essential, since it influenced the development of the innovation system throughout China (Guan and Yam, 2014). In addition, a substantial amount of elements of the national innovation policy have been formulated on the basis of the lessons learned and experiences obtained in the nation's capital, where Zhongguancun, China's oldest high-tech zone is located. In addition, the Zhongguancun S&T park, with its 16 sub-parks is often referred as "China's Silicon Valley" as it is China's largest and most active high-tech economic zone (Guan et al., 2009).

5.3. Zhongguancun science park

Zhongguancun Science Park is China's most dynamic hub for entrepreneurship and innovation, and a origin of strategic emerging industries in China. Given that Z-Park is the birthplace of strategic emerging industries, high-tech enterprises have established a cluster of emerging industries, which correspond to the strategic positioning of the Beijing Municipality and have achieved major breakthroughs in the fields of strategic new technologies including high-end LCD display, 4G mobile communications and mobile Internet, advanced equipment and processes for integrated circuit manufacturing, bio-health, etc. There are in total six highly competitive industry clusters: next generation Internet, satellite application, mobile internet and new-generation mobile communication, biology and health, environment protection and energy conservation.

Participant 2 explained that multiple factors contributed to the success of Z-Park. First of all, government support was definitely a key success factor for Z-Park to become China's leading innovation hub as new STI strategies/policies/programs issued by the government would always firstly be implemented and tested in Zhongguancun before extending them to the rest of China, therefore, Z-Park plays a leading and pioneering role in China. In addition, the State Council has approved the *Development Plan Outline for Zhongguancun National Demonstration Zone (2011-2020)* in which the strategic position for future innovation development and objectives haven been specified, with a general objective to develop Z-Park into an innovation hub and high-tech industrial base with a global influence by 2020. (Participant 2)

> *We will [...] gradually develop Zhongguancun in Beijing into a globally influential science and technology innovation center. Central Committe of the Communist Party of China (2011)*

However, according to participant 2, there were several more reasons for Z-Park's success. First of all, since Z-Park is located in the nation's capital it was able to attract an abundance of many good resources both domestic and foreign (talents, capital, etc.). Secondly, it has shaped a unique entrepreneurial ecosystem consisting of six elements, which was undoubtedly an essential foundation for success. Thirdly, all its famous residents and industry leaders made it more attractive than other science and technology parks and helped to attract resources such as capital and talents. Lastly, and according to participant 2 of greatest importance, is that what both Shanghai and Hong Kong are missing - angel investments. Both Shanghai and Hong Kong are focused on large companies and MNEs and rely on the banking sector as a source of finance, therefore are heavily lacking small-scale finance. Although both of these cities are endowed with many universities like Beijing, which also play an important role in the local ecosystem, participant 2 sees the comparative advantage of Beijing in angel investments in particular. As mentioned before, active angel investment agencies in Beijing accounted in 2014 for 80% of total in China, which is an essential source of financing for micro businesses and SMEs whose development Beijing heavily encourages. In addition, finance related to technology of all sizes is booming in Beijing and these types of finance and availability of capital play a vital role in Beijing.

The Z-Park assimilates both Chinese and international technologies, talents, capital and other entrepreneurial elements, thereby forming a unique entrepreneurship ecosystem, which consists of six elements.

1. *Industry leaders*. Z-park's industry leaders are constantly fostering and developing new startups, while simultaneously attracting new people to the Z-park with their presence.

2. *Universities and research institutions (URIs)*. Beijing has 14 leading national universities, which is more than in any other city in China and 260 national research centers. In addition to being origins of talents, URIs are incubators of original ideas and technology as well. Many famous universities in Beijing including Peking University and Tsinghua University actively perform all sorts of entrepreneurial activities, while many of these entrepreneurs are students, teachers and university alumni.

3. *Angel investors and venture finance*. Since the development is determined by innovation and innovation is driven by capital, angel investors are a key link in the entrepreneurship ecosystem. In addition, the Z-park is China's most active area for angel investments and its active angel investment agencies accounted in 2014 for 80% of total in China, while their cases represented more than 60% of total cases in China. The Zhongguancun angel investment guiding fund cooperates with 14 sub-funds (i.e. Gobi Partners, ZhenFund, etc.), which has the total volume of capital RMB 1307.84 million and RMB 161.5 million committed capital.

4. *Innovative incubators*. Z-Park has a great variety of innovative incubators with different models and entrepreneurial services. Innovative incubators signify in China a type of incubation where in addition to the mere workspace, a combination of offline and online services is offered to the ones incubated such as coaching, team building, product launching, technology research, financing (micro loans, angel investments, VC, etc.), mediating in finding partners, employees; etc. So far 37 incubators have been recognized as innovative incubators by the Administrative Committee of Zhongguancun Science Park.

5. *Culture of entrepreneurship*. Many entrepreneurs fail and unlike in some countries, where failure is seen as embarrassment which prevents people to become entrepreneurs, Beijing encourages a culture of entrepreneurship with failure as its constituting part. Since the culture in Beijing encourages entrepreneurship and accepts failure, the entrepreneurs even if they fail, go again and again until they succeed. However, this movement has appeared recently in China and was heavily influenced and advertised by the CPC, President, State Council and especially by the Premier Li Keqiang who emphasized that starting a business is not a privilege of the upper classes, but of everyone with a good idea regardless of his or hers background.

> *Entrepreneurship and innovation among the public are a must-have driving force to push the Chinese economy to a higher level and an essential part of economic restructuring. As we streamline the government and lower the threshold for startup companies, we facilitate the birth of new businesses in the market... Government supervision has to adapt to new technologies and new industries. Premier Li Keqiang during a visit to the State Administration of Industry and Commerce on March 20, 2015 State Council of P.R.C. (2015)*

In Z-Park, there are three main startup forces: executive entrepreneurship, serial entrepreneurship and student/post-1990s generation entrepreneurship, which have become a standard practice and that is the culture.

> *Entrepreneurship is not the privilege of a small group of people, but the choice of many people. In fact, the general public know better than us about what people need, and that is exactly the essence of public innovation. The spirit of innovation includes credibility, which is an integral part of doing business. State Council of P.R.C. (2015)*

6. *Talents are the main force in entrepreneurship*. One of the main missions of the Z-Park is to create a high-end pool of both domestic and overseas talents by employing a "talent-led and innovation-driven" development pattern where top talents play an essential role in facilitating innovative development. In addition, because of the first-class talent pool that already exists in the park, Z-Park is able to attract more and more talents both domestic and from abroad.

Z-park offers various preferential policies to its residents, but also a wide range of policies to attract talents both domestic and international, investors, people with ideas to set up their businesses, etc. The principle policies are the following.

- *Taxation*. The policies related to taxation are mainly related to tax deductions and tax exempt. For example, enterprises in Z-park that have been recognized as high-tech enterprises by the Administrative Committee of the Zhongguancun S&T park, enjoy tax deductions of 10 %, therefore instead of paying 25% of value-added tax (VAT), they pay only 15% of VAT, which truly is an enormous saving. Another example would be that, small-scale VAT taxpayers whose monthly sales do not exceed RMB 30.000 are granted a temporary exempt from value-added tax.

- *Finance*. The scientific financing system consists of 6 mechanisms including risk compensation; multiple cooperation between the bank, the government and the enterprise; integration of investments, security and loan centered around VC; credit incentives; continuous support; and market selection focused on key points; which are realized through 10 channels: angel investments, guarantee finance, VC, IPO, petite loans, credit, loan and trade financing, finance lease, M&A and agency stock transfer.

- *Human Resources (HR)*. Since top talents play an essential role in fostering innovative development, the talents service system was set forth in order to develop a talent zone, which is heavily supported by not only the Z-park, but fifteen Ministries as well. Various talent programs have been established in order to attract foreign talents as well as Chinese nationals studying/working abroad such as the "1.000 Talent Program", "Overseas Talent Program", etc. Z-park's supporting policies for developing, attracting and retaining talents include: housing, funding, medical care, spouse settlement, (part-time) residence and immigration, exchange settlement, overseas stock ownership and "Return-to-Invest", etc. (Participant 2).

6. Conclusion

The study tries to shed light on China's ongoing rapid transition into an innovation-driven economy and the success it has achieved, while giving answers to how this remarkable transformation was even possible in the first place and what mechanisms/actors were behind it. It is evident that China has achieved much since its opening up in 1978, especially given that the focus to a more higher-quality, knowledge-based growth driven by innovation started to shift in the mid-1990s, when the national policy of indigenous innovation was embraced with the intent to assist the Chinese enterprises to have a strong-point in key technologies. Today, indigenous innovation is still on the policy agenda of the government and in both their five-year and medium- and longterm plans, while heavily endorsing, advertising and promoting the culture of innovation and entrepreneurship in order to "fuel" the next era of China's economic growth. In addition, research has shown that in order for the late-coming nations to catch up in innovation, the governmental support has been proven to be crucial, which is also true for the case of China as well. The role of government in the development of STI in China has been manifold. The administration mechanism of China's national S&T system is the National Steering Group for S&T and Education in the State Council, which coordinates all activities related to innovation, education and research. More precisely, the government has been central in: proposing important plans and guiding policies documents for STI, for example the Five-Year Plans for National Economic and Social Development of the People's Republic of China; researching and examining major policies and national development strategies for education, science and technology; coordinating significant relationships between various governmental departments, local governments and the central government, concerning education, science and technology; issuing major S&T programs, proposing various laws and regulations that reinforce and support the development of S&T, among all.

The state of innovation in China and the progress of its ongoing rapid transition into an innovation-driven economy can be evident from the aggregate of national statistics on innovation inputs and innovation outputs, while the outcomes of China's transformation is its placement on the global innovation landscape. However, China is not only too vast and diverse, but also too unevenly developed with each of its provinces and cities having distinct features and a substantial populace, therefore under these circumstances statistics of national averages can be extremely misleading. One of the main characteristics of the Chinese innovation system, as well as many others, is a gap in the regional innovation performance and a large regional disparity in R&D, hence, the main focus of the research was on Beijing as it is impossible to generalize the findings found in Beijing on entire China.

Today, Beijing is not only the political and cultural, but also the educational and S&T capital of China. Being the center of the university education system in China, as well home to more universities and research institutes than any other city in China, Beijing utilized its rich URI resources, which served not only as providers of human capital and research centers for the whole country, but have also created spin-offs and established science and technology parks in order to commercialize their research and technologies. In addition, Beijing played a vital role in the development of the entrepreneurial environment and STI in China as a substantial amount of elements of the national innovation policy have been formulated on the basis of the lessons learned and experiences obtained in the nation's capital, where Zhongguancun S&T Park, China's largest and most active high-tech economic zone is located. Furthermore, Zhongguancun S&T Park with its 16 sub-parks has played and still plays a leading role not only in the development of STI in Beijing, but entire Mainland China as it truly has become an innovation hub with global recognition and influence.

China has also faced a great deal of criticism over the years, because of its unsustainable growth model heavily based on foreign technology transfer and imitation due to the lack of indigenous capabilities and creativity. In addition, nowadays, China is compelled to shift its current growth model based on long-existing, export-oriented low-cost manufacturing to a sustainable knowledge-intensive growth model with innovation as the main driving force, since it is losing its price competitiveness in manufacturing to other emerging markets, the amount of excess unskilled workforce is falling, and the environmental and resource constraints for sustainable growth have become increasingly important. In closing, even though some still argue that China has not yet become an innovation powerhouse, however, with all the key enablers in place, high government commitment and with Beijing and Zhongguancun as its main drivers, in that case, it is just a matter of time until it will become one.

References

Administrative Committee of Zhongguancun Science Park (4/27/2015). Official website of zhongguancun science park.

Central Committe of the Communist Party of China (2011). *The Twelfth Five-year Plan for National Economic and Social Development of the People's Republic of China*. Zhong yang bian yi chu ban she, Beijing, 1st edition.

Chen, K. and Kenney, M. (2007). Universities/research institutes and regional innovation systems: The cases of beijing and shenzhen. *World Development*, 35(6):1056–1074.

Chinese Academy of Engineering (6/3/2015). Chinese academy of engineering (cae) - official website.

Cornell University, INSEAD and WIPO (2014). *The Global Innovation Index 2014: The Human Factor in Innovation*.

European Commission (2014). Innovation union scoreboard 2014.

European Commission (7/1/2015). Erawatch country fiche: China.

Fruin, M., Lynn, L., Meil, P., and Salzman, H. (2012). Reshaping global technology development: Innovation and entrepreneurship in china and india. *Journal of Asia Business Studies*, 6(2):143–159.

Fu, X. (2015). *China's Path to Innovation*. Cambridge University Press.

Gao, P. (2015). Government in the catching-up of technology innovation: Case of administrative intervention in china. *Technological Forecasting and Social Change*.

Guan, J. and Chen, K. (2012). Modeling the relative efficiency of national innovation systems. *Research Policy*, 41(1):102–115.

Guan, J. C. and Yam, R. C. (2014). Effects of government financial incentives on firms' innovation performance in china: Evidences from beijing in the 1990s.

Guan, J. C., Yam, R. C., Lau, A. K., and Tang, E. P. (2009). Innovation strategy and performance during economic transition: Evidences in beijing, china. *Research Policy*, 38(5):802–812.

Hsu, P.-H., Wang, C., and Wu, C. (2013). Banking systems, innovations, intellectual property protections, and financial markets: Evidence from china. *Journal of Business Research*, 66(12):2390–2396.

Hu, M.-C. and Mathews, J. A. (2003). *National Innovative Capacity in East Asia*, volume MGSM WP 2003-17 of *MGSM working papers in management*. Macquarie Graduate School of Management, Sydney.

IMD World Competitiveness Center (2015). *IMD World Competitiveness Yearbook 2014: Executive Summary*. IMD WCC, Lausanne, Switzerland.

Lau, A. K. and Lo, W. (2015). Regional innovation system, absorptive capacity and innovation performance: An empirical study. *Technological Forecasting and Social Change*, 92:99–114.

Lundvall, B.-Å. (2007). National innovation systems: Analytical concept and development tool. *Industry & Innovation*, 14(1):95–119.

Ministry of Education (MOE) of the P.R.C. (5/26/2015). Official website of ministry of education (moe) of the people's republic of china.

Ministry of Science and Technology (MOST) of P.R.C. (2014). *China Science & Technology Statistics: Data Book*.

Ministry of Science and Technology (MOST) of P.R.C. (2/10/2015). Official website of ministry of science and technology (most) of the p.r.c.

National Bureau of Statistics of China (9/25/2014). China statistical yearbook 2014.

National Natural Science Foundation of China (6/29/2015). Official website of national natural science foundation of china (nsfc).

National People's Congress of the P.R.C (12/28/2013). Official website of the national people's congress of the people's republic of china: State structure of the people's republic of china.

Samara, E., Georgiadis, P., and Bakouros, I. (2012). The impact of innovation policies on the performance of national innovation systems: A system dynamics analysis. *Technovation*, 32(11):624–638.

Shah, R., Gao, Z., and Mittal, H. (2015). *Innovation, Entrepreneurship, and the Economy in the US, China, and India: Historical Perspectives and Future Trends*.

Shao, Y., Hernández, R., and Liu, P. (2015). Government intervention and corporate policies: Evidence from china. *Journal of Business Research*, 68(6):1205–1215.

Someren, Taco C. R. van and Someren-Wang, S. (2013). *Innovative China: Innovation Race Between East and West*. Management for professionals. Springer, Berlin and New York.

State Council of P.R.C. (2006). *The National Medium- and Long-Term Program for Science and Technology Development (2006-2020): An Outline*.

State Council of P.R.C. (6/2/2015). The state council of the people's republic of china: Official website.

Szirmai, A., Naudé, W. A., and Goedhuys, M. (2011). *Entrepreneurship, Innovation, and Economic Development: A Study Prepared for the World Institute for Development Economics Research of the United Nations University (UNU-WIDER) and Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT)*. UNU-WIDER studies in development economics. Oxford University Press, Oxford and New York.

Times Higher Education (2015). Times higher education 2014-2015 world university rankings powered by thomson reuters.

Watkins, A., Papaioannou, T., Mugwagwa, J., and Kale, D. (2015). National innovation systems and the intermediary role of industry associations in building institutional capacities for innovation in developing countries: A critical review of the literature. *Research Policy*, 44(8):1407–1418.

World Economic Forum (2014). *Global Competitiveness Report 2014-15*. World Economic Forum, Geneva, Switzerland.

World Intellectual Property Organization (2014). *World Intellectual Property Organization's (WIPO) IP Facts and Figures 2014*.

Xiwei, Z. and Xiangdong, Y. (2007). Science and technology policy reform and its impact on china's national innovation system. *Technology in Society*, 29(3):317–325.

Appendices

A. Questionnaire: Beijing Makerspace

创客空间
BEIJING MAKERSPACE

TU Graz
Graz University of Technology

Beijing Makerspace

Filip Krstanovic
filip.krstanovic@student.tugraz.at

Questions for the Beijing Makerspace

a) Facts and figures: total area in m2, nr. of employees, nr. of prototypes turned into products, nr. of members, etc.
b) Who are the owners/stakeholders of the Beijing Makerspace?
c) How is the Makerspace organized?
d) What are the prerequisites for becoming a member of the Beijing Makerspace?
e) What tools and resources do you offer in your facility?
f) What services do you offer to your members? Such as consulting, training, coaching, etc.
g) Who owns the IPR of a project in the Makerspace?
h) How is the Makerspace funded?
i) Have you received any support from the government through innovation support programs, projects and other activities? If yes, what kinds of support have you received and through which innovation support programs?
j) What happens after prototyping? Do you offer incubation as well? Do you fund projects? If no, are you thinking about implementing these services in the future? If yes, how many companies have you incubated and how many projects have you funded?
k) Could you please tell me more about your Maker Carnival (October 2nd and 3rd)? I.e. how many people, companies, Makers it has attracted…
l) Do you organize any other events and if yes how often? I.e. classes, Maker fairs, Hackathons, etc. What kind of events/activities do you organize? What is their aim?
m) Which Makerspace communication strategies do you use?
    a. How do you advertise the Makerspace and its services?
    b. How important is Makerspace marketing/public relations?
    c. How do you attract creative people to join?
n) Could you please describe several success stories? Why were these particular cases successful?
o) What are the future plans for the Makerspace?

B. Support Letter of the S&T Office of the Austrian Embassy in Beijing

AUSSEN
WIRTSCHAFT

Marktunterstützung China

Filip Krstanovic
z.H. Herrn Filip Krstanovic

AUSSENWIRTSCHAFTSCENTER PEKING
13. Juli 2015

Unser vollständiges Angebot zum Thema **CHINA** (Veranstaltungen, Publikationen, News etc.) finden Sie unter www.wko.at/aussenwirtschaft/cn.

1. Potentielle Ansprechpartner

(Bei Briefverkehr sollte die chinesische Anschrift kopiert, ausgeschnitten und als Adresslabel verwendet werden!)

Administrativ Committee of Zhongguancun Science Park	
Adresse: 5F, C Zuo, Yuhui Dasha, No.73, Fuchenglu, Haidian District, Beijing 100142 Kontakt: Ms. Yajie HE International Department	100142 北京市海淀区阜成路 73 号裕惠大厦 C 座 5 层 中关村科技园区管理委员会 国际处
T. (+86)10/88827963, 88827960	贺雅洁 小姐
F. (+86)10/88828882	
E.visit@zgc.gov.cn	
W. http://www.zgc.gov.cn (Englisch)	
Anmerkungen:	

Beijing Makerspace	
Adresse: Zhongguancun Mengxiang Shiyanshi, No.1, Haidian Dajie, Haidian District, Beijing 100005 Kontakt: Ms. Yuping LI BD	100089 北京市海淀区海淀大街 1 号 中关村梦想实验室(海龙大厦南侧楼,宁波银行西) 北京创客空间 李玉平 小姐
T. (+86)10/61943328, 57196164	
E.liyuping@bjmakerspace.com	
W. http://www.bjmakerspace.com (Chinesisch)	
Anmerkungen: Gründung: 2011 Mitglieder: mehr als 300	

Chinese Academy of Science and Technology for Development	
Adresse: No.8, Yuyuantan Nanlu, Haidian District, Beijing 100038 Kontakt: Ms. Nan SU Industrial Technology Development Research Institute	100038 北京市海淀区玉渊潭南路 8 号 中国科学技术发展战略研究院 产业科技发展研究所 苏楠 小姐
T. (+86)10/58884532	
E.sun@casted.org.cn	
W. http://www.casted.org.cn (Englisch)	
Anmerkungen: Gründung: 2007 Diese Akademy untersteht dem Ministry of Science and Technology of the People's Republic of China. Frau SU hat sich darauf hingewiessen, dass sie sich dabei behilflich sein wird.	

2. Weiterführende Informationen

SERVICEANGEBOT DER AUSSENWIRTSCHAFT AUSTRIA

Unter der Devise "Austria ist überall" und mit Hilfe einer breiten Palette von Serviceleistungen in den Bereichen Information, Coaching und Events sehen wir es als unsere Aufgabe, noch unentschlossene Unternehmen in den Export zu bringen, dynamische in neue Märkte zu führen und die bereits erfolgreichen beim Wachstum wirksam zu unterstützen.

Nutzen Sie unser Netzwerk, unsere Beratung und unser Know-how auf allen wichtigen Märkten dieser Welt. Mit den Services der AUSSENWIRTSCHAFT AUSTRIA steht der Internationalisierung Ihres Unternehmens nichts mehr im Wege! Nähere Informationen zum Leistungsangebot der AUSSENWIRTSCHAFT AUSTRIA finden Sie unter folgendem Link: wko.at/aussenwirtschaft/cn

INDIVIDUELLE FÖRDERMÖGLICHKEITEN

Da uns natürlich bewusst ist, dass Aktivitäten in China mit oftmals sehr hohen Kosten verbunden sind, möchte ich Sie bereits an dieser Stelle auf die Möglichkeit hinweisen, im Rahmen der Internationalisierungsoffensive go-international Förderungen für den Markteintritt in neue Märkte zu beantragen. So ist es z.B. unter dem Förderinstrument 1.8.2. (Exportscheck für Fernmärkte) möglich, 50% Ihrer direkten Markteintrittskosten (Reisekosten, Marketingkosten, Beratungskosten etc.) ko-finanzieren zu lassen.

Unter folgendem Link finden Sie Erstinformationen zur Internationalisierungsoffensive go international des Bundesministeriums für Wissenschaft, Forschung und Wirtschaft (BMWFJW) und der Wirtschaftskammer Österreich. http://www.go-international.at/go-international/foerderprogramme/Export__Foerderung/Export__F_rderung/index.php.

HAFTUNGSAUSSCHLUSS

Wir hoffen, Ihnen mit diesen Informationen weitergeholfen zu haben. Bitte beachten Sie, dass es sich bei unserer Bearbeitung um unverbindliche Auskünfte handelt, für die wir trotz gründlichster Recherche keine Haftung übernehmen können.

3. Ihre Ansprechpartner der AUSSENWIRTSCHAFT AUSTRIA in China

In China ist die AUSSENWIRTSCHAFT AUSTRIA mit vier AußenwirtschaftsCenter sowie drei AußenwirtschaftsBüros vertreten und unterstützt Sie bei Ihren Geschäften auf dem chinesischen Markt. Gerne sind wir für Sie da!

Österreichisches AußenwirtschaftsCenter Peking

Wirtschaftsdelegierter Dr. Martin Glatz
T +86 10 8527 5050
F +86 10 8527 5049
E peking@wko.at

Österreichisches AußenwirtschaftsCenter Shanghai

Wirtschaftsdelegierter Mag. Raymund Gradt
T +86 21 6279 7197
F +86 21 6279 7198
E shanghai@wko.at

Österreichisches AußenwirtschaftsCenter Guangzhou

Wirtschaftsdelegierter Stv. MMag. Dietmar Schwank
T +86 20 8516 0047
F +86 10 8516 0601
E guangzhou@wko.at

Österreichisches AußenwirtschaftsCenter Hongkong

Wirtschaftsdelegierter Mag. Christian H. Schierer
T +852 2522 2388
F +852 2810 6493
E hongkong@wko.at

C. Questionnaire: Zhongguancun Science Park

International Division of the Administrative Committee of Zhongguancun Science Park

Filip Krstanovic
filip.krstanovic@student.tugraz.at

Questions regarding the Zhongguancun (ZGC) S&T Park

(This information I couldn't find or the official website (http://en.zhongguancun.gov.cn/) nor in the China Statistical Yearbook 2014)

1. **Basic facts and figures on the Zhongguancun Science Park:**
    a. Owners/stakeholders of the ZGC S&T Park?
    b. The total area ZGC covers in km2?
    c. Number of companies (micro businesses, SMEs, LMEs, MNCs) in the park, growth trends?
    d. Number of foreign companies in the Park (according to countries of origin)?
    e. Number of startups incubated, number of startups received government incentives and other funding, survival rate of startups?
    f. Other institutions present in the park: R&D institutions, educational institutions, Technology Transfer offices, financing institutions (banks, seed and risk capital…)?
    g. Number of employees (full-time, short-termers, external coworkers, …)?

2. **Facts on the Administrative Committee of the Zhongguancun Science Park**
    a. Stakeholders of the Administrative Committee Of Zhongguancun Science Park?
    b. Organizational structure of the Administrative Committee of the Zhongguancun Science and technology park; which functions does each organizational unit perform?
    c. Explain briefly the division of ZGC into "two towns and two belts"?
    d. Can you clarify the "1+6" policy series of Zhongguancun National Innovation Demonstration Zone?
    e. The aims and roles of the Park's international offices around the world?
    f. Financial sources for Park operation?
    g. Park facilities, resources and infrastructure?
    h. Implementation of NIS: execution of innovation support programs, projects and other activities?
    i. Other services provided to Park residents i.e. services for startup companies, business & product development services, access to capital, growth management support, business internationalization services, matchmaking events (with investors, buyers…), etc. ?
    j. Park communication strategies:
        i. How do you advertise the Park and its services?
        How important is Park marketing/public relations?

International Division of the Administrative Committee of Zhongguancun Science Park

Filip Krstanovic
filip.krstanovic@student.tugraz.at

ii. How do you attract and encourage inventors, innovators, entrepreneurs and investors to set up business in ZGC?
iii. Do you organize innovation competitions and give innovation prizes?
iv. How do you foster a culture of innovation/entrepreneurship and collaboration (in the Park)?

k. Which were the ZGC key success factors to become China's leading innovation hub (except the support from the government)?
l. Please describe several success stories.
m. What are the ZGC future plans?

3. Advantages and benefits for residents of the Zhongguancun Science Park

a. What are the criteria for becoming a resident of the ZGC?
b. What are the benefits of being located at ZGC? (i.e. to being located in BJ, but outside of ZGC)
c. What measures and incentives for STI are offered on a park and sub-park level?
d. Available sources of financing (i.e. government incentives, risk capital: angel investments, VC, etc.) at ZGC?

D. Questionnaire: TusPark

TusPark
清华科技园

TU Graz
Graz University of Technology

TusPark

Filip Krstanovic
filip.krstanovic@student.tugraz.at

Questions regarding the TusPark Incubator:

1. **Basic facts and figures on the TusPark Science Park:**
   a. How many companies (micro businesses, SMEs, LMEs, MNCs) are in the park? Growth trends? How many of these are foreign companies?
   b. How many startups are incubated? How many startups received government incentives and other funding and what is the survival rate of startups?
   c. How many employees and researchers work in the park (full-time, short-termers, external coworkers, etc.)?
   d. Who are the stakeholders of the TusPark?
   e. How is the TusPark managed and organized? How is it related to the Z-park?
   f. Who are the members of the TusPark ecosystem (such as R&D institutions, financing institutions, etc.)?
   g. How many other incubators are there in the park? I.e. X-lab, Makerspaces, etc.

2. **Facts on the TusPark Incubator:**
   a. What are the prerequisites for being incubated in TusPark?
   b. What are the benefits of being incubated at TusPark? (i.e. in comparison to the other incubators available in Zhongguancun)
   c. Can you please tell me more about the innovation service system? What service do you offer to the incubated companies? What measures and incentives for STI are there?
   d. What are the available sources of financing (i.e. government incentives, risk capital: angel investments, VC, micro loans etc.)?
   e. What other services are provided to Park residents i.e. services for startup companies, business & product development services, access to capital, growth management support, business internationalization services, matchmaking events (with investors, buyers…), etc. ?
   f. How do you foster a culture of innovation/entrepreneurship and collaboration (in the Park)?
   g. How do you attract and encourage innovators, entrepreneurs and investors to set up business in ZGC?
   h. How do you encourage students to become entrepreneurs?

TusPark

Filip Krstanovic
filip.krstanovic@student.tugraz.at

i. Have you received any government support through innovation support policies and programs? If yes can you please briefly explain what kind? If no, what kind of support would you benefit from?
j. How are IPR organized in the park?
k. Park facilities, resources and infrastructure?
l. Financial sources for Park operation? Business model?
m. Please describe several success stories (companies that started at TusPark and have become successful).
n. What are the future plans for the TusPark?

E. Questionnaire: TusPark's entrepreneurs

TusPark

Filip Krstanovic
filip.krstanovic@student.tugraz.at

Questions for the entrepreneurs/innovators in the TusPark Incubator:

a) Basic info about the company :
   a. company name:
   b. established in:
   c. ownership (local/international, stakes):
   d. URL: www.
   e. contact person/interviewee:
   f. industry/sector:
   g. number of employees, seed capital, etc.

b) What motivated you to become an entrepreneur (instead of settling for a secure job and a regular paycheck)?
c) How did you find out about the TusPark and its services?
d) What were the reasons for setting-up business/incubation in TusPark? Why not one of many other incubators available?
e) Which services/measures/incentives offered by TusPark have you used;
 Which of them would you identify as of great support/value to your company? Why? Which have you not used? Why?
f) How did TusPark help you cut time-to-market (TTM)?
g) Does the connection between the Tsinghua University and TusPark help to provide an adequate talent pool for your company? How is this reflected in your company in terms of talent pool?
h) How does the presence of other companies affect your business? Does the presence of many other companies/competitors help or jeopardize your business? (churn: bigger companies can pay more and therefore pick the best talents)
i) Have you enjoyed any kind of government support through governmental STI policies, programs, measures, incentives, etc.? If yes, how did you find out about these Government innovation support programs? How have they affected your business? Which have you used?
j) What mechanisms/services are missing in the park that you consider to be useful for you?
k) What are the greatest benefits of setting-up/incubating in the Park? What are the greatest challenges?
l) What obstacles did your company face in the past? How have they affected your company? Do any of these obstacles still exist? Which main challenges are you facing nowadays?