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Theoretical and Practical Approaches to Management of Knowledge Transfer between Universities and Industry

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NORMATIVE REFERENCES

In this thesis the following normative references were used:

Code of the Republic of Kazakhstan «On Taxes and Other Obligatory Payments to the budget" (Tax Code) No. 99-IV as of December 10, 2008 (amended as of July 3, 2013).

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Interindustry Plan for Scientific and Technological Development of the Republic of Kazakhstan till 2020, approved by the government regulation No. 1291 as of November 30, 2010, Astana.

Law of the Republic of Kazakhstan "On Education" as of July 27, 2007, No.319-III, Astana.

Law of the Republic of Kazakhstan "On innovation activities", July 3, 2002, No. 333-II, Astana.

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The Concept of Innovative Development of the Republic Kazakhstan till 2020, approved by the Decree of the President of the Republic of Kazakhstan No. 990 as of July 30, 2012, Astana.

NOTATIONS AND ABBREVIATIONS

CIS – Commonwealth of Independent States
R&D – research and development
SECI – Socialization, Externalization, Combination and Internalization
BIS – Department for Business, Innovation and Skills
HEIs – higher education institutions
TTO – Technology transfer office
S&T – science and technology
GII – Global Innovation Index
GDP – gross domestic product
SMEs – small and medium enterprises
OECD – Organization for Economic Cooperation and Development
DIUS – Department for Innovation, Universities and Skills
BIS – Department for Business, Innovation and Skills
HEIF – Higher Education Innovation Funding
WIPO – World Intellectual Property Organization
ISRs – Industry- science relationships
ICT – Information and Communication Technologies
USSR - Union of Soviet Socialist Republics
ESPAs – educational, scientific and production associations
CPSU – Central Party of the Soviet Union
NAS – National Academy of Science
NAE – National Academy of Engineering
INSEAD – Institut Européen d'Administration des Affaires (European Institute for Business Administration)
WIPO – World Intellectual Property Organization
NIS – National Innovation System
SEZ – Special Economic Zone
NATD – National Agency for Technological Development
KTTN – Kazakhstan's Technology Transfer Network
STI – scientific and technological information)
JSC – Joint-Stock Corporation
LLP – Limited Liability Partnership

INTRODUCTION

General research characteristics. This research builds upon theoretical approaches and world-wide practices to explore the process and governance forms of knowledge transfer between universities and industry in telecommunications sector of the Republic of Kazakhstan.

Actuality of the research. It has become obvious today that innovative development of a country is critical to its economic success. This is evident from the growing interest and increased discussion on industrial and innovative progress in political and scientific realms. Innovative development is particularly a 'hot topic' for discussion in developing countries such as Asian and the Commonwealth of Independent States (CIS) countries, since in order to align themselves with developed countries, they must focus on innovation.

Innovation was included into different strategic programs of the Republic of Kazakhstan as one of the main factors contributing to the development and prosperity of the country. It has been more than 15 years since the *Strategy "Kazakhstan – 2030"* was adopted. The strategy described 30 directions for the development of the Republic of Kazakhstan. One of the main directions of the strategy was the implementation of high technologies and support of innovative activities. Specifically, this direction covered the following aspects: technology transfer, financial support of innovative projects, demand for research results, and intellectual property rights and trademarks protection. The result of the Strategy should have been entering the list of 50 world's most competitive countries by 2030. To date, Kazakhstan already stands at 51st position in the Global Competitiveness Index 2012-2013. In this connection, the President of the Republic of Kazakhstan Nursultan Nazarbayev reported in his latest address to the nation on 14th of December 2012, that Kazakhstan had accomplished the goal and the main objectives of *Strategy "Kazakhstan – 2030"* ahead of schedule; and now it's time to adopt a new challenging but realistic *Strategy "Kazakhstan – 2050"* the main goal of which is to become one of 30 most developed countries in the world by 2050.

The new strategy emphasizes the importance of stimulating private firms to invest funds in research and development which would result in innovations. Additionally, a vital role is assigned to modernization of the education system by implementing new methods, solutions and tools to teaching. It is important to note that to attain the established targets, the government of Kazakhstan invests in expansion of one of its six priority sectors (*Strategy "Kazakhstan – 2030"*) – telecommunications sector which plays a large part in the development of the infrastructure and contributes to innovative growth of the country.

In recent years, the number of consumers of telecommunications services (fixed phones, mobile communications and the Internet) in Kazakhstan has grown. However, this is not enough for the telecommunications sector to prosper. Thus, the President N. Nazarbayev instructed the government to develop policies to modernize education in technical sciences by implementing the most contemporary programs. He also pointed to the need of establishing tight linkages between education and business sectors to facilitate the process of knowledge and technology transfer. This will contribute to the creation of a new economy based on knowledge.

A great role in a knowledge-based economy is assigned to the development and integration of the elements of a “knowledge triangle” (education, research and innovation) introduced by Lisbon Agenda in 2000. Universities are increasingly complementing traditional research and education functions with the transfer of knowledge to business which is an essential component of the innovation system that has a significant economic and societal impact. However, contacts between universities and industry do not only include the transfer of knowledge from one party to another, but they also help scientists to formulate interesting research tasks, conduct high-quality research and get a clearer understanding of how to apply research results to industry.

Unfortunately, as an observation shows direct partnerships between universities and business entities are rare and not very well developed in Kazakhstan. As noted in the *Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014,* there is a deficiency of synergy between science and industry. But successful practices of the most innovative economies in the world (Japan, Switzerland, and Finland) suggest that knowledge collaboration between universities and industry is one of the key success factors for innovative development. Therefore, it is necessary to develop effective governance mechanisms which would facilitate the establishment of strong relationships between universities and companies, and in particular to ensure the transfer of knowledge in Kazakhstan’s priority sectors. However, developing these mechanisms is impossible without a deep understanding of the specificities of knowledge transfer in the context of Kazakhstan. Thus, at present time it is important to explore university-industry knowledge collaboration in Kazakhstan putting an emphasis on telecommunications sector.

The extent of the research issue elaboration. The literature review revealed a large number of studies covering theoretical and practical approaches to university-industry knowledge transfer. Among them we would like to outline the following authors: Winer and Ray (1994), Debackere (2004), Fontana *et al*. (2006), Fritsch and Slavtchev (2007), Schiller and Leifner (2007), Segarra-Blasco and Arauzo-Carod (2008), Rossi (2010), Fassin (2010), Ślusarek *et al*. (2010), Dalmarco *et al*. (2012). Specifically, some authors explored the forms of collaboration and the types of knowledge transfer channels: Meyer-Krahmer and Schmoch (1998), Santoro and Gopalakrishnan (2000), Schartinger *et al*. (2001), Nieminen and Kaukonen (2001), Cohen *et al*. (2002), Debackere (2004), Arundel and Guena (2004), Butterill and Goering (2005), Brennenraedts *et al*. (2006), Bekkers and Freitas (2008), Abreu *et al*. (2008), Gils et al. (2009), Arza (2010), Howlett (2010), Rossi (2010), Arza and Vazquez (2010), Fuentes and Dutrénit (2010), Niedergassel (2011), Gertner *et al*. (2011), Kaymaz and Eryiğit (2011).

Some works focused on university-industry linkages in particular countries like the United Kingdom (Abreu *et al*., 2008; D’Este and Patel, 2007; Howlett, 2010; and Gertner, 2011), Switzerland (Arvanitis *et al*., 2008), the Netherlands (Dalmarco *et al*., 2012; Gils *et al*., 2009), Finland (Nieminen and Kaukonen, 2001), Sweden (Lööf & Broström, 2005), Canada (Bramwell *et al*., 2012), Mexico (Fuentes and Dutrenit, 2010), India (Joseph and Abraham, 2009), Turkey (Kaymaz and Eryiğit, 2011), Spain (Segarra-Blasco and Arauzo-Carod, 2008), Thailand (Shiller and Leifner, 2007; Worasinchai *et al*., 2008), and China (Wang and Lu, 2007). Yet others emphasized knowledge transfer between academia and industry in certain sectors: information and communication technologies (Audretsch and Keilbach, 2008); biomedical engineering (Brennenraedts *et al*., 2006); pharmaceuticals (Dooley and Kirk, 2007); life sciences (Owen-Smith *et al*., 2002); automotive, biotechnology and electronics (Rasiah and Govindaraju, 2009). The sector of our interest – the telecommunications was highlighted by Lööf and Broström (2005), Fontana *et al*. (2006), Bigliardi *et al*. (2012), Lovrek *et al*. (2003), and Bekkers and Freitas (2008).

The review of literature also showed that many studies investigated the factors influencing university-industry collaboration: Cohen and Levinthal (1990), Adams *et al*. (2000), Leiponen (2001), Arundel *et al*. (2000), Mohnen and Hoareau (2002), Cohen *et al*. (2002) Laursen and Salter (2003), Arundel and Guena (2004), Veugelers and Cassiman (2005), Fontana *et al*. (2006), Fontana *et al*. (2003), Rasiah and Govindaraju (2009), Lööf and Broström (2005), Segarra-Blasco and Arauzo-Carod (2008), Fritsch and Slavtchev (2007), Liefner (2003), Butler *et al*. (2009), Bjerregaard (2009), Chakrabarti and Santoro (2004), and Abreu *et al*. (2008). At the same time, some other studies examined the attitudes of both universities and firms towards knowledge collaboration: Link and Tassey (1989), López-Martínez *et al*. (1994), Meredith and Burke (2008), Fontana *et al*. (2006), Joseph and Abraham (2009), Nieminen and Kaukonen (2001).

A large number of studies focused on studying the obstacles to university-industry collaboration: Ślusarek *et al*. (2010) Fuentes and Dutrenit (2010), Elmuti *et al*. (2005), Gopalakrishnan and Santoro (2004), Franklin *et al*. (2001), Abreu *et al*. (2008), Fassin (2010), Arvanitis *et al*. (2008), Siegel *et al*. (2003). Moreover, many authors looked at the obstacles from different perspectives. For example, Shiller and Leifner (2007), Kaymaz and Eryiğit (2011) and Tartari *et al*. (2012) studied the barriers from academicians' perspective; Nieminen and Kaukonen (2001), Rasiah and Govindaraju (2009), and Bruneel *et al*. (2010) examined the obstacles from firms' perspective. Renko (2004) considered both perspectives.

Much research was devoted to scrutinizing the benefits of university-industry partnerships: Lee (2000), Arza (2010), Fendandes *et al*. (2010), Ślusarek *et al*. (2010), Dooley and Kirk (2007), Meyer-Krahmer and Schmoch (1998), Seigel *et al*. (2003), Renko (2004), Nieminen and Kaukonen (2011), Bishop *et al*. (2011), Dutrenit *et al*. (2010). Additionally, such authors as Etzkowitz and Leydesdorff (2000), Bhuiyan (2011), Rossi (2010), Freitas *et al*. (2010), Abramovsky and Simpson (2011), Wang and Lu (2007), Nieminen and Kaukonen (2001), Phiblin (2008), Etzkowitz (2011), Dalmarco *et al*. (2012), Kaymaz and Eryiğit (2011), and Pugh (2013) contributed to the study of governance forms of university-industry knowledge collaboration.

The review of literature in Kazakhstan revealed a vast deal of studies describing the challenges and the perspectives of education, science, and innovations in our country. Thus, the works by Kenzheguzin M., Dnishev F. and Alzhanova F. (2005), Alzhanova F. (2009), Fursova T. (2012), Adekenov S. (2011), Darenskih G. (2009), Kokanov S. and Doschanova A. (2010), Iskakov U. (2010), Umirzakov S. (2007), Yessengeldin B. and Sitenko D. (2011), Goltsev A. and Zhumagazinov Y. (2010), Zhurinov M. (2011), and Smirnova Y. (2011) examined science in the context of innovative development of Kazakhstan. Yet some researchers emphasized the role of universities in the development of science which leads to greater innovative output (Bekturganova R., 2011; Akimbayeva A., 2010; Alzhanova N., 2010; Adilov Zh., 2011; Insepov Z., 2010; and Zhurinov M., 2010).

Although much previous research in Kazakhstan focused on the development of education, science, and innovations, a thorough literature revealed only a limited number of studies on the transition of our country to a knowledge-based economy (Sahanova A. and Medeuova D., 2009; Alzhanova F., 2007; Sabden A., 2011; Sahanova A. and Sadykova M., 2009). Moreover, our literature analysis did not uncover descriptive or empirical studies on governance of university-industry knowledge transfer in Kazakhstan. Only few local works were found to mention about a need for strengthening ties between academia and industry (Bishimbayev V., 2011; Adekenov S., 2011; Adilov Zh., 2011; Zhurinov M., 2011). This literature gap had predetermined the choice of the topic and purpose and objectives of this dissertation.

The purpose of the study is to identify theoretical tools for knowledge transfer and practical mechanisms for effective governance of university-industry relationships in the telecommunications sector of Kazakhstan.

To achieve this goal the following theoretical and practical objectives were set:

- to develop theoretical bases and to analyze, classify, and systemize existent world approaches to governance of knowledge transfer and forms of university-industry collaboration;
- to determine the nature, main characteristics and channels of university-industry knowledge transfer;
- to identify key factors, features and channels of university-industry knowledge transfer in the telecommunications industry of the Republic of Kazakhstan;
- to identify the mechanism and develop tools for effective governance university-industry knowledge transfer in Kazakhstan.

The object of the study is universities and companies in telecommunications sector of Almaty.

The subject of the study is the process of governance of knowledge transfer between academia and industry.

Theoretical and methodological basis of the study is represented by works of foreign and Kazakhstani scholars on issues related to governance of university-industry collaboration and knowledge transfer. The methodology of the dissertation study is built upon a research "onion" and relies on the use of a hypothetical-deductive method for the construction of the research logic. The main research tools used in this thesis are: analysis, synthesis, induction and deduction, comparisons, generalizations, etc. Among of the key practical instruments of the research are surveys and interviews with leading experts, top managers of companies, and the administration of various universities involved in the process of knowledge transfer.

Informational basis of the study includes the materials and reports published by the Agency of Statistics, the concepts and strategies of development, state programs, legislation of the Republic of Kazakhstan, as well as international reports such as Global Innovation Index 2013 and Global Competitiveness Report 2012-2013.

Scientific novelty of the research includes theoretical basis for management of knowledge transfer between companies and universities as well as the development of university-industry knowledge exchange mechanism existing in practice. In particular, **theoretical** and **practical** novelty of the study is the following:

- a categorical apparatus necessary for studying the process of knowledge transfer in Kazakhstan was examined and identified for the first time. In this connection, the author's definition of "transfer of knowledge" was given which described knowledge transfer as the process of exchanging information, ideas, research results, and experiences between firms, universities, research organizations, government and other communities which fosters the development of innovations in all spheres of the economy;
- based on the study of theoretical and methodological approaches to the analysis of knowledge transfer between universities and enterprises the main channels of knowledge transfer, benefits and barriers were identified, classified and systematized depending on the country and economic sector/industry;
- foreign practices in management of knowledge transfer were analyzed and the role of the state in governance of university-industry relationships was determined in both developed and developing countries;
- the role of the innovation infrastructure to bridge education, science and business was revealed and the evolution of legislative definition of innovation infrastructure in the Republic of Kazakhstan was determined;
- a new methodology for evaluation of the effectiveness of the innovation infrastructure as a bridging element between education, science and business was proposed and applied to the Republic of Kazakhstan;
- a methodology for the analysis of university-industry knowledge transfer in telecommunications sector was developed and implemented in RK;
- a model of university-industry knowledge transfer governance in the Republic of Kazakhstan was elaborated.

Theoretical contribution of the study. Theoretical conclusions of this research go a long way towards the formation of theoretical foundations of university-industry collaboration and governance of knowledge transfer in Kazakhstan. The analysis of the structure of R&D expenditures proves the importance of business R&D spending which is positively related to scientific output. The results imply that higher intensity of university-industry collaboration in R&D fosters scientific and innovative development of a country.

The identified and defined by the author categorical apparatus makes it possible to scientifically approach the process of managing the knowledge transfer between university science and innovations on enterprises. The analysis presented in the dissertation provides an insight into a process of university-industry interactions and the attitudes of both universities and firms towards knowledge transfer. It contrasts the agents' perspectives and identifies the most important channels in general and for each party in particular as well as examines the obstacles hindering knowledge collaboration in telecommunications sector of Kazakhstan. Moreover, the study elaborates a model of university-industry knowledge transfer which explains the deficiencies of the relationships and identifies the main directions for improvement of the agents' relations.

Another important theoretical contribution of the conducted research is a scientific analysis of the elements of the innovation infrastructure which typically perform a liaison function for education and business sectors. A new methodology for the analysis of the effectiveness of the innovation infrastructure provides a more objective basis for making inferences about its condition.

Practical contribution of the study. The suggestions and recommendations provided by the author are of particular importance to policy makers dealing with governance of university-industry knowledge transfer who could revise the legislative documents, programs, and strategies and implement new instruments to motivate both universities and companies collaborate in the field of knowledge. This research provides an understanding of the perceptions of the agents about collaboration with each other. Additionally, the results of this study may be used to increase the effectiveness of the innovation infrastructure as well as to provide a deeper integration both educational, business, and institutional structures.

Basic propositions for thesis defense:

- author's definition of knowledge transfer in the context of Kazakhstan realms;
- the results of a comparative analysis of successful foreign practices and the role of the state in governance of knowledge transfer in developed and developing countries;
- a methodology for the evaluation of innovation infrastructure effectiveness as a bridging element between education, science and business and its application to the Republic of Kazakhstan;
- a methodology for the analysis of university-industry knowledge transfer and the results of the empirical study in the telecommunications sector of RK;
- a model of university-industry knowledge transfer in the context of RK.

Approbation and implementation of the research results. The main propositions and results of this study were reported at international scientific and practical conferences: "Making Innovation Work for Society: Linking, Leveraging and Learning", Kuala Lumpur, Malaysia, 2010; "Innovation in Education and Science", Kaskelen, 2011; "Innovation and Development: Opportunities and Challenges in Globalization", Hangzhou, China, 2012; "Entrepreneurship, Innovation Policy and Development in an Era of Increased Globalization", Ankara, Turkey, 2013; "2nd World Conference on Business, Economics and Management", Antalya, Turkey, 2013; and "V Congress on Entrepreneurship", Almaty, Kazakhstan, 2013.

Additionally, some propositions and results of the research work were introduced at "Leadership and Management for Integrity" summer school and "Business Integrity in Emerging Markets" policy lab in Budapest, Hungary, 2011.

The key theoretical, methodological, and empirical findings of the dissertation were presented at the GLOBELICS Academy – a 9th PhD School on Innovation and

Economic Development in Tampere, Finland, 2013. The author's work received valuable comments and was highly appreciated by Prof. Manuel Godinho (Technical University of Lisbon, Portugal).

Moreover, the main propositions and results of the research were expounded and practically implemented at four universities and five telecommunications firms. Among the universities were: Kazakh-German University, Turan University, Almaty University of Power Engineering and Telecommunications, and Suleyman Demirel University. Firms at which upon the request of top managers presentations and discussions were held included: Skymax Technologies, ZyXEL, Basis Telecom, Resolution, and Aspan Telecom. Both universities and telecommunications firms provided the acts on the implementation of results.

This research exerted a positive influence on the image and reputation of Suleyman Demirel University as well as other universities in the eyes of telecommunications firms. The end result of this was the establishment of university-industry collaboration in the field of knowledge between ZyXEL and Suleyman Demirel University.

Publications. On the topic of the dissertation altogether 14 scientific papers were published. Among them are: 4 articles in Kazakhstani journals ("Vestnik Universiteta Turan", "Ekonomika i Statistika", "Vestnik KazNU", and "Ekonomika: Strategiya i Praktika") recommended by the Higher Attestation Commission of the Republic of Kazakhstan; 1 article in the international journal ("Interdisciplinary Journal of Contemporary Research in Business") indexed and abstracted in 10 databases comprising Ulrich's Journal Database; 3 articles in the international journals listed in Scopus database ("Procedia – Social and Behavioral Sciences", "Quality in Ageing and Older Adults", "Social Responsibility Journal" – the article in the latter journal was chosen as a Highly Commended Award Winner at the Emerald Literati Network Awards for Excellence 2013); 1 chapter in the book "Quality Innovation: Knowledge, Theory and Practices" (USA), and 5 articles in the materials of international conferences, 4 of which were abroad (Malaysia, China, and Turkey).

Structure of the thesis. The structure of the dissertation reflects the logic and the order of resolving the tasks. This thesis consists of introduction, three main parts, conclusion, list of references, and appendices. The volume of the dissertation is 142 pages, including 20 figures and 20 tables. The list of references contains 221 items.

1 THEORETICAL UNDERPINNINGS OF KNOWLEDGE TRANSFER AND UNIVERSITY-INDUSTRY RESEARCH COLLABORATION

Today, many researchers all over the world come to understand that knowledge is a key factor for the development of nations in the information age. In an economy based on knowledge, technological innovation becomes a crucial element for achieving competitive advantage. Traditionally, higher education institutions[1] are being perceived as the source of knowledge, science, and technology. However, to bring a greater benefit to an economy, knowledge and technology should not only be created at the universities but should also be transferred to an economy and implemented in the industry [1]. It has been proved that effective university-industry relationships strengthen a country's economic development and foster innovation growth [2].

In this chapter, we look at theoretical underpinnings of knowledge transfer and university-industry collaboration. Specifically, theoretical review brings up some basic definitions and concepts of knowledge and puts an emphasis on its explicit and tacit nature. Thus, in this part we draw a line between theoretical knowledge taught at the universities and practical that can be implemented in an organizational context. Knowledge that stands alone is not economically useful. Therefore, we further consider different models that explain the process of knowledge transfer. The main agents in this process are universities and organizations in which universities play the core role as generators and disseminators of knowledge.

In the second part of the chapter, we consider theoretical underpinnings of university-industry knowledge transfer. In particular, we look at the phenomenon of university-industry collaboration; describe its nature and determinants. The channels through which knowledge can be transferred are given a particular importance. Further, the discussion focuses on the benefits from university-industry collaboration and the barriers to these interactions as pursued by the parties. A variety of governance forms for effective knowledge transfer are presented in the last section of this part.

In the third part of Chapter 1, we look at how theoretical approaches find their practical application in both developed and emergent economies. It is necessary to note that there is a consensus in the literature on the difference in the nature of university-industry relationships and knowledge transfer in these groups of countries. Thus, we will analyze the examples of developed countries in university-industry collaboration and selected emergent economies which might have similarities with Kazakhstan in economic, political and cultural contexts. The experience of these nations as well as their policies implemented to foster university-industry collaboration will be thoroughly examined in this section.

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[1]According to the law of the Republic of Kazakhstan *"On Education"* (2007), higher education institutions are divided into three types: universities, institutes, and academies.
University delivers educational training in three or more directions at the undergraduate, graduate and postgraduate levels, performs basic and applied research, and plays a role of a research and methodological center. *Institute* provides training only in undergraduate educational programs. *Academy* delivers educational training in one or two directions at the undergraduate, graduate and postgraduate levels.
In this dissertation the terms "university" and "higher education institution" are used interchangeably to represent the sector of higher education in general.

1.1 Conceptualization of Knowledge and Knowledge Transfer

1.1.1 The Nature of Knowledge and Knowledge Transfer

Prior to conceptualization of "knowledge transfer" it is logically to understand the nature of knowledge. Today, the concept of "knowledge" and the ways of its dissemination are vigorously discussed by many scholars in the world. The interest in this issue is not surprising as it has become obvious that knowledge embraces many aspects of our lives such as "science, humanities and technology, research and development (R&D), innovations, education, languages, literatures and art" [3, p. 990]. In this connection, some authors argue that every society has always been a knowledge society in that knowledge has always reinforced economic growth and social development [4].

Although "knowledge" is an integral part of our lives, the term itself is not easy to define. There were many attempts to precisely define "knowledge" but the search for a formal definition still continues [5]. To date, one of the most popular definitions of knowledge pertains to Nonaka (1994) who described it as a justified personal belief which increases an individual's capability in effectively performing cognitive and intellectual activity [6].

Later, Nonaka and Takeuchi (1995) defined knowledge as "a dynamic human process of justifying personal belief towards the truth" [7]. A more broad definition of knowledge was provided by Davenport and Prusak (1998).This definition was adopted for the purpose of this study because it is quite complete and reflects the contextual aspects of knowledge:

> "Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information" [8, p. 5].

As the above mentioned, knowledge is a dynamic process, i.e. it is created, accumulated and disseminated. Various classifications of knowledge were proposed by different scholars. Thus, Winter (1987) distinguishes between tacit – articulable, not teachable – teachable, not articulated – articulated, not observable in use – observable in use, complex – simple and element of a system – independent [9]. Anderson (1983) divides knowledge into declarative and procedural knowledge [10]. Later, Quinn *et al*. (1996) adds one more dimension – causal knowledge [11]. In contrast, Leonard-Barton (1995) identifies three major types of knowledge: public-scientific, industry-specific, and firm-specific [12].

According to the view of the social system, knowledge can be classified as human, social, and structured [13]. Human knowledge refers to what individuals know, or know how to do and combines both explicit and tacit elements of knowledge. Social knowledge is largely tacit, shared by group members and develops only because of interaction among individuals. Structured knowledge is explicit and it is embedded in an organization's systems, processes, tools and routines [13].

Despite the numerous classifications of knowledge, most experts such as Nonaka and Takeuchi (1995), Polanyi (1966), Kogut and Zander (1992), Steward (1999), Smith (2001), Greiner *et al*. (2007), Jensen *et al*. (2007), Abreu *et al*. (2008), Howlett

(2010), Jones and Mahon (2012) agree that knowledge by its nature can be either tacit or explicit [7, 14, 15, 16, 17, 18, 19, 20, 21, 22].

This classification of knowledge into tacit and explicit was first introduced by Michael Polanyi in 1966. He described tacit knowledge as highly personal and accumulated through learning, reflection and experience. Tacit knowledge is deeply rooted in individuals' actions and experiences [14] and resides within the minds of people [16]. Polanyi (1966) further divided tacit knowledge into two dimensions: technical and cognitive. Technical dimension includes informal personal skills and crafts often called "know-how" and cognitive dimension comprises beliefs, ideals, values and mental models which shape how the one perceives the world [14].

Tacit knowledge is something known but not easily articulated. In other words, tacit knowledge is intangible and must be converted into words, models, or numerical numbers to be communicated [20]. Usually, tacit knowledge "requires intense interaction and can be successfully transferred only in a small group setting at the specific location where the knowledge is used" [23]. This all implies that tacit knowledge is hard to transfer; one can learn it mostly through experiences and personal interactions. However, some part of tacit knowledge can be transferred through the process called "codification" although it is inherently difficult [20].

In contrast, explicit knowledge, also called codified, is the information that includes facts, axiomatic propositions, and symbols [15] which can be easily codified, stored [22] in certain media like manuals, mathematical expressions, copyright and patents [17, 20], and can be readily transmitted in formal language [14, 18]. Smith (2001) describes explicit knowledge as structured, systematic, and technical [17] which may be obtained through reading manuals [24], reading books, attending lectures, and accessing data bases [19]. The key characteristics of explicit and tacit knowledge were summarized by Howlett [21] (see Table 1).

Table 1 – The Key Characteristics of Tacit and Explicit Knowledge

Tacit knowledge	**Explicit knowledge**
Subjective quality	Objective quality
Difficult to formalize or articulate	Expressible in formal language
Storage in the minds of individuals	Capture and storage in records possible
Bound to a specific context	Largely context-free
Note – Compiled by the author based on [21]	

In comparison with tacit knowledge which is often called "know-how", explicit knowledge is often referred to as "know-what". De-Alwis and Hartman (2008) argue that most firms and organizations are familiar with explicit (codified) knowledge [24]. Although it might be true to some extent, we think that explicit knowledge used in organizational context is always accompanied by tacit element. In this regard we agree with Howlett (2010) who has noted that "explicit knowledge only represents the tip of an iceberg, with tacit knowledge as the far larger bottom of the iceberg hidden under the surface" [21]. Moreover, Jones and Mahon (2012) state that both tacit and explicit are incomplete without each other [22]. This all implies that knowledge is rarely completely codified or completely tacit [25]; this should be taken into consideration during the process of knowledge transfer.

Having continued our study on the nature of knowledge and knowledge transfer it is important to note that the term “knowledge transfer” has a wide range of meanings and uses. In our opinion, in a general sense knowledge transfer can be understood as a process of transmitting information and ideas from one party to another. Dyer and Nobeoka (2000) define knowledge transfer as knowledge sharing among people which implies giving and taking of information [23]. Knowledge transfer occurs through processes of socialization (e.g. education and learning) and cultural exchanges; it may be purposeful or may result as an outcome of other activities [26].

Szulanski (2000) views knowledge transfer as “dyadic exchanges of knowledge between a source and a recipient in which the identity of the recipient matters” [27]. The recipient and the source may possess different preceding levels of knowledge, and as a result they may have different perceptions and interpretations of the same information [23] which may serve as an obstacle to effective knowledge transfer.

According to Wilkesmann *et al.* (2009), knowledge transfer may occur at three levels: individual, intra-organizational, and inter-organizational [28].

- ✓ Knowledge transfer at the *individual level* can be described as exchange of information, skills and expertise between peers, friends and acquaintances.
- ✓ *Intra-organizational knowledge* transfer involves sharing information, ideas, and facts which occurs within one organizational setting (e.g. department, division, organization or university) [28].
- ✓ *Inter-organizational knowledge* transfer is the process of learning from outside the organizational boundaries through which one organization learns from the experience and knowledge of another [29]. Knowledge transfer between universities and enterprises occurs at the inter-organizational level.

Quite often researchers use the terms “knowledge transfer” and “technology transfer” interchangeably [21, 30]. However, a recent study by Abreu *et al*. (2008) found that technology transfer is only one aspect of the knowledge exchange process [20], and knowledge transfer has a broader meaning than technology transfer [21, p. 297]. Technology is more specific in its focus, more tangible, less prone to subjective interpretation and refers more to new tools, methodologies, processes and products. Knowledge, on the other hand, “embodies broader learning evidenced as changes in the strategic thinking, culture and problem solving trough techniques used by a firm” [30]. The distinction between the concepts of technology and knowledge was summarized by Howlett [21] (Table 2).

In Kazakhstan, the concept of technology transfer is relatively new. The first detailed explanation of the concept and its importance may be attributed to scholars from the Institute of Economics of the Ministry of Education and Science of the Republic of Kazakhstan – Kenzheguzin M., Dnishev F., Alzhanova F. [31]. But at the same time, the concept was clearly reflected in “Strategy Kazakhstan-2030”: At the New Stage of Kazakhstan’s Development” introduced in 1997. Despite this, the concept of knowledge transfer has never existed in our country. This is evidenced from the analysis of a set of government programs, strategies and laws which has revealed

Table 2 – Key Dimensions of Technology and Knowledge Transfer/Sharing

	Knowledge	Technology
Breadth of construct	-Narrower and more specific construct -Can be seen as an instrumentality or set of tools for changing the environment	-Broader and more inclusive construct -Embodies underlying theories and principles related to cause and effect relationships
Observability	-More tangible and precise	-Less tangible and amorphous
Overarching characteristic	-More explicit and codified where learning can be taught -Primarily stored in blueprints, data bases, and manuals	-More tacit where learning is mainly by doing -Stored primarily in people's heads
Organizational learning	-More reliance on controlled experiments, simulations and pilot-tests	-More trial and error
Nature of interactions	-Inter- and intra-organizational interactions that deal mostly with operational issues and how things work	-Inter- and intra-organizational interactions that deal mostly with strategic issues and why things work the way they do.
Note – Compiled by the author based on [21]		

that policymakers make an emphasis on technology transfer and neglect the importance of introducing the concept of knowledge transfer which is a prerequisite for the former. Thus, the use of the term 'technology transfer' was found in the following government documents:

- ✓ *Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014;*
- ✓ *Program for the Formation and Development of the National Innovation System of the Republic of Kazakhstan for 2005–2015;*
- ✓ *State Program for Accelerated Industrial Innovative Development of the Republic of Kazakhstan for 2010-2014;*
- ✓ *State Program for the Development of Education of the Republic of Kazakhstan for 2011-2020;*
- ✓ *Innovative Industrial Development Strategy of the Republic of Kazakhstan for 2003-2015;*
- ✓ *"Strategy Kazakhstan-2050": A New Political Course of the Established State";*
- ✓ *"Strategy Kazakhstan-2030": At the New Stage of Kazakhstan's Development";*
- ✓ *The Concept for Formation and Development of Industrial and Innovation Infrastructure (Special Economic Zones, Industrial Zones, Technological Parks, and Business Incubators) (2007);*
- ✓ *The Concept of Innovative Development of Kazakhstan till 2020;*
- ✓ *Law "On state support of innovation activities" (2006);*

- ✓ *Law “On state support of industrial and innovation activities” (2012);*
- ✓ *Interindustry Plan for Scientific and Technological Development of the country till 2020.*

Although the earliest mention of “technology transfer” was in 1997 in the *Strategy “Kazakhstan - 2030”*, its first official definition appeared in 2006 in the law entitled *“On state support of innovation activities”*. The law defined technology transfer as the transfer of rights from the owner to the subjects of innovation activities for the use of innovations that are patented in the Republic of Kazakhstan and (or) abroad. Obviously, that definition was narrowly focused merely on granting rights for the use of innovations and not specifying the nature of innovations. A recent definition of technology transfer in the Law *“On state support of industrial and innovation activities”* (2012) is much broader which describes it as the process of introduction of a new or improved technology by subjects of industrial innovation, the rights of ownership, possession and (or) the use of which have been received by means not prohibited by the law of the Republic of Kazakhstan.

Some scholars argue that focusing merely on technology transfer is not practical. “The linear approach to technology transfer has been replaced by approaches that emphasize the interactive and social nature of the knowledge transfer process” [32]. It is important to note that effective technology transfer may be impossible without knowledge transfer. Therefore, there a need for the introduction of the concept of “knowledge transfer” in Kazakhstan. However, borrowing this concept from other countries may be somewhat tricky as the term “knowledge transfer” has different meanings in different contexts [21]. Thus, we propose the following definition of knowledge transfer in the context of Kazakhstan:

> Knowledge transfer is the process of exchanging information, ideas, research results, and experiences between firms, universities, research organizations, government and other communities framed by sociocultural characteristics of the agents which fosters the development of innovations in all spheres of the economy.

The proposed definition implies that the process of knowledge transfer is multilateral, i.e. it involves many parties starting from business enterprises to governmental organizations. The greatest part of knowledge is transferred though social and cultural exchanges [26]. Cultural differences between countries in transferring knowledge were covered by several studies [28, 33, 34]. For example, a study by Wilkesmann *et al*. (2009) found that knowledge transfer in Hong Kong is more unorganized but also more innovative than in Germany [28]. Based on this, we suppose that specific characteristics of knowledge transfer in Kazakhstan are also shaped by cultural aspects which may impact the speed, the quality and the effectiveness of knowledge exchange.

Another important perspective that was covered in the new definition is the impact of knowledge transfer which has a positive effect on a country’s competitiveness and economic growth [35]. However, as Audretsch and Keilbach (2008) noted investments in new knowledge do not automatically translate into competitiveness and growth [35]. It may take some time for the new knowledge to be absorbed by the agents. Plus, in most cases it matters how knowledge has been transferred which determines the rate of success. The next section discusses the complexity of knowledge exchange and describes different knowledge transfer models.

1.1.2 Knowledge Transfer Models

The review of literature has identified a number of basic models of knowledge transfer. The most relevant for this study were developed by Nonaka and Takeuchi (1995) – the knowledge spiral model [7], Szulanski (2000) – the communication model [27], and Liyanage *et al.* (2009) – a process model [36]. Although the communication model of knowledge transfer was developed later than the spiral it is vital to include it first into our discussion as it was the first to describe knowledge transfer as a communication process.

The Communication Model views the process of knowledge transfer as a transmission of a message from a source to a recipient which flows through four stages: initiation, implementation, ramp-up, and integration, summarized in Figure 1.

Initiation stage is characterized by realization of the need for knowledge transfer. The participants must understand what knowledge they need, how and from where the information can be collected and whether the information is feasible or not to satisfy knowledge they need.

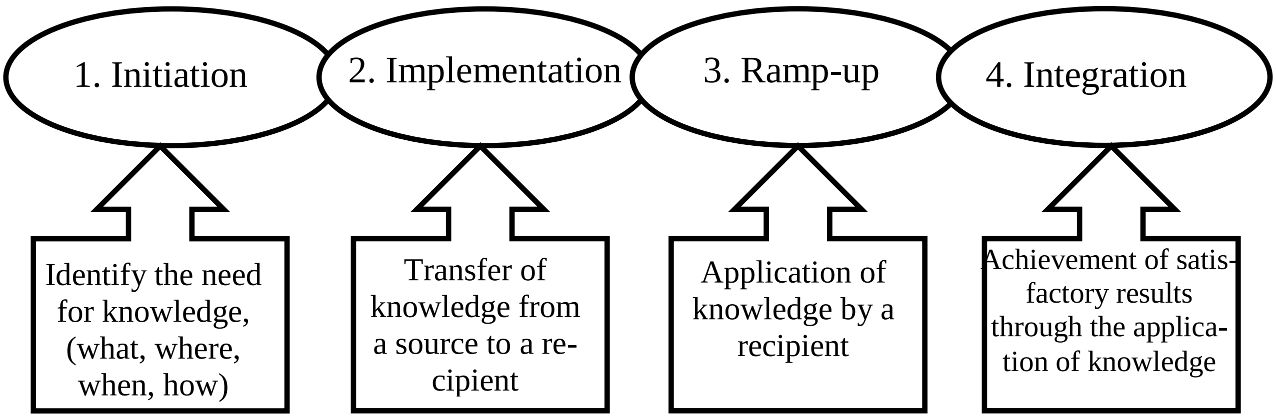

Figure 1 – Communication Process Model

Note – Drafted by the author based on [27]

Implementation stage begins with decision to proceed. Once the decision to transfer knowledge has been taken, the information (e.g. communication, documentation) can be released by one party and received by the other. Both parties adapt knowledge to suit their needs. Once knowledge transfer is completed the implementation stage commences.

Ramp-up stage begins when the recipient starts applying the transferred knowledge to solve problems in his/her daily work. The recipient evaluates the knowledge according to its ease of implementation and application, and the success it will bring to solving his/her problem.

Integration stage begins after the recipient achieves satisfactory results of applying the transferred knowledge. As the time passes, knowledge transfer between the sources and the recipients is increased. Knowledge can flow more freely; it adds new applications to the existing knowledge [27].

While developing a communication process model Szulanski (2000) introduced the concept of knowledge "stickiness" as the main obstacle to effective knowledge transfer. He defined knowledge stickiness as a difficulty in transferring knowledge because of routines in organizational setting. His main finding was that knowledge stickiness exists in every stage of the communication model, thus he proposed to "unstick" sticky knowledge transfers by using process thinking [27].

The spiral model, also called knowledge conversion model, was firstly developed by Nonaka and Takeuchi [7, pp. 57-60]. The process of knowledge creation is viewed as a continuous interaction between tacit knowledge and explicit dimensions of knowledge. The process consists of four modes: Socialization, Externalization, Combination and Internalization which are abbreviated as SECI (Figure 2).

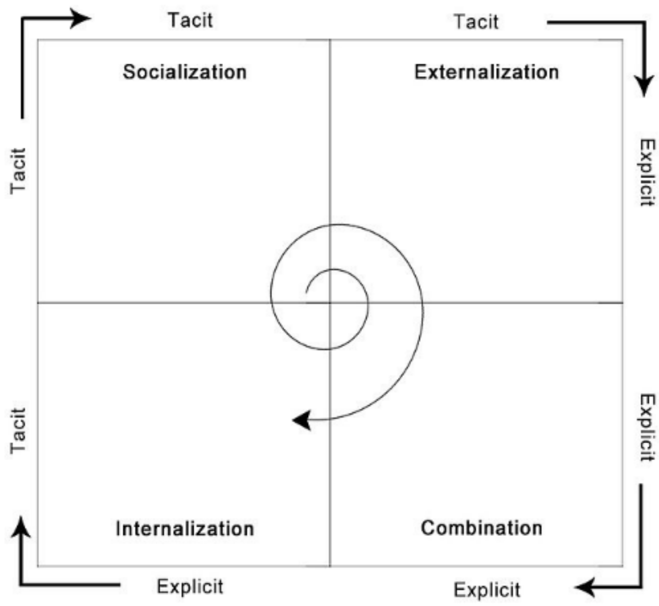

Figure 2 – Knowledge Transfer Model

Source – [7]

Socialization (tacit to tacit) involves sharing knowledge through face-to-face communication or experiences (e.g. meetings, brainstorming, on-the-job training). Since tacit knowledge is difficult to formalize, it can be acquired only through shared experience in a specific social setting rather than from written manuals or textbooks.

Externalization (tacit to explicit) occurs when tacit knowledge is transformed into a more explicit form like concepts, models, images, and written documents which can be communicated by language. In other words, tacit knowledge is made explicit, thus allowing it to be shared by others.

Combination (explicit to explicit) is the process of combining or reconfiguring existing explicit knowledge to generate new explicit knowledge. Computerized networks and computer databases strongly support this knowledge combination process.

Internalization (explicit to tacit) is the process of application of explicit knowledge, for instance, through experimenting in different ways, such as through real life experiences or software simulation [7].

Although this model of knowledge transfer explicitly demonstrates how tacit and explicit knowledge, discussed in the first part of this Chapter, may interact with each other, it doesn't cover some environmental factors which might influence the transfer process. In this respect, one of the latest works by Liyanage *et al*. (2009) [36] puts the study on knowledge transfer forward by developing a detailed model of knowledge transfer process on the basis of the theories of translation and communication (Figure 3). The model is built upon the two elements – the source and the receiver – extracted from the communication theory. The spiral model developed by Nonaka and Takeuchi (1995) was also used in the process model to describe different modes of knowledge transfer.

A **Process Model of Knowledge Transfer** consists of six steps and depicts in details how knowledge flows from source to receiver:

1. *Knowledge awareness* refers to the identification of the appropriate or valuable knowledge;
2. *Knowledge acquisition* occurs provided that both receiver and source have the willingness and the ability to do it and influenced by intensity, speed, and direction knowledge flow;
3. *Knowledge transformation* is accomplished simply by adding or deleting knowledge;
4. *Knowledge association* involves conversion relating the transformed knowledge to internal needs of the organization;
5. *Knowledge application* is the phase in which the acquired knowledge is brought to bear on the problem at hand;
6. *Knowledge externalization* involves the transfer of the experiences or new knowledge created by the receiver to the source.

Though the above steps describe a complete model of knowledge transfer process, Liyanage *et al.* (2009) argue that the theory of translation raises a need to include three other elements into the process model: networking, influence factors, and performance measurements. *Networking* implies tight collaborations between individuals, teams, and organizations which subsequently lead to a more efficient coordination of the acquired knowledge. *Influence factors* represent the barriers or constraints of the transfer mechanism as well as positive factors that can promote the process of knowledge transfer. Influence factors are broadly categorized into two elements: intrinsic influences and extrinsic influences. *Performance measurements* allow the participants to assess the accuracy and quality of the knowledge acquired which reduces the possibility of repeating mistakes in future knowledge transfer practices [36].

To summarize, the communication model has shown the roles of sender and receiver in the knowledge transfer process. The knowledge spiral model has helped

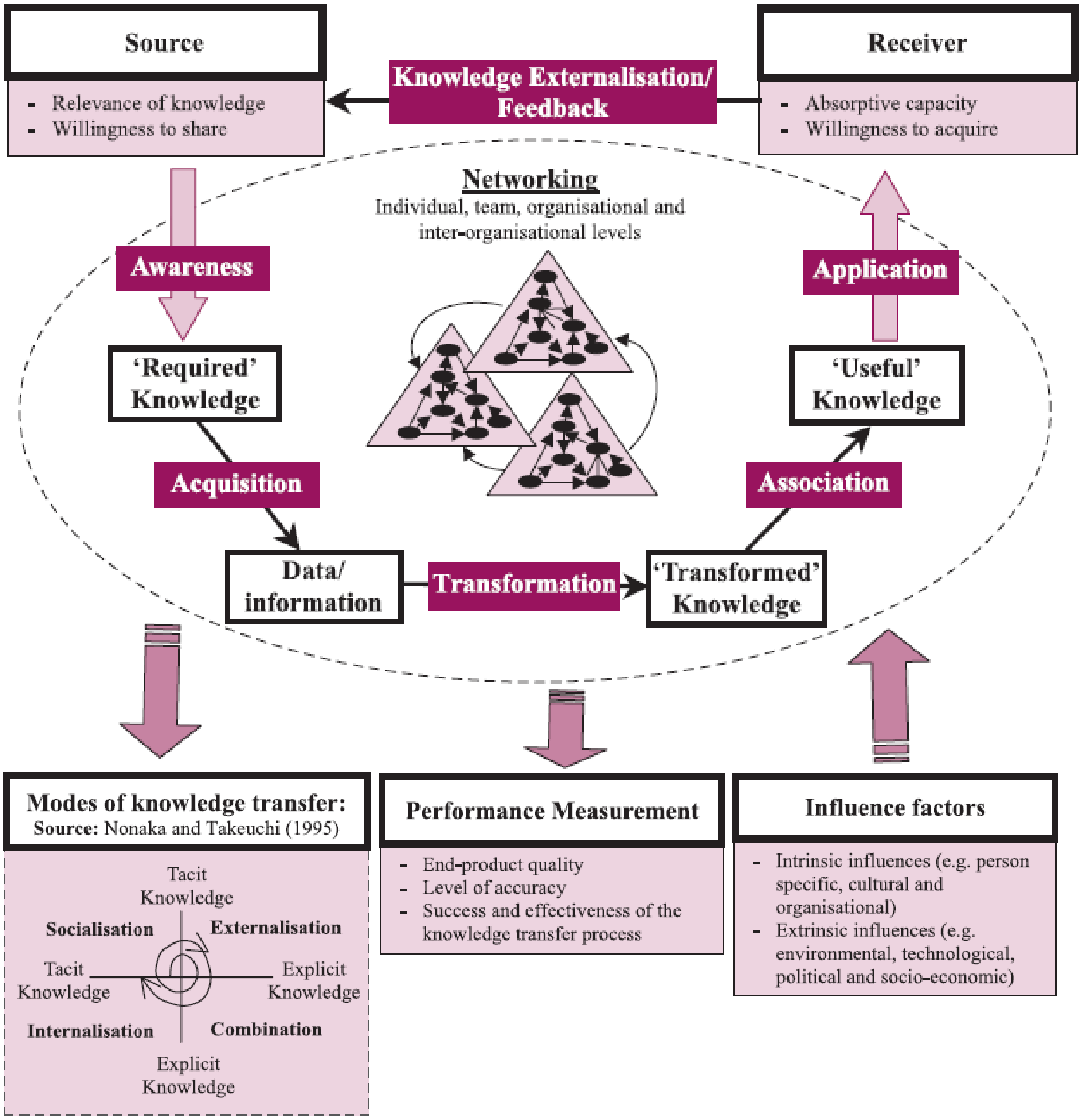

Figure 3 – Knowledge Transfer – A Process Model

Source – [36]

us to understand how intimately connected the processes of transferring and creating knowledge are. The two models of knowledge transfer complement each other.

The communication model demonstrates the steps involved in the process of knowledge transfer and views transfer as a transmission from source to a recipient while the spiral model to a greater extent focuses on the transformation of knowledge from tacit to explicit and vice versa. The knowledge transfer process model shows us that “knowledge transfer, per se, is not a mere transfer of knowledge” [36] but it involves different stages of transformation and is influenced by positive and negative factors.

We think that the knowledge transfer process model by Liyanage et al. (2009) is most relevant to this study as it provides a detailed description and brings deeper understanding of how knowledge moves from sender to the receiver shaped by environmental factors. Moreover, this model encompasses the findings of Nonaka and Takeuchi (1995) which demonstrate different modes of explicit and tacit knowledge transfer. Although the model by Liyanage et al. (2009) seems to be applied to different agents participating in the knowledge transfer process, it might be particularly useful in explaining this process from university-industry perspective.

1.1.3 The Role of Universities in the Knowledge Transfer Process

Traditionally, universities have performed mostly research and education functions. But today universities are increasingly complementing these functions with the transfer of knowledge to the industry which is an essential component of the innovation system that has a significant economic and societal impact [37]. It has added a new dimension to the university's role in the society: "economic development of technological innovation and transfer" [38].

A recent study by Cosh and Hughes (2009) summarized the roles universities perform in the context of the innovation system development:

- ✓ Provide the economy with skilled labor force (undergraduates, graduates, post-docs);
- ✓ Produce and disseminate codified knowledge through research publications, patenting, prototyping, etc.;
- ✓ Perform problem-solving activities for industry through contract research, faculty consulting, incubation services, etc.;
- ✓ Provide public space, i.e. create a platform where individuals can meet and exchange ideas (e.g. formation of networks, socialization of interactions) [39].

Universities are considered to be the most important mechanism for generating, preserving and disseminating knowledge into our society (20, 40, p. 2, 41). Universities are first of all the source of scientific knowledge and technical skills [42]. Plus, they provide our economy with two most valuable assets: educated people and new ideas [43]. In this regard Etzkowitz (2002) notes that "*universities increasingly provide the basis for economic development through the generation of social and intellectual, as well as human capital…*" and by doing so "*…they become core institutions in society*" [44, p. 1]. This emphasizes the role of universities as promoters of economic development in addition to their two traditional functions of teaching and research [45].

In a knowledge-based economy, universities are expected to play an active role in promoting technological change and innovation [32]. Scientific research conducted at universities is translated into new technologies that may be adopted in future by the society [46]. This is usually achieved through the integration of education, research and innovation into a "knowledge triangle" which was introduced by the Lisbon Agenda in 2000.

The integration of a knowledge triangle is a prerequisite for building innovative economy. Innovations in this economy are usually supported by innovative entrepreneurship the ideas for which are derived from university knowledge [47]. In this case, universities may act as “incubators” for knowledge intensive spin-offs [48]. Hence, in order to stimulate innovative and entrepreneurial activity it is necessary to create linkages between universities and enterprises. It should be kept in mind that the relationships between universities and industry do not only include the transfer of knowledge from one party to another, but they also help scientists to formulate interesting research tasks, conduct high-quality research and get more clearer understanding of how to apply research results to the industry [37]. As noted by Mueller (2006), such interactions between universities and industry increase the rate of innovation in the economy [49].

The term “university-industry knowledge transfer” implies the exchange of knowledge and technology between universities and firms at different levels which involves different activities [50]. For example, university personnel may provide consultations to industry representatives, analyze data, or even run some experiments and tests [38]. Knowledge may also be disseminated through R&D cooperation, scientific publications, workshops, seminars, and informal relationships [48]. One of the most important instruments in university-industry knowledge transfer is teaching. Cooperation in graduate education and advanced training for enterprise staff [51] increases the qualification of the labor force, i.e. increases intellectual capital of the nation.

There are some cross-sectional differences in the role that universities play in the knowledge transfer process. Thus, in the chemicals sector the main role of universities is to help firms to reduce costs and risks in order to finalize products; in agro-industry, to help organizations to meet government regulations; and in computer services sector, to facilitate firms to acquire and update technical knowledge [52].

The role of universities in the transfer of knowledge differs between countries, as well. Schiller and Leifner (2007) argue that the role of universities in developing economies is to educate the population and help to absorb knowledge from developed countries. Thus, in Thailand teaching at universities is mainly conducted for undergraduate students and is mostly restricted to social sciences and humanities; science and technology programs are suffering from the lack of equipment and outdated curricula. The greatest part of the research projects in this country is focused on adapting knowledge from developed countries and applying it in Thai context. Although Thai professors try to cooperate with private firms in consultancy, teaching and research, truly interactive research collaboration is not yet in place [53].

In developed countries such as Spain [54] and the United Kingdom [20], universities generate and disseminate new knowledge which is directly related to economic development and innovation growth of their economies. The transfers of knowledge and university-industry relationships in most developed nations are shaped by government regulations. Such an approach to university-industry interactions in which the government plays a crucial role is called “Triple Helix” [55]. Under this approach the government develops different incentives (subsidy programs, tax credit, etc.) to promote R&D cooperation between firms and universities.

In Kazakhstan, policy makers have just come to understand the role that universities play in an innovative economy. This is evidenced from some recent studies which discuss a need to involve universities in the innovation process [56] and to strengthen the “knowledge triangle”: education, research, and innovation [57]. According to the *State Program for the Development of Education of the Republic of Kazakhstan for 2011-2020*, by 2020 universities will be actively participating in scientific and technological modernization of the country.

At present time, the development of innovations at Kazakhstani universities is characterized by a traditional linear model where fundamental scientific knowledge is translated into applied research which in turn serves as the basis for advanced technologies [58]. Every university in Kazakhstan is considered as a functional part of the innovation system and contributes to the development of world science and its institutional integration in the innovation system [59]. The involvement of universities in innovation activities responds to two global challenges: first, the development of intellectual potential of the nation through mass higher education, and secondly, the generation and transfer of knowledge for the purpose of fast implementation of innovative technologies in various fields [56].

The government of Kazakhstan is highly concerned with the involvement of universities in innovation activities. This is evidenced from the *Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014* which describes one of the latest government initiatives to create industry clusters which would serve as a platform for university-industry interactions by integrating education, research, and production.

The issue of university-industry interactions and knowledge transfer has been raised in the work by Yesengeldin and Sitenko (2011) who point out to the need for closer ties between the agents in order to stimulate research and innovation activities at the universities. They proposed that universities should focus their efforts on studying industry needs for new technologies in order to ensure their future products would be demanded [56]. Although this suggestion makes some sense, we think that the government should play a decisive role in raising industry demand for new technologies and providing some incentives for university-industry collaboration. By doing so the government will support universities in performing their third mission which a transfer of knowledge. The role of the government in supporting university-industry relationships as well as the nature, the benefits and the obstacles to university-industry collaboration are discussed in the next part of this chapter.

1.2 Theoretical Approaches to University-Industry Collaboration

1.2.1 University-Industry Collaboration: the Nature and the Determinants

The phenomenon of collaborations between universities and private sector is not entirely new. Science historians have traced collaborations between European companies and university researchers back to the 1800s [60]. Today, in turbulent times a need for collaboration between academia and industry is as high as never before. Knowledge produced or transferred through such collaborations is a crucial source of competitiveness for nearly all traditional units, spanning from the individual to firm, region and nation [35].

In literature, there are different explanations of the term collaboration. Generally, collaboration is understood as working together to achieve a common goal. A more elaborated definition of collaboration was provided by Winter and Ray (1994) who defined it as "a mutually beneficial and well-defined relationship entered into by two or more entities to achieve results they are more likely to achieve together than alone" [61].

Very often the term "collaboration" is used interchangeably with "cooperation" [60]. However, some authors make a distinction between the two concepts. Thus, Dillenbourg *et al*. (1995) argue that cooperation involves the division of labor among participants where each person is responsible for a portion of work; while collaboration is a mutual engagement of participants into work where responsibilities are shared by members [62]. Moreover, collaboration is a long term pervasive relationship that usually results in a new structure while cooperation is more informal and short term with no clearly defined mission and structure; collaboration involves sharing resources while in cooperation resources are maintained separately [61]. The main distinctions between collaboration and cooperation are summarized in Table 3.

Table 3 – The characteristics of Collaboration vs. Cooperation

Collaboration	**Cooperation**
Long term	Short term
More persuasive relationship	Informal Relations
Commitment to a common mission	No clearly defined mission
Results in a new structure	No defined structure
Comprehensive planning	No planning effort
Well defined communication channels at all levels	Partners share information about the project at hand
Collaborative structure determines authority	Individuals retain authority
Resources are shared	Resources are maintained separately
Greater risk: power is an issue	No Risk
Higher intensity	Lower intensity
Note – Compiled based on [61]	

In our study, we will use the concepts of collaboration and cooperation interchangeably to reflect a multilateral nature of university-industry relationships which can be both long term and short term, formal and informal, etc.

The modern perspective of university-industry relationships implies the dynamic transfer of knowledge, labor and money between both institutions [46] which enables them to sustain growth in their areas [60]. It is important to note, however, that both firms and universities differ in terms of the incentives to collaborate. The motives for university-industry collaboration were studied by Abreu *et al*. (2008); Ślusarek et al. (2010); Lee (2000); Faems et al. (2005); Turk-Bicakci and Brint (2005); Ryan (2006); Bjerregaard (2009); and Bruneel et al. (2010) [20, 60, 63, 64, 65, 66, 67, 68].

Universities mostly collaborate to gain research funds to acquire laboratory equipment [63] and sustain faculty productivity [60]. In contrast, Turk-Bicakci and Brint (2005) argue that procuring funds is of secondary importance for universities which are primarily concerned with discovering scientific knowledge [65], gaining a practical perspective on academic research and testing theories [63] using new and different applications. In addition, Bjerregaard (2009) notes that university motives to collaborate with firms vary depending on their previous experiences. Thus, universities with a great experience in collaboration with industry tend to pursue a goal of maximizing immediate R&D outcome; universities without previous relationships are motivated to collaborate in order to learn and build networks [67].

Companies collaborate with universities to gain from researchers' ideas to increase innovation performance [60, 64] and competitive advantage. Firms typically want universities to help them to decrease costs, improve the organization's image, increase the learning capacity of the organization [66] and develop the firm's human capital [68]. Abreu et al. (2008) added that companied may want universities to help them identify issues of which previously they were unaware, may have a need for additional capability and a broad spectrum of expertise related to the industry [20].

Some authors have proposed models for university-industry collaboration and knowledge transfer. For example, based on experiences and successful practices of Polish universities, Ślusarek et al. (2010) suggests that collaboration with firms may occur through technology licensing, technology transfer centers, incubators of entrepreneurship, research collaboration agreements, consortiums, and high-level research and technology alliances [60].

Wang and Lu (2007) developed a typology of university-industry interactions on the example of China. The authors identified that the complexity of the knowledge transfer process is influenced by two factors: the degree of knowledge gap between university and industry and the degree of knowledge stickiness. Depending on the degree of these two factors, university-industry interactions may occur at four stages: university-dependent low sticky interactions; university-dependent high sticky interactions; mutual-dependent high sticky interactions; and mutual-dependent low sticky interactions [69]. The characteristics of four dimensions of university-industry interactions are presented in Figure 4.

The degree of knowledge stickiness and knowledge gap determine the strategies to be used for university-industry interactions. Thus, if knowledge stickiness is low and knowledge gap is high, the interactions are university-dependent and low sticky meaning that there is no formal arrangement between the agents and technology can be accessed through buying patents or training company employees. When both knowledge stickiness and knowledge gap are high (university-dependent high sticky), the interactions should focus on establishing collaboration agreements, facilitating human interactions, tacit knowledge transfer, and accumulating experiences for commercialization. Mutual-dependent high sticky interactions are characterized by low knowledge gap and high knowledge stickiness. In this case, the parties should focus on maintaining trust relationships, sharing information and experiences, blurring organizational boundaries for knowledge sharing, and encouraging joint research. If interactions are mutual-dependent and low sticky, both universities and firms should

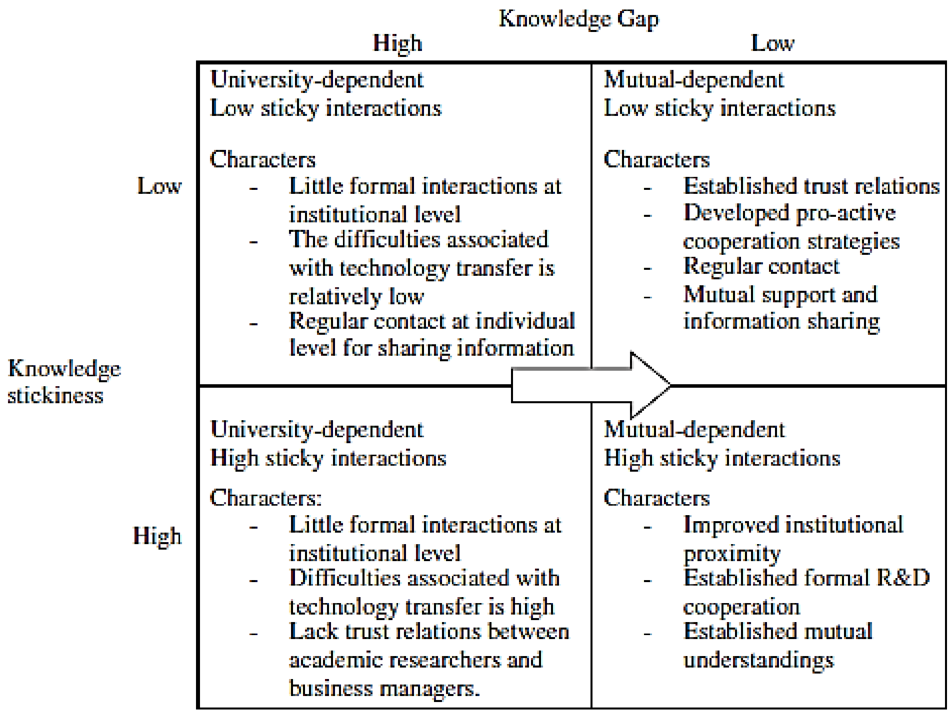

Figure 4 – A Typology of University-Industry Interactions

Source – [69]

adopt strategies to maintain long-term relationships, for example, by involving professors as university consultants or business practitioners as PhD theses supervisors, and conducting joint or contact R&D [69].

Some studies revealed that collaboration between firms and universities is influenced by some organizational characteristics. One of the most important organizational characteristics is absorptive capacity of a firm [70]. The ability of firms to absorb external information, knowledge, and technology increases their propensity to collaborate with universities [54]. Firms usually want to get access to the world-class academics and highly skilled researchers who are both scientifically and industrially aware of the state of the art, access to new knowledge (both codified and tacit) and scientific competence built up within the university, acquire competitive advantage by enhancing the product development process [71].

Some studies on university-industry interactions indicate the importance of firm size as a driver for cooperation. Thus, Adams *et al*. (2000) and Leiponen (2001) obtained a positive size effect of R&D collaborations with universities [72, 73]. The importance of size is in line with the results of other studies on the determinants of university-industry relationships [52, 74, 75, 76, 77, 78, 79]. Nevertheless, Mohnen and Hoareau (2002) did not find firm size to be significantly related to collaboration with universities [75]. Fontana *et al*. (2003) also confirm the importance of firm size as a significant driver for collaboration with universities [80]. Their results suggest that the probability of collaboration depends on the "absolute size" of the firm. Larger firms have a much higher probability of R&D collaboration than smaller firms. Although this is mostly the case, Rasiah and Govindaraju (2009) argue that small and medium firms in Malaysia tend to collaborate with universities more often as compared to large enterprises due to the lack of resources and low capability to undertake R&D [81].

Furthermore, an empirical study by Lööf and Broström (2005) revealed that industrial characteristics influence the incidence of firms' collaboration with universities. Thus, the authors found that such industries as telecommunications, instruments, and business services have a higher possibility to collaborate [82]. However, a later study by Fontana *et al*. (2006) refuted previous findings about telecommunications firms by arguing that these firms have lower incidence of collaboration with universities. Moreover, in some sectors companies are less willing to collaborate as they consider that universities lag behind industry and most graduate students tend to ignore recent industry developments [52]. In addition, Veugelers and Cassiman (2005) found that foreign ownership has a negative effect on cooperation with universities in Belgium [79]. This is consistent with the view that the central R&D department of foreign subsidiaries is located abroad.

Other organizational characteristics such as R&D intensity and access to public subsidies [54] positively affect capacity of a firm to cooperate with universities and other public research institutions. The amount and the quality of academic research [48, 83] tend to determine the firm's choice of the universities to collaborate with.

Informal contacts [20; 78; 84] and trust [67; 85] play an important role in effective university-industry relationships. Informal contacts are contacts between individuals rather than institutional relationships [20] which are usually built based on trust between the agents which positively contributes to building research networks.

Although trust between the parties is vital only few previous studies explored the attitudes towards university-industry collaboration from the perspective of universities and firms [86, 87; 88]. In most cases, industry representatives perceive universities as "unable to effectively perform directed research", whereas universities which are mostly engaged in basic research perceive firms as oriented to non-academic problem solving [86, p.50].

Firms typically don't want to collaborate with universities for a number of reasons: discrepancies between objectives of the two parties, the length of time involved in university research, different focus of universities and firms, and cultural differences [52]. In India, the majority of firms think that their own R&D capacity is enough to innovate, plus, cooperating with universities may not be worth as they have no or little understanding of their line of business [89]. In contrast, a study conducted by Nieminen and Kaukonen (2001) in Finland found that limited firms' in-house R&D activities and weak absorptive capacity are the primary reasons for not collaborating with universities [90].

A study by Meredith and Burke (2008) in Mexico based on the experiment of collaboration in the form of consulting teams showed quite positive attitudes of firms towards interactions with universities [88]. At the same time, the attitudes of both firms and universities in Kazakhstan towards knowledge collaboration with each other are unknown. Therefore, one of the objectives of this thesis is to identify the attitudes from both perspectives.

1.2.2 University-Industry Interactions: Knowledge Transfer Channels

The review of literature has identified a great number of studies on university-industry interactions and knowledge transfer channels [21, 50, 51, 76, 91, 92, 93, 94, 95, 96, etc.]. The authors suggest that knowledge between universities and firms may be transferred through a number of channels which include publications, participation in conferences, co-operation in graduate education, advanced training for enterprise staff, mobility of academic staff and company personnel, cooperation in R&D, sharing facilities, contract research and academic consulting commissioned by industry, the development and commercialization of intellectual property rights on the part of universities, and spin-offs[2] and entrepreneurship [51, 93, 97].

Many scholars and several institutions have tried to align knowledge transfer channels for industry-science collaboration, however still no unique or shared taxonomy of the organizational forms seems to exist [98]. Thus, Abreu *et al*. (2008) grouped the channels on the basis of modes of knowledge transfer. He identified five modes of knowledge exchange with higher education institutions (HEIs): people (recruitment, personnel exchanges and internships, and studentship); codified knowledge (publications, patents, and prototypes); problem solving contract research (joint R&D projects, consortia, consulting by university staff, testing, standards, access to specialized equipment, and licensing); public space (meetings and conferences, entrepreneurship centers, and networks); and other [20].

Some other authors offered classifications of knowledge transfer channels. For instance, Arza (2010) classified channels into four categories: service, traditional, bi-directional, and commercial, and linked the channels with benefits [95]. The traditional channel contributes to firms' benefits while the service channel drives researchers' benefits, moreover, commercial channel does not bring any benefits to neither party under any conditions [99].

Based on forms of university-industry interactions Fuentes and Dutrénit (2010) categorized knowledge transfer channels into information & training (InfoChannel), R&D projects & consultancy (ProjectChannel), Intellectual Property rights (IPRChannel), and human resources (HRChannel). Their study aimed to identify different perceptions from researchers and firms along the three stages of the linking process: i) the engagement in collaboration (e.g. the drivers), ii) the knowledge transfer during collaboration (e.g. channels of interaction), and iii) the benefits from collaboration [100]. Their findings are discussed further in this chapter.

Yet an earlier study by Bekkers and Freitas (2008) grouped knowledge transfer channels into six clusters: scientific output, informal contacts and students, labor mo-

[2] "University spin-offs are one widely recognized way of commercializing the results of university-conducted research. This is particularly common in such fields as information technology and life sciences. Such spin-offs include: i) firms founded by public sector researchers, including staff, professors and post-doctorate students, ii) start-ups with licensed public sector technologies, and iii) firms in which a public institution has an equity investment. Spin-offs are an entrepreneurial and risk-taking method of exploiting knowledge developed by university laboratories for commercial benefit." [101]

bility, collaborative and contract research, contacts via alumni or professional organizations, specific organized activities, and patents and licensing [94]. The main classifications of knowledge transfer channels by Arza (2010), Fuentes and Dutrénit (2010), and Bekkers and Freitas (2008) are summarized in Table 4.

Additionally, many authors have tried to measure the importance of knowledge transfer channels. A study by Cohen et al. (2002) reported that publications and reports are the most important channel, followed by informal contacts, conferences and consulting. According to their survey, licensing and personnel exchange are the least important [76].

At the same time, Campbell (2007) claims that transferring knowledge and innovation from universities to firms requires a more formal mechanism like a technology transfer office (TTO). TTO's aim is to facilitate research, develop mutual ties with the industry, motivate academic staff, and ultimately increase income of universities. TTOs pursue these objectives with the following activities: "commercialization of research results, negotiation of research agreements, support for the creation of new spinout companies, and training and education for scientists in the field of technology transfer" [102].

The importance of staff exchange was raised in the works of Lundvall and Johnson (1994), Gertner et al. (2011) and Kaymaz and Eryiğit (2011) who pointed out to a higher tacit component of knowledge which is transferred during these interactions [103, 104, 105]. In addition, Jacobson *et al.* (2005) argue that the practice of consulting may be another important channel for the transfer of knowledge between universities and firms [106].

Many studies have focused on studying the importance of knowledge transfer channels from the perspectives of both universities and firms. Thus, a survey carried out by Schartinger *et al*. (2001) found that employment of graduates, supervision & financing of PhDs and masters' theses are the most important knowledge transfer channels from firms' perspective [107]. Nieminen and Kaukonen (2001) found a similar trend about masters' theses in Finland, plus, firms there also consider contract research and product development as crucial for the transfer of knowledge hence, making collaboration more product-oriented [90].

The results for universities concerning the importance of writing masters' thesis as part of a company project are in line with those for firms. Some other important channels of knowledge transfer for universities include: lectures by firm members at universities, contract research, joint research, employment of university researchers in the business sector. In contrast, Meyer-Krahmer and Schmoch (1998) and Arundel and Guena (2004) reported that collaborative research, informal contacts, and education of personnel are the most important and common forms of interactions between universities and industry from university researchers' perspective [78, 91].

We suppose there are also some cultural aspects which impact the choice of knowledge transfer channels. Thus, in India university researchers emphasize participation and discussion in industry-related conferences and seminars, consulting services, on-site supervision, and lecturing for industry representatives [89]. In Canada, the most common channels of university-industry knowledge transfer are internships in companies and collaborative research [108]. An empirical study by Bekkers and

Table 4 – Classifications of Knowledge Transfer Channels

Bekkers and Freitas (2008)	Arza (2010)	Fuentes and Dutrénit (2010)
Labor mobility - flow of university staff members to industry positions (exc. PhD. graduates) - staff holding positions in both a university and a business - temporary staff exchange (e.g. staff mobility programs	***Service*** - consultancy - tests - monitoring	***Human resources (HRChannel)*** - hiring recent graduates
Scientific output, informal contacts and students - scientific publications in (refereed) journals or books - other publications, including professional publications and reports - participation in conferences and workshops - personal (informal) contacts - university graduates as employees (BSc or MSc level) - university graduates as employees (Ph.D. level) - students working as trainees	***Traditional*** - training graduates - publications - conferences	***Information & training (InfoChannel)*** - publications - conferences - informal information - training
Collaborative and contract research - joint R&D projects in the context of EU Framework Programs - joint R&D projects (except those in the context of EU Framework Programs) - contract research (excl. Ph.D. projects) - financing of Ph.D. projects - consultancy by university staff members	***Bi-directional*** - joint research - networks	***R&D projects & consultancy (ProjectChannel)*** - contract R&D - joint R&D - consultancy
Patents and licensing - patent texts, as found in the patent office or in patent databases - licenses of university-held patents and 'know-how' licenses	***Commercial*** - spin-offs - incubators - licenses	***Intellectual Property rights (IPRChannel)*** - technology licenses - patents
Specific organized activities - contract-based in-business education and training delivered by universities - university spin-offs (as a source of knowledge) - specific knowledge transfer activities organized by the university's TTO - sharing facilities (e.g. laboratories, equipment, housing) with universities		
Contacts via alumni or professional organizations - personal contacts via membership of professional organizations - personal contacts via alumni organizations		

Note – Compiled by the author based on [94, 95, 100]

Freitas (2008) in the Netherlands found that “classic” transfer instruments such as scientific publications and professional publications are the most important as considered by both academicians and industry researchers [94]. Nevertheless, in many studies university researchers give overall significantly higher ratings to any channel than industry researchers.

Some authors observe cross-sectoral differences in the importance of knowledge transfer channels. For example, Bekkers and Freitas (2008) examined how the preference of clusters differs among sectors. They found that “scientific output, students and informal contacts” and “collaborative and contract research” clusters are the most important channels of knowledge transfer for medical science, chemical engineering, and computer sciences firms; “contacts via alumni and professional organizations” are more crucial for firms working with economics and business; “labor mobility” cluster is important for those working with psychology and cognitive studies; “specific organized activities” is vital for knowledge referring to material and social sciences; and “patents and licensing” cluster is more important for chemical engineering, material sciences, social sciences and biology [94].

A study by Caloghirou *et al*. (2004) which focused on four sectors found significant results only for the sector of radio, television and communication equipment and apparatus. Firms operating in this sector rely on the use of journals and training of employees as a source of new knowledge and information [109]. Other knowledge transfer channels widely used in telecommunications sector include joint laboratories and research programs [110]. In chemicals sector, the relationships with universities are established via public programs and are reinforced by hiring university researchers while in food and beverages sector knowledge is mostly transferred through informal contacts where universities perform testing and provide expert advice to firms [80].

To summarize, during the analysis of knowledge transfer channels in a particular industry, one needs to take into consideration sector specificities, the characteristics of knowledge needed in this industry, R&D intensity, human capital, and absorptive capacity of firms in this sector. As we have seen from the previous research the preferences for university-industry interactions and knowledge transfer channels may vary across sectors substantially.

1.2.2 Benefits from University-Industry Relationships

There are enormous benefits that stem from university-industry collaboration [63, 95, 111], including benefits to universities and companies, as well as the society [60]. As Ślusarek *et al*. (2010) notes society benefits from university-industry relationships through innovative products, new technologies, and practical applications [60]. Moreover, university-industry collaboration enhances economic development of the region/s [112] in which the agents operate.

Universities can advance their research and companies can get consultancy on how to promote products more quickly into the marketplace. Moreover, collaborations with universities allow companies to access expertise not available in corporate laboratories, to gain access to students as potential employees and university facilities [92], as well as leverage internal research capabilities. At the same time, universities benefit from collaborations in another way, i.e. they obtain financial support [71] for the university's educational and research mission , fulfill the university's service mission, broaden the experience of students and faculty, identify significant, interesting, and relevant problems [63, 91], and increase employment opportunities for students [112].

Several studies have been conducted to examine the benefits of university-industry collaborations as perceived by firms and universities. For example, Lee (2000) revealed that the participants of university-industry research collaboration tend to realize significant expected and unexpected benefits [63]. Firms mostly realize benefits from an increased access to new university research and discoveries, and faculty members get the most significant benefit from the ability to complement their own academic research by getting a different perspective [113] new insights into their own research and securing funds for graduate students [63, 114].

On the basis of interviews with Finnish university researchers, Nieminen and Kaukonen (2011) divided benefits from external collaboration into two sets: (1) financial/facility-related benefits and (2) knowledge-related benefits. The former include grants for university research, funds for organizing academic seminars, and the ability to use companies' testing and laboratory facilities when needed. Knowledge-related benefits comprise six categories:

- ✓ Access to up-to-date knowledge about technical development of the industry;
- ✓ Economies of scale, i.e. fast access to company knowledge which otherwise would require years of research work;
- ✓ Access to tacit knowledge to anticipate future developments and research;
- ✓ New contacts and information about potential partners;
- ✓ Access to data and databases which otherwise may be expensive or impossible;
- ✓ A chance to study interesting and important phenomena [90].

Bishop *et al*. (2011) proposed a classification of firms' benefits into three broad types. First, firms benefit from the outputs generated by scientific research at universities which contribute to our understanding of particular phenomena, in the form of theories, laws, new technologies and methods. Second, firms benefit from the education provided by universities as the latter contributes to the generation of highly qualified individual candidates which may be potential employees of these firms. Third, firms benefit from personal contacts with university researchers who are considered as valuable sources of knowledge for firms' innovation processes [115].

One of the most recent studies conducted in Canada by the *Board of Trade of Metropolitan Montreal* (2011) distinguished between eight types of benefits from university-industry collaboration for firms. These include access to competencies and expertise developed in universities, access to highly qualified workers, access to innovative technologies, development of a new product or service, access to scientific networks, access to R&D tax credits, development of "scientific credibility" with international customers, and risk-sharing regarding the innovation. The findings of the research reveal that the greatest part of firms in Canada perceive access to skills and expertise developed in universities and access to highly qualified labor as the most important benefits from university-industry collaboration [108].

Another empirical study conducted in the United Kingdom by Bishop *et al*. (2011) also assessed university-industry collaboration benefits as perceived by firms. The authors asked industry representatives to rate the list of nine benefits on a 5-point Likert scale. The list of firms' benefits proposed by the authors included:

- ✓ Improved understanding of foundations of particular phenomena;
- ✓ Source of information suggesting new projects;
- ✓ Generation of patents (in products or processes);
- ✓ Assistance in problem solving;
- ✓ Recruitment of university postgraduates;
- ✓ Training of company personnel by university researchers;
- ✓ Contribution to the successful market introduction of new products/processes;
- ✓ Cost reduction in product or process development;
- ✓ Reducing the time required for completion of company's R&D projects [115].

After some statistical tests, it turned out that the last three benefits in the list were relatively highly correlated with each other, so the authors grouped them together to construct a new variable which was called "downstream-related benefits". The results of this study suggest that the two benefits from interactions with universities ranked as the highest are 'problem solving' and 'improved (fundamental) understanding'. Plus, around one third of the UK firms pointed out to the benefits from downstream activities to be important to them [115].

Arza (2010) claims that certain channels of university-industry interactions result in different types of benefits for firms and for researchers. She offered a theoretical framework to distinguish the benefits for firms and for public research organizations (PROs) which include universities and research institutes [95]. As elaborately described in Dutrenit *et al*. (2010), PROs typically gain economic benefits (share equipment/instruments, provision of research inputs, and financial resources) and/or intellectual benefits (ideas for further collaboration projects, inspiration for further scientific research, share of knowledge/information, and reputation). Firms typically receive benefits related to short-term production activities (obtain technological/consulting advice to solve production problems, make earlier contact with university students for future recruitment, perform test for products/processes, etc.) and/or related to long-term innovation strategies (augment firm's ability to find and absorb technological information, technology transfer from university, contract research, etc.) [116].

Further, several other authors applied the theoretical framework developed by Arza (2010) to empirical studies. Thus, Fernandes *et al*. (2010) found that bi-directional channels of university-industry interactions in Brazil yield intellectual benefits for researchers and innovative benefits for firms; service channels were found to yield both intellectual and economic benefits for university researchers [111]. A study by Arza and Vazquez (2010) in Argentina confirmed the assumption of Arza (2010) about predominant importance of service channels for conveying economic benefits for researchers. Moreover, the authors found that bi-directional channels are important for firms seeking all types of benefits [99].

The above discussion has shown that university-industry ties bring enormous benefits to both parties. But despite mutual collaboration advantages, linking the intellectual resources of a university with the problem-solving needs of a firm presents a challenge [117]. Thus, the next section of this Chapter looks at the obstacles that firms and universities may face while engaging in collaboration.

1.2.3 Obstacles to University-Industry Knowledge Collaboration

Companies view universities as producing knowledge for the knowledge's sake focusing mostly on basic research while firms need knowledge for increasing their profitability focused more on technology development projects [60, 100]. Therefore, both firms and universities have different perceptions about the purpose of knowledge production. There are also some differences in the views of universities and firms about knowledge dissemination. University researchers are usually engaged in the long term research which results in publications thereby pursuing academic freedom and open disclosure; firms in contrast, are interested in short-term projects (e.g. a new product/ service development) which will have no or limited public disclosure [38, 60, 117].

Elmuti *et al*. (2005) argues that the main challenges to university-industry collaboration include the differing cultures of the agents and issues related to ownership of intellectual property rights and the division of revenue amongst the parties [118]. Some other studies have added to the list of obstacles the following:

- ✓ lack of mutual trust [30];
- ✓ lack of culture for entrepreneurship at the universities [119];
- ✓ lack of skills and competences for collaboration [20];
- ✓ lack of information on both sides about possibilities for interaction [20, 38];
- ✓ lack of human resources for knowledge and technology transfer [120];
- ✓ improper reward system for academic achievements [113], and
- ✓ too many rules and regulations imposed by universities [117].

In addition, Bruneel *et al*. (2010) divided barriers into two types: i) 'orientation-related barriers' – those that are related to the differences in orientations of industry and universities and ii) 'transaction-related barriers' – barriers related to conflicts over IP and dealing with university administration. The study showed that transaction-related barriers are much more difficult to mitigate than orientation-related barriers [68].

Many authors have tried to look at the barriers from different perspectives. For example, Shiller and Leifner (2007), Kaymaz and Eryiğit (2011) and Tartari *et al*. (2012) studied the barriers from academicians' perspective [53, 105, 121]; Nieminen and Kaukonen (2001), Rasiah and Govindaraju (2009), and Bruneel *et al*., (2010) examined the obstacles from firms' perspective [68, 81, 90]. Renko (2004) considered both perspectives [114].

An empirical study by Kaymaz and Eryiğit (2011) identified the factors that might have been considered as barriers to university-industry collaboration from academicians' perspective in Turkey. One of the main factors hindering these relationships is the lack of information on the possibilities and capabilities of both parties. Other issues the like lack of academicians' and industrialists' interest in interactions, inefficient bureaucracy, remoteness of field studies, insufficient publicity, lack of communication, and previous bad experiences negatively affect the incidence of university-industry partnerships [105].

Schiller and Leifner (2007) studied the barriers to cooperation with private companies from academicians' perspective in Thailand. The authors reported that 60% of university researchers have a feeling that companies do not want to cooperate at all indicating that there is a wide gap between higher education and industry; this reflects the lack of communication and trust between the parties. The situation is further aggravated by bureaucratic restrictions imposed by universities, the lack of incentive schemes, and weak institutional framework for commercialization [53].

Malaysian firms have similar perceptions about collaborating with universities and research institutes to those in Thailand. Companies in Malaysia consider public research organizations and universities too bureaucratic and lacking transparency which serves as the main impediment to collaborative activities [81].

Concerning the barriers to university-industry collaboration in Finland [90], the results for firms are comparable to the perceptions of Turkish academicians which include the lack of knowledge and information about the cooperation possibilities. Other most common factors preventing Finnish firms from collaboration with universities are the lack of time and the lack of resources.

Canadian firms claim that the main obstacles to collaboration with universities are that the latter don't understand the realities of the business world, too much administrative complexity and red tape, and insufficient in-house resources to support collaboration [108].

In contrast to other studies, Renko (2004) examined the perspectives of both academic and industry researchers in Slovenia. From the academicians' perspective, institutes in Slovenia do not provide enough encouragement for researchers to undertake more applicable research and contacts between industry and universities are rare. In addition, researchers from institutes claim about a need for companies to be more development-oriented and for the state to provide more funds for investments into development and education with appropriate tax-relief measures. From firms' perspective, factors hindering university-industry knowledge collaboration in Slovenia include the lack of university researchers' awareness about actual needs of enterprises, establishment of cooperation on the basis of personal contacts, and the lack of state support to enterprises in the form of fiscal incentives for joint research and development with universities [114, pp. 49-50].

Based on the previous studies it is possible to group the barriers to university-industry collaboration into 3 categories: 1) common barriers, 2) firm-specific barriers, and 3) university-specific barriers (Table 5). Common barriers refer to the barriers faced by both firms and universities. Firm-specific and university-specific barriers comprise the perceptions regarding the barriers of each of the agents. We suppose that a systemic effect of all these barriers hinders collaboration between universities and firms. In the context of Kazakhstan, it is important to know the differences in perceptions of barriers by firms and universities in order to develop appropriate strategies and policies.

Table 5 – Classification of Barriers to University-Industry Collaboration

Common Barriers	Firm-Specific Barriers	University-Specific Barriers
- lack of communication between the parties;	- lack of time;	- lack of culture for entre-preneurship at universities;
- lack of information about possibilities and capabili-ties for interaction;	- lack of financial re-sources;	- insufficient publicity;
- lack of mutual trust;	- lack of human resources for knowledge and tech-nology transfer;	- lack of incentive schemes for academic achieve-ments;
- differing cultures;	- issues relating to the di-vision of revenue amongst the parties;	- few incentives for re-searchers to undertake more applicable research;
- a wide gap between higher education and in-dustry;	- limited awareness of uni-versity researchers about actual needs of enterprises;	- need for companies to be more development-oriented;
- lack of academicians' and industrialists' interest in interactions;	- remoteness of field stud-ies;	- issues relating to owner-ship of intellectual proper-ty rights;
- different goals and stra-tegic orientation;	- short-term projects orien-tation with limited public disclosure;	- need for the state to pro-vide more funds for educa-tion and research;
- different perceptions about the purpose of knowledge production;	- inefficient bureaucracy and red-tape at universi-ties;	- long-term research orien-tation, academic freedom and open disclosure;
- different views about the ways of knowledge dis-semination;	- lack of state support to enterprises (e.g. fiscal in-centives);	- weak institutional framework for commer-cialization.
- lack of skills and compe-tences for collaboration;	- establishment of coopera-tion on the basis of per-sonal contacts.	
- previous bad experiences.		
Note – Compiled by author		

1.2.4 Effective Governance of University-Industry Collaboration

Good governance of university-industry collaboration facilitates production of knowledge which positively contributes to the creation of a knowledge-based society [122]. Existent literature distinguishes between different governance forms which range from the simple use of openly disseminated academic knowledge on the part of firms [50] through long-term university-industry contractual arrangements and technology transfer offices [123] to financial incentives provided by the government [124].

Rossi (2010) developed a framework that explains the choice of specific governance forms for university-industry interactions depending on the degree of knowledge appropriablity and knowledge complexity and uncertainty. She suggested four governance forms:

a) *University research without industry involvement, publicly funded* – used when both knowledge appropriablity and knowledge complexity and uncertainty are low;
b) *Research performed within the firm with marginal or no university involvement* – appropriate when knowledge appropriablity is high and knowledge complexity and uncertainty are low;
c) *University research funded by contracts from industry, academic consulting* – applied when both knowledge appropriablity and knowledge complexity and uncertainty are high;
d) *University-industry research projects and collaborations, research consortia, joint ventures (with public or mixed public-private funding)* – suitable when knowledge appropriablity is low and knowledge complexity and uncertainty are high [50].

Wang and Lu (2007) offered to implement Professors of Practice as one of the governance forms for building and maintaining effective university-industry interactions in China. A professor of practice performs a role of an integrator of business and academy, settles down a conflict of interest and facilitates the establishment of mutual trust [69].

Another study by Freitas *et al*. (2010) investigated the nature and intensity of institutional and contractual personal collaborations between firms and universities in Italia. The authors explored the characteristics of firms involved/not involved into these two governance forms of knowledge transfer. The results of their study suggest that smaller firms tend to be involved in contractual personal collaborations and they are more often interested in the acquisition of external knowledge [123]. A study conducted in Canada showed that there are few ways to make future collaboration between universities and firms more likely and more effective; these include greater awareness of collaboration opportunities and better alignment between university activities and business objectives [108].

There is much consensus in the literature on the obsolescence of a traditional linear view of university-industry relations which states that the research conducted by knowledge institutions to be absorbed and applied by companies will subsequently be commercialized and marketed. A modern perspective called the “Triple Helix” implies a three-dimensional integration of university, industry, and government which fosters the capitalization of knowledge and speeds up the innovation process [125].

The Triple Helix of university-industry-government interactions suggests reciprocal relationships at different points in the process of knowledge capitalization [44]. Universities create knowledge which is applied in the organizational context, and the government acts as a facilitator of effective partnerships between universities and firms (Figure 5).

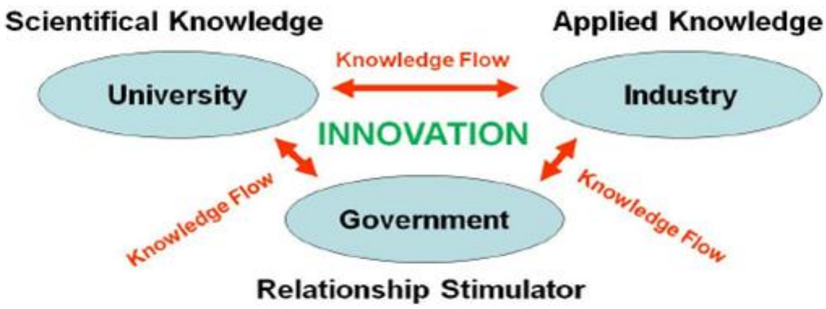

Figure 5 – Knowledge Flow between University and Industry, with Government as a Stimulator Agent

Source – [46]

According to Nieminen and Kaukonen (2001), the government performs two primary roles: (1) provides financial support for research and (2) improves interactions between science and society [90]. The first role of the government includes the development of legislative framework to stimulate joint research. Phiblin (2008) and Abramovsky and Simpson (2011) emphasize the importance of funding and financial incentives to foster collaboration between firms and universities [124, 126]. As evidence shows, fiscal incentives are considered among the key drivers of collaborative research between industry and public research institutions/universities [127]. Such incentives are prevalent in many developed countries like Japan, Italy, Norway, the United Kingdom, Canada, Denmark, and etc. For example, Italy introduced a 40% tax credit to companies carrying out research with universities or public research organizations; Belgium has recently simplified the scheme of tax incentives by applying a single 75% reduction of R&D wage bill for all categories of researchers. Denmark and Hungary have offered tax allowances of 200% and 300% of taxable income, respectively, for donations to non-for profit R&D organizations in Denmark and for joint projects with universities or public research organizations in Hungary [128]. In Turkey, the government has developed a legislative framework according to which it provides significant financial advantages to firms for several years: (i) firms' R&D staff and research staff are exempt from income tax; (ii) income from registered development operations about R&D is exempt from corporation tax, and (iii) services delivered related to system management, data management, internet, mobile telephone and military command application software are exempt from income tax, corporation tax and value added tax [105].

Concerning the second role of the government, Nieminen and Kaukonen (2001) noted that linkages between science and practical use can be divided into three forms: direct, indirect, and mediated linkages. Direct linkage mechanisms include university-industry joint research projects, research contracts or more informal meetings at conferences. Indirect linkages comprise researcher training, background knowledge and professional networks which affect society's problem-solving capacity. Mediated linkages create possibilities for direct linkages by infrastructures such as science councils, research funding agencies, technology centers, or advisory bodies attached to ministries [90].

Although many authors refer to Triple Helix as a vital governance form for the integration of university, industry and government, there are some criticisms about the applicability of this model in the context of developing countries or weaker regions in developed countries. According to the Triple Helix model all the three spheres are required to work together to drive innovation, but the model might not work if one of these three helices or the links between them are too weak [129]. Of course, it is important to take into consideration the limitations of the model but we cannot deny its relevance to developing countries despite the criticisms.

We suppose that Triple Helix approach is still relevant to developing countries which are at the initial stage of innovation development. As evidence shows, university-industry relationships in these countries are rare mostly because of the lack of trust and information about each other's capabilities. The governments in developing countries usually do not provide enough incentives to both firms and universities to cooperate with each other and even worse, they don't want to spend money on innovations. However, if these governments could come up to understand the importance of Triple Helix approach at the initial stage of the development of innovations, their economies would benefit from it. At least it could be a kind of push for innovation and university-industry collaboration.

The role of the government in promoting innovations in developing countries is vital as these governments may be sometimes the only source of demand. Purchasing power in developing countries is low, population is concerned with social issues, and firms are merely concerned with making profits. The demand for innovations is very low. Quite often it is very difficult for developing countries to market innovations into an international arena as developed countries have occupied all the niches and provide goods and services of better quality at affordable prices.

The government of developing countries may contribute to the creation of university-industry linkages in different ways, not necessarily through funds. The government may itself create a demand for innovations and may also offer different financial incentives, e.g. tax credits or tax allowances.

One of the greatest examples of successful application of Triple Helix approach in developing countries is the former Soviet Union where education, research, enterprises, and the government were integrated. Was the country successful in innovations? Yes, until it collapsed for political reasons. What's going on now in ex-Soviet countries is disintegration of all the elements of the Triple Helix which results in a standstill of science and innovation development. Is Triple Helix relevant in these countries? At the moment, the government may be the only effective instrument for the integration of science and business.

1.3 World Approaches to Management of University-Industry Knowledge Transfer

In the literature, there is a consensus on the differences in the nature of university-industry relationships in developed and developing nations. We suppose that the differences mostly arise from economic, political, and cultural backgrounds which shape the transfer of knowledge in every country.

Economic differences typically arise as a result of different productivity levels of the economies and gaps in the standards of living. Political differences refer to direct role of the government played in the facilitation of university-industry linkages, e.g. through funding, as well as indirect role through the development of fiscal incentives and legal frameworks supporting collaboration. Cultural differences are linked to the traditions and customs of counties, e.g. in some countries there is a long tradition of university-industry collaboration, in other economies firms historically tend to rely on own R&D capabilities.

Schiller and Liefner (2007) argue that although governments in developing countries are often less stable and powerful than those in industrialized nations they have a relatively strong funding capacity for higher education institutions as compared to other agents in their economies (e.g. students, companies, business associations) [53]. At the same time, universities in emergent economies are under-funded and cannot allow themselves to buy latest research equipment [53] to conduct basic research [46].

As Schiller and Liefner (2007) noted, university faculty staff in developing countries tends to be less qualified than their counterparts in developed economies. In addition, higher education institutions in emergent countries put more emphasis on undergraduate teaching rather than on research and as a result cannot supply new knowledge to companies [53]. Instead, collaboration with industry in emergent economies typically occurs "to develop technological applications based on companies' needs" [46]. It is obvious that university-industry knowledge transfer practices in developing nations tend to be different from that in industrialized economies.

In this study, we are interested in getting a deeper insight into the nature of university-industry relationships in both emergent and developed economies. Hence, we will analyze some country studies in this part. First, it will be important to look at the ranking of countries in terms of the intensity of university-industry collaboration. This ranking is provided by the *Global Innovation Index 2013* report [130]. We've picked out top ten developed and top ten developing economies to look at their stand in university-industry collaboration.

As seen from Table 6, developed countries occupy top ten positions in the list, except the ninth position which is occupied by a developing country Qatar. Interestingly, the newly industrialized countries Singapore and Israel stand fifth and eighth in the list of university-industry collaboration, respectively. Among the developing countries, Qatar, Malaysia, and the United Arab Emirates occupy the three leading positions. Former Soviet country Lithuania is on the fourth position and ranked 28th worldwide in university-industry collaboration.

The third section of this chapter further discusses university-industry collaboration, S&T policy, and the role of governments in top five developed economies and selected 5 emerging countries.

1.3.1 University-Industry Linkages in Developed Countries

For the analysis of university-industry collaboration in developed economies, we have selected top five countries university-industry collaboration as ranked by the *Global Innovation Index 2013 (GII)* [130]. Looking deeper into the indicators that

Table 6 – The List of Top Ten Developed and Developing Countries Ranked by Their Intensity of University-Industry Collaboration

#	Top 10 Developed Economies	Rank	#	Top 10 Developing Economies	Rank
1	Switzerland	1	1	Qatar	9
2	United Kingdom	2	2	Malaysia	17
3	United States of America	3	3	United Arab Emirates	25
4	Finland	4	4	Lithuania	28
5	Singapore	5	5	South Africa	29
6	Belgium	6	6	Saudi Arabia	30
7	Sweden	7	7	China	33
8	Israel	8	8	Costa Rica	34
9	Netherlands	10	9	Hungary	35
10	Germany	11	10	Barbados	36
Note – Compiled based on [130]					

may bring some insight into the understanding of the success of selected countries (Table 7), we can observe that Finland is the leader among the top five economies in both gross expenditures on R&D and researchers per million of population. However, the absolute leaders worldwide in these two indicators are Israel and Iceland with 4.4 percent gross expenditures on R&D and 13,101 researchers per million of population, respectively. As indicated in Table 7, Switzerland and Finland have the highest share of R&D expenditures by business. One might suppose that these are the most important indicators of success in university-industry collaboration however they don't explain why Switzerland is ranked top worldwide. Hence, we will try to look at specificities of the relationships between firms and universities in each of these five countries.

Table 7 – Top Five Industrialized Leaders in University-Industry Collaboration by Gross Expenditures on R&D and Researchers

#	Countries	Gross expenditure on R&D, % DGP	R&D financed by business, % GPD	Researchers, headcounts/ mln population
1.	Switzerland	2.9	68.2	6,057.4
2.	United Kingdom	1.8	44.6	6,363.4
3.	United States of America	2.8	60	n/a
4.	Finland	3.8	67	10,655.8
5.	Singapore	2.1	53.1	7,188.0
Note – Compiled by the author based on [130]				

Switzerland. According to the Global Innovation Index 2013 report, Switzerland is not only a leader in university-industry collaboration but it's also the most innovative country in the world [130]. What might account for this dramatic success?

Firstly, Switzerland spends 2.9% of its Gross Domestic Product (GDP) on R&D which puts it among the top seven countries worldwide. Secondly, most framework conditions and structural characteristics strongly favor the performance of the Swiss national innovation system: excellence of science, S&T skills and competences, innovative performance of SMEs, financial development, and clusters [131].

As Foray (2007) notes, Switzerland is distinguished by its remarkable knowledge infrastructure (scientific research, S&T human resources). The country has achieved a great success in scientific and technical publications intensity and literature citations index. Most universities are focused on applied sciences and committed to relations with industry. Moreover, for a country of its size, Switzerland has a great number of multinational companies focused on R&D which make the whole local system more innovative and more oriented towards cooperation with local universities. It is also important to note the role of SMEs in the innovation development of Switzerland. The innovativeness and absorptive capacities of Swiss SMEs are outstanding; however their linkages with universities are not that strong as the government would like them to be [131].

Current Swiss innovation policy focuses on promotion of university-industry cooperation. This cooperation is promoted indirectly as Switzerland has no tradition of direct government intervention, e.g. through provision of direct funding. The main policy mechanism for promoting collaboration between universities and firms is funding of R&D for business sector gained from Swiss public research institutions where the project partners (academy and business) define the subject of the research by themselves, and the business side covers at least 50% of the project costs [131].

Surprisingly, but the main channel of university-industry knowledge transfer in Switzerland is not a formal form of collaboration but rather informal contacts. This was revealed by the two studies which focused on both firms' [132] and universities' [120] perspectives. Academicians in Switzerland perceive educational activities as the top priority for the transfer of knowledge, followed by informal informational activities and research activities while consulting and activities related to the utilization of technical facilities are considered to be less important categories of channels. Among educational activities the three channels were marked as the most important: contracts with graduates employed in the business sector, contracts with former staff employed in the business sector and thesis projects in collaboration with firms [120].

Swiss firms' perspective is somewhat similar to this of university researchers'. Informal contacts and educational activities are also considered the most important but with the former being more important. Among educational activities firms in Switzerland perceive employment of graduates in R&D as the most important channel of knowledge transfer. In contrast with academicians, firms scored research activities (research cooperation, research contracts, and research consortium) relatively low [132]. So, we can conclude that both firms and universities in Switzerland rely more on informal relationships shaped by educational activities rather than formal forms of collaboration.

United Kingdom. Since the 1990s, the UK government has focused its efforts on facilitating interactions between universities and firms [20, 133]. The establishment of the Department for Innovation, Universities and Skills (DIUS) which was later called the Department for Business, Innovation and Skills (BIS) has proved to be a key governance instrument in the field of business-university interactions. Up to now policy in this sphere had been divided between trade and education ministries which focused on two different aspects innovation and skills, respectively. Today, policy in this sphere emanates from a single government department. However, there are some criticisms about the capability of this large department to provide a synergy between the interests of all its elements [134, p. 18].

The United Kingdom uses a combination of subsidies and tax incentives to stimulate private R&D investments. For example, the government provides for the accelerated depreciation for plant, machinery and buildings used in R&D which allows businesses to make an immediate 100% write-off against profits. In addition, the UK stimulates collaborative research between industry and public research institutions/ universities by providing more generous tax relief in the form of 125% tax allowances [135].

Universities in the United Kingdom receive a single funding stream of Higher Education Innovation Funding (HEIF) which supports different forms of university-industry interactions [134, p. 18]. Two studies in the UK have focused on the examining the variety of forms of collaboration from firms' [39] and university researchers' [41] perspectives. The results of the study by Cosh and Hughes (2009) suggest that the most important type of interactions for firms in terms of frequency is informal contacts, followed by recruitment of graduates, and publications and conferences [39]. As for university researchers, the most widespread forms of interactions with industry are meetings and conferences; consultancy and contract research are viewed as second in importance while creation of physical facilities (i.e. spin-offs and new laboratories) was the least frequent form of interactions [41].

United States of America. A key turning point in university-industry relationships in the USA was the 1980 Bayh-Dole Act which created a policy that allowed universities to patent publicly funded research [136]. Those changes to intellectual property rules provided a monetary incentive for universities to create partnerships with industry.

Concerning R&D funding, the U.S. system is highly decentralized. Private universities by their nature are more eager to seek for extramural funds. At the same time, public universities do not solely rely on funding from state and national governments but also depend on foundations and corporate support, tuition revenues, and alumni gifts [137]. University-industry collaboration is of particular importance for both types of universities which allows the parties to exchange state-of-the-art knowledge. The most popular forms of interactions in the U.S. include informal contacts/ partnerships, internships, and recruitment of graduates [39]. Moreover, small firms in the U.S. are more likely to collaborate with universities in comparison with large ones [138, p. 16].

The United States of America as well as the United Kingdom uses a combination of subsidies and tax incentives to stimulate private R&D investments. The government both directly funds R&D and offers a favorable tax treatment. In addition to national R&D incentives, many federal states in the U.S. offer their own R&D tax reliefs [135]. A combination of national and federal fiscal incentives substantially decreases the cost of conducting R&D for business.

Finland. Today Finland is one of the leading countries in the world despite it was one of the poorest European countries as recently as several decades ago. It has succeeded well in international comparisons of education, research and technology and the quality of enterprises' operating environments [139].

The 1990s was a crucial moment in the evolution of Finnish policy – a period of science and technology driven integration. The concept of a national innovation system was introduced as an official policy concept which emphasized closer interaction among universities, business firms, and governmental research units. Universities were encouraged to strengthen their relationships with industry and other knowledge users on the highest political level [90]. In addition, several centers of expertise were established to foster collaborative research among small firms, local governments, science parks, universities and research institutes [140].

Today one of the greatest roles in promoting university-industry collaboration is prescribed to Tekes – a Finnish Funding Agency for Technology and Innovation. Tekes makes collaboration possible by providing financing and creating environments for cooperation as well as it helps potential partners to find each other [90].

The most popular forms of university-industry collaboration and knowledge transfer in Finland are supervision and financing of masters' theses and contract research. Moreover, instruments and equipment, services, information and communication technology and the chemical industry tend to be the most cooperative branches in Finland [90].

Surprisingly, but Finnish government neither subsidizes nor provides preferential tax treatment to business R&D; still private R&D expenditures are high. This situation is partly explained by Finnish industrial structure focusing on highly-skilled, human capital intensive production and low tax rates on business income as compared to other OECD countries [135].

Singapore. Singapore is one of the smallest countries in the world which granted a status of a developed economy in 1997. The case of Singapore is different from any other Asian country and it requires an in-depth analysis. The discussion in this section is based on the research headed by Risaburo Nezu which was published by the World Intellectual Property Organization (hereinafter, - WIPO) in 2007.

Singapore has realized a need to move to an innovation-driven economy earlier than other Asian countries. In 1981, the government initiated the Research and Development Assistance Scheme which used grants to stimulate R&D in the form of university-industry collaboration. In addition to general funding of R&D at universities, the government developed a series of incentives to support collaboration with industry: IP protection, support for commercialization and start-ups, business development, investment, and tax incentives [101].

Singapore has developed a strong cultural tradition of interaction with industry through internships, research collaboration, technology licensing, adjunct appointments, etc. Singapore's success can be attributed to several factors. First, the use of

English as a working language has allowed the country to get access to the world's latest research and to adopt good practices. Second, the actual handling of technology transfer is left to the universities. However, universities in Singapore do not only directly involve in technology licensing, they also place a list of available technologies on "technology offer database" on the Internet. Companies in their turn evaluate technologies and if they are interested can submit a business plan for negotiation [101].

The experiences of developed countries ranked top five worldwide in university-industry collaboration showed that the interactions between industry and science have become one of the characteristics of their cultures. The role of the government in these countries diverges from providing direct funding and tax incentives to minimum intervention which is shaped by political and cultural aspects.

1.3.2 Knowledge Transfer in Developing Countries

Although the top five emergent economies in university-industry collaboration are Qatar, Malaysia, United Arab Emirate, Lithuania, and South Africa, we will not select all of them for our analysis as they may not represent an interest due to different cultural and political contexts. On the contrary, our analysis will be more focused on Asian countries. Kazakhstan is a Central Asian economy which tries to benchmark some South Asian countries, in particular Malaysia. Plus, Kazakhstan has inherited many systemic and cultural aspects from the Soviet Union. Therefore, we have selected Malaysia, China, Thailand, India and Russian Federation as the units for our analysis. China and India will be interesting cases to study because in addition to the fact that they are Asian countries, they are the world's most rapidly growing economies and Kazakhstan's important strategic and trade partners. Russia is the key ally of Kazakhstan and has much in common with the latter in terms of legal-political, socio-cultural and economic contexts.

According to the *Global Innovation Index 2013* ranking, Malaysia and China are on top positions in university-industry collaboration among the selected countries (Table 8). Additionally, China has the highest share of gross expenditures on R&D among the selected countries, and Malaysia has the highest share of R&D financed

Table 8 – List of Developing Countries Selected for the Analysis

Country	Rank of UI collaboration in GII 2013	Gross expenditure on R&D, % DGP	R&D financed by business, % GPD	Researchers, headcounts/ mln population
Malaysia	17	0.6	84.5	715.4
China	33	1.8	71.7	1302.9
Thailand	44	0.2	48.7	575
India	49	0.8	33.9	n/a
Russian Federation	83	1.1	27.7	2580.6
Note – Compiled by the author based on [130]				

by business worldwide. In terms of the number of researchers per million of population Russia leads in our list. It will be useful to learn how the selected countries promote university-industry linkages in order to understand their nature and peculiarities as compared to developed countries.

Malaysia. Since early 1990s, the Malaysian government has come to understand the role that universities play in driving firm-level innovations [81]. The government recognized the need to increase R&D (both fundamental and applied) which can be applied in the industrial context [141] and started to implement policies to stimulate university-industry R&D collaboration in Malaysia.

A country report on Malaysian university-industry relationships prepared by Rahim and Said (2007) makes a solid contribution to the understanding of policies implemented there. Thus, it becomes obvious that the Malaysian government provides a strong support to the development of linkages through three main forms: infrastructure, tax incentives, and funding allocation.

In terms of the infrastructure, Malaysia currently has seventeen public funded institutions of higher learning and a number of public research institutes which actively conduct research in the fields of their specialization. Research in public institutions is mainly funded by the government but in recent times they have been encouraged to collaborate with industry to catch additional funding.

Fiscal incentives to stimulate R&D activity have been incorporated in Malaysia since 1991. The main incentives include: five years' tax exemption for new technology-based firms and for existing companies involved in R&D, double deductions for those contributing money to or using facilities and services of the approved research institutions.

In recent years, the government has intensified financial support to companies commercializing R&D, to government sector research institutes and institutions of higher learning where research is conducted in identified priority areas. Financial support is also provided for collaborative research work between industry and academic sector.

Given the above described government policy in terms of R&D support, it is obvious that Malaysia is in the right direction. However, Rahim and Said (2007) argue that still the main obstacle to effective university-industry R&D collaboration and knowledge transfer is the traditional mindset of both agents. Academicians in Malaysia feel a need to preserve their academic independence by doing research in the areas of their interest while firms think that academic research is far removed from practical application required in industry. Therefore, what is needed to propel university-industry collaboration in Malaysia is the change in the mindset, the recognition that such collaborations would be beneficial to both parties [141].

China. The discussion of China experience is based on two broad studies conducted by Wang and Lu (2007) and Nezu (2007) which describe the evolution and the main challenges of university-industry relationships as well as the governments' role in facilitating these relationships [69, 101].

The history of university-industry partnerships begins in the early 1950s when China was under the Communist regime. Universities were called upon to make contributions to the increase of production in Chinese economy. In 1980s, the major policy change made the government to change its role from direct intervention and control to supervision and guidance through legislation. In the late 1990s, the Chinese government took a series of specific actions to push universities and companies to collaborate by developing bilateral and multilateral mechanisms in the form of mutual part-time jobs and training. Other mechanisms for university-industry collaboration widely in practice today include: technology transfers, contractual research, consultancy, and enterprise incubation.

Chinese universities are particularly successful in receiving funds the largest part of which comes from the government and the rest from enterprises and institutions. In addition to this, both universities and companies may together apply for a non-reimbursable government grant if their common project conforms to the industrial policy of the government. Other types of public support may take the form of lump-sum grants, interest-free loans, or stock equity by the government [101].

In addition to direct funding of university-industry collaboration, the Chinese government has established a number of intermediaries which proved to be very effective in transferring technology from universities to industry: Technical Research Centers, university science parks, incubators, and technology transfer offices (TTO). The latter three types of intermediaries usually emerge within the universities.

Concerning the legal status of public universities, China has a unique situation in the region. The Chinese law permits universities to make investments and establish a corporation with its own capital. This allows universities to act more independently and engage in profit seeking businesses. Such university-run enterprises can be involved in a variety of scientific or non-scientific activities such as shops [101].

Another way for universities to gain profits is to commercialize research results by creating university spin-offs which are particularly common in such fields as information technology and life sciences. In China, spin-offs usually include: i) firms founded by public researchers, ii) start-ups with licensed public sector technologies, and iii) firms in which public institutions has an equity investment [101].

Despite there is so much government stimulation of university-industry relationships, establishing them presents a challenge. Firms in China perceive universities as lacking strategic focus and long-term orientation which prevents companies from achieving full economic potential. Communications between universities and firms is another challenge. Since both agents work in different contexts and perform different practices there is a knowledge gap between them, plus, there is a lack of trust which hinders collaboration [69].

Thailand. Over the last ten years, the Thai government's policy has been focused on encouraging interactions between universities and firms [142]. But Thailand's private sector is not very active in research; only large firms can afford having own laboratories. The country has limited experience in university-industry collaboration. There is no all-encompassing framework which would underpin such collaboration, for example, there are no regulations on royalties, disclosure of information, or reporting requirements [101].

Thai higher education institutions are relatively new and still growing. Public funds still account for 70-80% of the university budget, the rest funds come from tuition fees. The government allows universities to generate their own funds from endowments and assets but still there many restrictions on these activities [53]. Therefore, universities in Thailand are trying to find new sources for funds in order to survive, and collaboration with industry seems to be one of the solutions [143].

Effective university-industry collaboration presents a challenge in Thailand as university researchers are mostly motivated to collaborate with firms in order to get additional personal income to compensate low public sector salaries and are not very much concerned with the quality of their services. In addition, links between the agents are mostly based on informal consulting [53]. The relationships are usually started on a personal basis when researchers and business representatives already know each other or have met before. So, university-industry relationship in Thailand can be more precisely defined as “connection based”. The Thai government is currently trying to formalize the relationships [101].

Formalization will not be easy because industry representatives do not perceive universities as being capable to conduct a high quality research. Indeed, most universities are suffering from a lack of equipment and outdated curricula. The research conducted at universities is based on personal interests and expertise of the faculty [97] and mostly comprises applied research which borrows practices from developed countries and puts it in the Thai context [53]. A wide knowledge gap is reported between higher education institutions and industry in Thailand which is accompanied by the lack of trust and communication between the parties. Moreover, public universities are too bureaucratic and have weak institutional framework for commercialization [53].

The Thai government has recognized the above discussed weaknesses and it is currently concerned with raising awareness of university research in Thai society and industry sector. The latest government initiative to respond to the challenges was an establishment of bridging organizations such as science parks and business incubator units with some universities [53].

India. There are few studies on university-industry collaboration in India, especially those discussing science and technology policy. The only one study which somehow covers the policy was conducted by Nezu (2007). So, the discussion about India is mostly based on his work.

After independence in 1947, Indian science and technology policy was integrated into a planned economy. Every five years the government developed a series of plans to foster economic growth and industrial development. Over the last ten years, India has revised its policy and decided to move from a planned and closed economy to a more open and deregulated one.

In 2003, Indian government developed a new *Science policy* and its implementation plan which became the foundation for science and technology policy. The responsibility of execution of science and technology policy lies on many government ministries and their departments, each one of which has an authority in different fields, e.g. health, information technology, environment, agriculture, and water. But the central role in promoting science and technology is assigned to the Ministry of S&T.

In India, most of the R&D funding comes from government ministries, the greatest part of which goes to national laboratories rather than to universities. This happens because national laboratories conduct a research at advanced stages which tends to be more expensive while universities mostly focus on basic research which is less expensive. The two biggest fields for national research funding in India are engineering and medical sciences. In addition to general funding, some government departments fund collaboration with private sector at various stages of development. For example, the University Grant Commission provides funds at the initial stage of collaboration on the condition that the outcome is patented [101].

University-industry collaboration in India does not have a long history. Only in recent years firms have started being engaged in collaborative programs with universities. The collaborations that occur are mostly in the form of consultancies which typically do not involve large-scale projects [101]. The majority of Indian firms think that their own R&D capacity is enough to innovate, plus, cooperating with universities may not be worth as they have no or little understanding of their line of business [89].

Russian Federation. The discussion about Russia is based on the observations of the author and the work published by OECD (2005) which describes the government's role and the nature of public-private partnerships in Russia [144].

In the Soviet Union times, teaching was the sole function of universities. Although universities had close relationships with enterprises which were assigned by the central government, the primary concern of both sides was the recruitment of graduates for work and students for internship. Universities and science were two separate worlds. This was one of the reasons why research at universities was underdeveloped.

Only since 2003, universities in Russia started getting government support for basic research. However, universities still play a minor role in R&D. This legacy from the Soviet Union has not been corrected yet despite the relatively good performance of university-based laboratories in terms of both publications and contract research. Hitherto, the greatest part of scientific research is performed by public sector, specifically by the state-owned centers and the Academies of Sciences.

Industry-science relationships (hereinafter, - ISRs) in Russia remain weak. ISRs tend to be irregular; their number, size, technological scope and geographical spread are very limited. The majority of firms lack absorptive capacity and motivation to collaborate; the research sector is inexperienced in the transfer of technology and knowledge; and the government sector lacks appropriate institutional frameworks to stimulate and regulate ISRs. Once collaboration between industry and science representatives occurs informal channels of knowledge transfer are assumed to be of a particular importance.

Another issue that hinders public-private collaboration in Russia is uncertainty regarding intellectual property rights allocation which creates conflicts of interest for the engaged parties. The legal basis for such allocation is not yet transparent. Additionally, the disposal of tangible assets owned by the state is poorly regulated in practice because it is very difficult to exercise control over such a big number of state-owned enterprises [144].

The analysis of S&T policy and university-industry collaboration practices in developing countries has shown a limited influence of governments and insufficient policies to foster knowledge transfer between public and private sectors. Universities in developing countries get inadequate funds from governments which restricts their ability to conduct research. In order to increase funds universities try to substitute government funding by funding through students, donors, and companies but this does not provide higher education institutions with significant financial strengths and improved quality of research [53]. Another conclusion that can be brought from our analysis is that informal contacts based on trust play an important role in building university-industry interactions in both developed and developing economies.

To summarize, this chapter has provided a theoretical overview of knowledge transfer and university-industry collaboration phenomena. The author offered own definition of knowledge transfer in the context of Kazakhstan. The channels of knowledge transfer as well as the main benefits of and obstacles to university-industry collaboration were discussed. A variety of governance forms for effective knowledge transfer were presented in the second part of this chapter. The third part of the chapter looked at how theoretical approaches found their practical application in both developed and emergent economies. It thoroughly examined the experiences of selected nations as well as their policies implemented to foster university-industry collaboration.

2 UNIVERSITY-INDUSTRY LINKAGES AND KNOWLEDGE TRANSFER IN THE CONTEXT OF INNOVATIVE DEVELOPMENT OF KAZAKHSTAN

In 2005, Kazakhstan started to develop a knowledge-based economy (*Program for the Formation and Development of the National Innovation System of the Republic of Kazakhstan for 2005–2015*). In this kind of economy, universities are assigned a key role to create, store, and disseminate knowledge.

To foster transition to a knowledge-based economy, the government of Kazakhstan initiated a number of programs and strategies. It created the national innovation system and innovation infrastructure to facilitate the transfer of knowledge between the agents. The main elements established during the last decade include: the National Innovation Fund, eight regional technology parks, special economic zone “Park of Innovation Technologies”[3], scientific and technological holding "Parasat", "KazAgroInnovatsiya" company, four design offices, seven industrial innovation centers, nine commercialization offices, and four domestic venture capital funds (*The Concept of Innovative Development of Kazakhstan till 2020*). All these elements are aimed at enabling the creation of new knowledge in the economy which is further translated into innovations.

Over recent years, Kazakhstan has developed own approach to knowledge management which involves interactions between science and production organizations that take advantage of their own employees as well as outsourced experts in education and consulting [145]. This approach seems to be the most suitable in the case of market economies. However, the implementation of this approach in Kazakhstan is characterized by severe challenges.

This Chapter addresses the challenges that Kazakhstan experiences being in transition to a knowledge economy in which innovations are the result of interactions between several agents. Thus, the first section starts from a historical perspective by evaluating science and production linkages in Kazakhstan when it was a part of the USSR. It continues with the discussion of current state of science and innovative development of Kazakhstan since its independence.

The second section of Chapter 2 analyzes the role of R&D expenditures in innovative development of the country and, in particular, looks at the structure of R&D spending in both developed and developing nations and explains which sector (government or private) should play a major role in R&D financing in CIS countries and specifically in Kazakhstan.

The third part evaluates the effectiveness of Kazakhstan’s innovation infrastructure based on the methodology developed by the author, analyzes the bridging capability of its elements, and discusses some policy controversies, as well as future initiative of the government in this regard.

The last part of Chapter 2 focuses on university-industry linkages in telecommunications sector. It starts from describing the main tendencies in the Information and Communications Technologies (ICT) market over the last years and revealing the

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[3] This special economic zone was created in 2003 and was initially called “Park of Information Technologies”. In 2011, it was renamed into “Park of Innovative Technologies”.

specificities of the telecommunications sector. It continues with the discussion of policies and structures that have been created to foster university-industry collaboration and innovative development of this sector.

2.1 Retrospective Analysis of Science-Industry Linkages and Innovation Performance of the Republic of Kazakhstan

2.1.1 Science and Production Linkages in the Soviet Social Republic of Kazakhstan

In 1991, Kazakhstan gained its independence and became the Republic of Kazakhstan. Because the country experienced severe difficulties after the dissolution of the USSR such as plummeting of industrial production and widespread corruption, the government of Kazakhstan envisioned a need of moving towards a knowledge-based society and economy [122]. The country tried to develop new policies, programs and laws, made systemic and structural changes, however the legacy of the Soviet Union is still apparent almost in every aspect of the country's life, especially in public organizations and education system of Kazakhstan.

In the USSR, the necessity of ties between higher education institutions and enterprises was realized as back as in the late 1920s. The Soviet government took immediate actions and during 1930s the vast majority of universities and technical colleges were established under the economic commissariats, or in other words branch ministries. Later in the mid-1930s, the government developed a scheme under which students were assigned to particular companies six months before the graduation and had to work there at least for three years [146]. During the World War II, the importance of university-industry ties was understood as never before, and in subsequent times the Soviet government ran a number of reforms to strengthen these ties.

The impact of university science on the acceleration of the pace of scientific and technological progress in the post-war Soviet Union was described by Nikiforak (1983). The author claims that the primary goal of the interactions between higher education and production was to improve the training level of students who will be further directed to work on the enterprises. To achieve that goal, educational facilities of universities and production base of industrial enterprises were integrated. Then enterprises could contribute to the activities of higher education institutions by helping them to improve the content of the curricula, methods of teaching and by recruiting students as trainees in the course of internship programs [147].

As Nikiforak (1983) notes, the main forms of the interaction between higher education and production in the USSR were: i) contracts for assistance of enterprises in strengthening the material and technical basis of higher education institutions; ii) equity participation of branch ministries and their departments in major construction of universities/institutes; iii) contracts assigning to study in universities; iv) joint development of qualifications needed for professionals; v) the involvement of highly qualified industry employees in the education process; and vi) the establishment of university departments on enterprises. The effectiveness of each of these forms was directly dependent on the quality cooperating universities and industrial organizations, as well as the extent of their mutual interest in collaboration. The primary end product of the interaction between the agents was high quality training received at higher education institutions which conformed to the requirements of a specific industry.

Scientific and technical cooperation between universities and enterprises was a matter of great importance in the USSR. Above all, such cooperation was designed to enhance knowledge-intensity of the training process and mastery of the teaching staff. In addition, the cooperation implied active involvement of students in the research process which allowed them to develop creative thinking and find practical application to their theoretical knowledge [147].

The USSR government directed all its efforts to the integration of the research process which lied in the move from narrow and small-scale studies to large and systemic. The main feature of large systemic studies was a close connection between all phases of fundamental and applied research to be further implemented in practice. To accomplish this, the government introduced a program-target method of research organization which clearly regulated the responsibilities of all the parties involved. As a result, the effectiveness of interactions between university science and production through increased significantly in such forms as applied research laboratories, agreements in scientific and technical cooperation, integrated creative teams, etc.

In the mid-1970s, the interaction of higher education and production in the Soviet Union entered a new stage of its development. The process became more complex; the integration of science and industry took place within single organizational structures. Those structures were called educational, scientific and production associations (ESPAs) [147].

Although this may sound absurd but the Soviet Union allowed democratic freedom in science, the researchers could choose the area and the direction they liked. USSR science managed to attract the best minds. Progressive youth lined up to enter postgraduate programs the competition for which was very tough. We may even say that being a scientist was “fashionable” in the Soviet Union. The salary of a candidate of sciences was higher than the one of the Regional Secretary of the communist party. Doctors of science had the highest salary and academics of science received more than secretaries of the Central Committee of the Central Party of the Soviet Union (CPSU) [148].

The critics of the Soviet Union system [149] argue that science had been artificially separated from the higher education system. There was only a limited number of universities which actively contributed to the development of science by producing new knowledge and attracting students to it: Moscow State University, Moscow Higher Technical School, Moscow Engineering Physics Institute, Moscow Physical and Technical Institute, and Novosibirsk State University. Additional albeit very weak mechanism for attracting students to scientific research involved economic contracts of universities with enterprises. After collapse of the USSR, these mechanisms were eliminated which created a situation in which science, universities, and business exist on their own [149]. Simply, the Soviet system of education was closed, so it was doomed to fail one day [150].

The proponents of the USSR system [59] claim that in the field of knowledge Kazakhstan owes to the Soviet Union. The golden age of Kazakhstani science as well as the USSR science was in 1960-1980s. At that time, the Kazakh Academy of Sciences was one of the leading Academies in the Soviet Union [148].

The Soviet system worked successfully until it collapsed due to political reasons in 1991. Just in several years Kazakhstani science was ruined. In the Soviet Union, science was divided into three categories [151]: academic (fundamental research presented by the Academy of Science and funded by the government), agency-level (scientific and practical specialized institutions under the ministries), and university-level research. It so happened that university science in Kazakhstan was not well developed but academic and agency-level sciences were strong. In the 1990s, the first hit was taken by the agency-level science, followed by the academic. Additionally, after the integration of National Academy of Sciences of RK with the Ministry of Education, and termination of the integration just in several years, the Academy lost its institutes [148].

2.1.2 Science and Innovative Development of Independent Kazakhstan

After collapse of the USSR, Kazakhstan entered into a period of severe recession. The economic downturn negatively affected the country's scientific potential [152]. Given the understanding that science is the key driver of social and innovative development [153, p. 7] as well as economic success, since the late 1990s, Kazakhstan's government has tried to implement effective mechanisms to revitalize science and foster innovative development of the country. Thus, the government did several structural reorganizations, ran a number of reforms, and created new institutional formations such as technology parks, business incubators, centers of commercialization, etc.

The development of Kazakhstan's science after the country's independence can be broken down into several periods: the first period from 1991 to 1995 – the period of the formation of the scientific and technical policy and the governance structure of science; the second period from 1996 to 2000 – a radical reorganization of science; and the period from 2001 to the present time – the period of modernization of the legislative and regulatory framework of Kazakhstan's science [154, p. 159].

Zhurinov (2010) argues that in the early years of Kazakhstan's independence the state focused on the purchase of technology from abroad [148] which seemed to be much easier and more efficient rather than investment in the basic research. However since 1999, the government has refocused its attention on the development of science [152] and innovations rather than on the purchase of technologies from overseas. Today the state provides financial support for both for basic and applied research to satisfy the needs of the industry [155].

According to the *Law of the Republic of Kazakhstan "On Science" (2011)*, research funding may take three forms:

- ✓ *Grant* – funding research projects in accordance with the national priorities of the country;
- ✓ *Program-oriented* – funding in strategic areas, and
- ✓ *Fundamental* – funding for research organizations through the state orders.

Nevertheless, even though this funding scheme looks quite adequate the overall funding level is insufficient – only 0.17 percent of GDP is spend on research and development [156]. In addition to scanty funding, there are many other problems which are common for all CIS countries: poor management of science, ageing research personnel, weak level of training in scientific and technical spheres, low demand for research, and weak public-private partnerships [157].

Bhuiyan (2011) compares Kazakhstan's situation in science with the African case where researchers and university faculty get low salary, universities and the government do not provide enough incentives for hardworking knowledge workers [122]. However, Bhuiyan (2011) also notes that the government of Kazakhstan has recently introduced a scheme of generous grants and awards to productive faculty researchers. Thus, every year the government provides 75 research grants for talented scientists at the age of 35 and younger. Other yearly prizes for all age categories include awards for the best research in the field of natural sciences, agricultural sciences, humanities, pedagogy, and Turkic Studies [122]. Definitely, there is some progress in the incentives scheme but yet this is not enough to push scientific and technological development in Kazakhstan. There must be a systemic approach to management of science under which all research, government, and private objects would interact.

Currently, the research sector of Kazakhstan is represented by the National Academy of Science (NAS), National Academy of Engineering (NAE), branch academies, research institutes, and universities. As Darenskih (2009) notes, NAS provides effective framework for the dialog and linkages with industry: more than 20 research and production centers operate under the Academy. Additionally, NAS was actively involved in the creation and development of Kazakhstan's technology parks; its departments and branches closely work with manufacturing enterprises in a number of regions [158]. However, the research sector still remains highly centralized with little focus on regional development of science [159].

Despite there seems to exist science infrastructure and some financial support for the researchers is provided, commercialization of the invention in Kazakhstan still presents a challenge (Figure 6). The analysis of the innovation activity of the research sector showed that the main problem is the transfer of knowledge and technologies developed by research institutes and universities [158]. In other words, it turns out to be very difficult for the inventor to get reasonable profits after patenting the invention. As of today, the best options for gaining as much possible from the invention in terms of profits are: to sell the invention abroad or to the local company, use own funds, or keep the patent without disclosure for better times. But just a couple of years ago a number of commercialization centers were opened in leading universities and research institutes. The effectiveness of commercialization centers is not yet known as they are relatively new units but the government places a lot of hopes on them.

The current level of innovation activity in Kazakhstan tends to be low. Kazakhstan stands only 84 out of 142 economies in the *Global Innovation Index 2013* [130]. The report shows that the country is still weak in the production of knowledge (ranked 82) and is even weaker in its diffusion (ranked 115). Kazakhstan stands 53 in research and development indicator which is calculated on the basis of the number

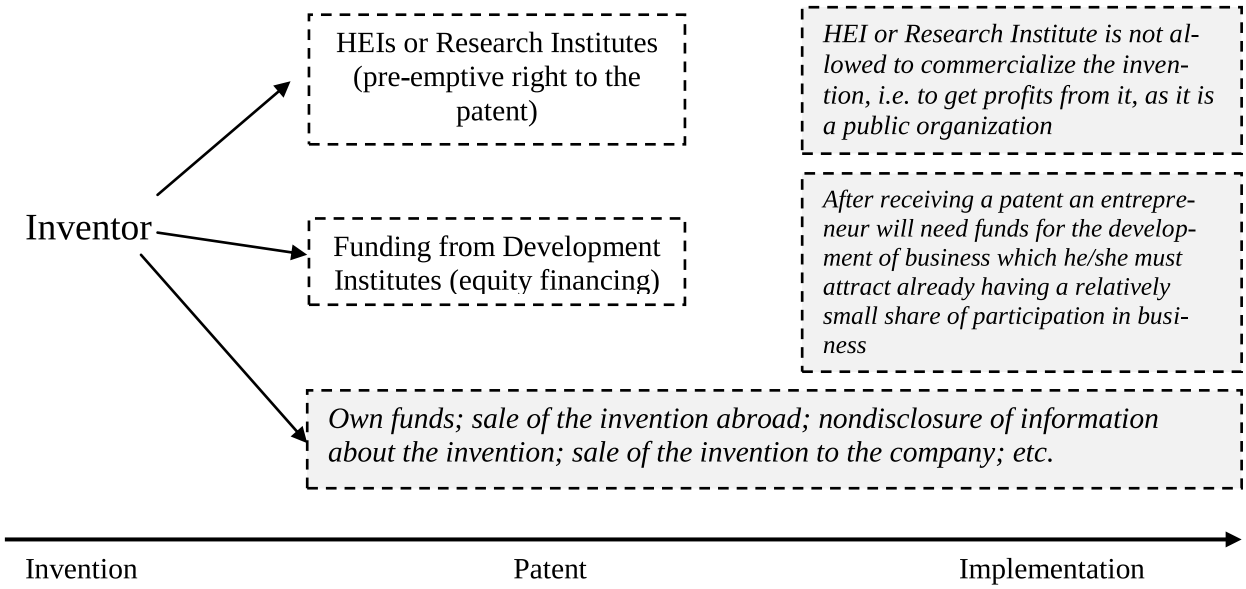

Figure 6 – Pathways for Commercialization of Invention in Kazakhstan

Source – [160]

of researchers in the economy, R&D expenditures as percentage of GDP, and average score of top three universities in the country. The situation of Kazakhstan concerning innovation is even worse in the *Global Competitiveness Report 2012-2013*, despite that the country is ranked 51 (out of 144) in the competitiveness worldwide. The weakest points of Kazakhstan are: quality of scientific research institutes (ranked 108), availability of scientists and engineers (ranked 104), company spending on R&D (ranked 94), capacity for innovation (ranked 92), and university-industry collaboration in R&D (ranked 90) [161].

Innovative development is an ardently discussed topic in Kazakhstan's scientific community. For example, Alzhanova F. (2010) states that in order to create favorable institutional conditions for innovative development the government should focus on four directions: the development of science and human capital, creation of the innovation infrastructure, development of innovation institutes, and creation of new markets [162]. Zhumagulov (2011) emphasizes the importance of politechnical universities for innovative development of the country [150] while Bekturganova (2011) stresses the need for stimulation of small innovative businesses [163].

According to Tuimenbayev (2010), the best option for Kazakhstan is to adopt Finnish model which has been recognized as the most effective in the world. This model is built upon three pillars: high level of education, competitive distribution of funds for science, and developed innovation infrastructure. It is also important to take into consideration Chinese model which combines both centralized and market elements [157].

In our opinion, studying experiences of other countries adds to our understanding of their success and mistakes. However, one should remember that adopting foreign experience without adapting it to the local economic, political, and socio-cultural context may be a direct way to utopia.

The government of Kazakhstan is aware of the situation and understands that there is a need to create a synergy of science, new technologies, business sector and government, as stated in the *Concept of Innovative Development of Kazakhstan till 2020*. There is also a recognition that private sector should play an important role in financing R&D as it facilitates the transfer of knowledge and technologies. This conception has been borrowed from developed countries without any doubt.

2.2 The Role of R&D Expenditures in Innovation Development of Kazakhstan

According to our research, it is important to note that the structure of R&D expenditures (government or private) should be given a principal concern in CIS countries and in particular in Kazakhstan [164].

On the basis of the international practice, the main classification of R&D funding is broken down into five sectors: business, public, private non-profit, and higher education sector [165].

Business sector includes all firms, organizations and institutions whose primary activity is to produce or to provide market goods or services (excluding higher education) for sale to consumers at economically reasonable prices, as well as private non-profit organizations which provide services to them. The main players in this sector are private enterprises (corporations or quasi-corporations) regardless of whether they distribute profits or not. There may be few firms among these enterprises for which R&D is the main activity (e.g. commercial institutions and research laboratories). In addition, private companies that provide services in the field of higher education should be included in the higher education sector.

Public sector consists of the departments, offices and other state agencies which do not sell but provide services (other than higher education) to the community that cannot be provided in other convenient or economically feasible ways including administration of the state, economy and social policy. Public sector also includes non-profit organizations which are controlled and financed by the state excluding higher education sector.

Private non-profit sector comprises nonmarket, private non-profit organizations providing services to individual enterprises (i.e. citizens) and self-employed private persons.

Higher education sector consists of universities, technical colleges and other institutions providing post-secondary education regardless of their legal status or source of financing; research institutes, experimental laboratories and clinics which are directly controlled by the institutions of higher education or related to them in any other way.

In most industrialized nations, private sector plays a vital role in innovative development by providing the largest share of funds for conducting R&D as compared to other sectors. That is why, in his latest address to the peoples of Kazakhstan entitled "*Strategy Kazakhstan-2050: a New Political Course for the Established State*" N.A. Nazarbayev speaks about the importance of the implementation of innovations and the need to encourage private companies to invest in research and development. In our opinion, in order to enter top 30 developed nations worldwide by 2050, Kazakhstan should focus on the development of innovations in all possible fields. However, one should remember that only conducting research and development is not enough, it is important to implement innovations. In many cases, business sector becomes the most effective mechanism for the implementation of innovations.

According to the data published by Cornell University, INSEAD and WIPO in the annual report the "*Global Innovation Index 2013*", top ten innovative countries are Switzerland, Sweden, the United Kingdom (UK), the Netherlands, the United States of America (USA), Finland, Hong Kong (China), Singapore, Denmark, and Ireland. In comparison with 2012, the composition of the top ten economies has not changed. The only change that occurred is the movements within this group of countries. Thus, Switzerland did not change its position and remains an absolute leader in innovations. In contrast, Singapore moved down the rank by 6 positions while USA went up by 5 positions.

As seen from Table 9, the majority of countries-leaders in innovations spend on research and development around 2-3 % of GDP. Many of these countries have a high share of private sector participation in financing R&D which has been achieved through the implementation of tax incentives and tax preferences (e.g. tax holidays, income tax deductions, tax credit, etc.).

Table 9 – R&D Expenditures of Top Ten Innovative Countries Worldwide

No	**Country**	**R&D expenditures (in % of DGP)**	**R&D financed by business sector (in % of GDP)**
1	Switzerland	2.9	68.2
2	Sweden	3.4	58.2
3	UK	1.8	44.6
4	Netherlands	2.0	45.1
5	USA	2.8	60
6	Finland	3.8	67
7	Hong Kong (China)	0.8	45.8
8	Singapore	2.1	53.1
9	Denmark	3.1	60.2
10	Ireland	1.8	48.1
Note – Compiled by the author based on [130]			

The share of public sector R&D financing in developed countries is usually insignificant: Switzerland – 0.7 %, Sweden – 4.4%, UK – 9.2%, Netherlands – 12.6%, USA – 10.6%, Finland – 9.1%, Singapore – 7.6%, Denmark – 2.9%, and Ireland – 4.3% [165]. The only exception is Hong Kong (China) where the share of R&D funding by public sector reaches 50.9% [166]. This is due to a unique Chinese model of science management which combines both centralized and market models [157]. The rest of the R&D funding in countries-leaders in innovations is provided by higher education and private non-profit sector with the latter having the smallest share.

As was noted earlier, the level of R&D expenditures in Kazakhstan is insufficient to support innovative development of the country. In terms of R&D expenditures Kazakhstan lags behind several CIS countries: Azerbaijan, Armenia, Moldova, Belarus, Ukraine, and Russia. Concerning the *Global Innovation Index 2013* position, Kazakhstan is left behind six CIS states: Moldova, Armenia, Ukraine, Georgia, and Belarus (Table 10).

By the structure of R&D expenditures CIS countries can be grouped into two categories: those using centralized model and those using market model for the management of science. Centralized model implies that the country relies on the bulk share of R&D expenditures financed by the government; in a market model, the primary source of R&D financing is business sector [157].

Thus, we would rank Azerbaijan and Tajikistan first in the "centralized model" category; the share of public sector R&D financing in these countries equals to 93.6% and 93.1%, respectively (Figure 7). In the second position of the same category we would add Moldova (73.5%) and Georgia (73.2%), while Armenia (69.5%) and Kyrgyzstan (59.6%) could be placed in the third position in this category. In the above listed countries the state plays a key role in achieving scientific and technological progress. The danger of using a centralized model of science financing is that science and innovations become directly dependent on the state budget. This particularly might be dangerous in Azerbaijan, Georgia, and Tajikistan which make a great emphasis on public sector financing while private sector financing is absent. The remaining part of R&D expenditures in these countries comes from universities. We would highlight Georgia here where a significant share of R&D expenditures is financed by universities – 26.8%.

As for the countries using "market model", we may include Russia, Belarus, and Ukraine into this category. These countries proceed along the same path of many western states. The main source of funding for R&D in this group of countries is business sector with 55-60 percent share of financing (Figure 7).

Table 10 – CIS Countries: The Global Innovation Index 2013

Country	**Global Innovation Index 2013**	**Rating of R&D Expenditures (2009)**	**R&D Expenditures, % og GDP (2009)**
Moldova	45	53	0.53
Armenia	59	73	0.27
Russia	62	29	1.25
Ukraine	71	37	0.86
Georgia	73	88	0.18*
Belarus	77	46	0.64
Kazakhstan	84	79	0.23
Tadjikistan	101	99	0.09
Azerbaijan	105	75	0.26
Kyrgyzstan	117	91	0.16
Uzbekistan	133	-	-
Turkmenia	-	-	-

Note 1 - *2005 data
Note 2 – Compiled by the author based on [130, 165]

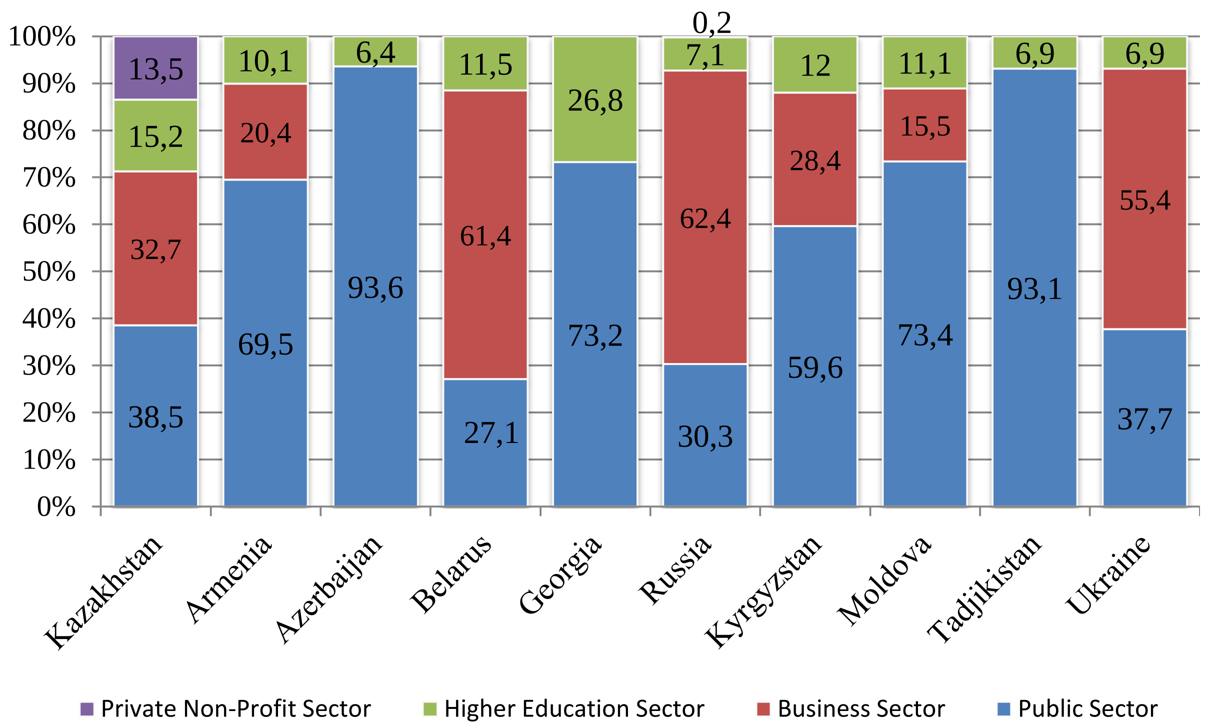

Figure 7 – The Structure of R&D Expenditures by Sectors: CIS Countries, 2009 (in percentage)

Note – Drafted by the author based on [165]

In contrast to other CIS countries, Kazakhstan uses a combination of planned and market models to science management which is similar to the one used in Hong Kong. As seen from Figure 7, business sector (32.7%) and public sector (38.5%) have approximately equal shares of R&D expenditures in Kazakhstan. Moreover, Kazakhstan is the country among CIS states where R&D is also funded by private non-commercial sector (13.2%). Another such country is Russia with the share of non-profit organizations in R&D expenditures equal to 0.2%. Worldwide, the share of R&D funding by non-profit sector remains very low (less than 3%) with the exception of Cyprus, Chile, and Portugal where the share of financing by this sector constitutes to 14%, 11.7%, and 10.6%, respectively.

However, according to the latest data, the structure of R&D financing in Kazakhstan has changed. Thus, in 2011, the shares of domestic R&D expenditures were as follows: public sector – 25%, business sector – 51.6%, higher education sector – 16.4%, and private non-profit sector – 7%. Such distribution of R&D funding is indicative of Kazakhstan’s transition to a market model of managing science funding which prevails in most developed countries.

One of the indicators to measure the effectiveness of R&D is the number of patent applications per million of population. In addition, the literature suggests that patents are considered to be an important channel of knowledge transfer. The absolute leader worldwide is Sweden with 311 patent applications/mln of population, followed by Switzerland and Finland. Among CIS countries the greatest number of patent applications is registered in Russia, Ukraine, and Georgia (see *Global Competitiveness Report 2012-2013*).

In this regard, we have analyzed the relationships between patent applications and R&D expenditures (public and business) on the example of CIS countries. It is expedient to test the relationship between the two indicators in this group of countries because, firstly, Kazakhstan is a member of this group; secondly, all the CIS countries are developing; and thirdly, these countries have common history and lifestyles inherited from the Soviet Union era.

To estimate the relationships we used the data from Table 11. Since the data about some countries' indicators is not available for the year 2009 which we have selected as the base year, it is rational to employ the average value of patent applications filed with national Patent Offices since 2005 to 2009. Turkmenistan and Uzbekistan were excluded from our analysis due to some missing data.

Table 11 – Patent Applications and R&D Expenditures in CIS Countries

CIS countries	Patent applications filed with national Patent Offices (in units)						R&D expenditures by sectors (in percentage)	
	2005	2006	2007	2008	2009	Average	Business	Public
Kazakhstan	1626	1557	-	173	-	1119	32,7	38,5
Armenia	287	-	-	227	-	257	20,4	69,5
Azerbaijan	208	193	-	230	127	190	0	93,6
Belarus	1462	1525	-	1730	-	1572	61,4	27,1
Georgia	461	535	162	247	468	375	0	73,2
Russia	37691	37691	39439	41849	38564	39047	62,4	30,3
Kyrgyzstan	-	-	158	138	-	148	28,4	59,6
Moldova	388	312	347	295	139	296	15,5	73,4
Tajikistan	36	26	-	-	12	25	0	93,1
Turkmenistan	-	-	-	-	-	-	-	-
Uzbekistan	444	509	522	448	412	467	-	-
Ukraina	5592	5890	6163	5697	4814	5631	55,4	37,7
Note – Compiled by the authors based on [165]								

The first stage of the statistical analysis includes the calculation of correlations: i) between business sector R&D expenditures and patent applications, and ii) between public sector R&D expenditures and patent applications. The correlations were calculated using formula (1):

$$\boldsymbol{r_{xy}} = \frac{\boldsymbol{Cov(x,y)}}{\boldsymbol{s_x \cdot s_y}}, \qquad (1)$$

where,

r_{xy} – correlation between variables x and y;

$Cov(x, y)$ – covariance between variables x and y;

s_x – standard deviation of variable x;

s_y – standard deviation of variable y.

The result of the correlation between patent applications $\boldsymbol{y}$ and business sector R&D expenditures $\boldsymbol{x}^*$ is as follows: $\boldsymbol{r_{xy}}^*$ = 0.568 which indicates of a moderate positive relationship between the two variables. The correlation $\boldsymbol{r_{xy}}^{**}$ between patent applications $\boldsymbol{y}$ public sector spending on R&D ($\boldsymbol{x}^{**}$) equals to -0.486; which points out to a moderate negative relationship between variables $\boldsymbol{y}$ and $\boldsymbol{x}^{**}$.

In most developed countries private enterprises are considered to be the main source of R&D funding while public sector plays only a secondary role. As shown in Table 9, in CIS countries where the greater share of R&D is financed by business, the number of patent applications is bigger than in states where public sector plays a significant role in funding of science. Based on this observation and the result of the correlations it is possible to put forward two hypotheses.

- ✓ *Hypothesis 1:* There is a positive relationship between business sector R&D expenditures and the number of patent applications for inventions, in other words, the higher the share business sector in financing R&D the greater the number of patent applications filed in a country.
- ✓ *Hypothesis 2:* There is negative relationship between public sector R&D expenditures and the number of patent applications for inventions, in other words, the higher the share of government spending in R&D the smaller the number of patent applications filed in a country.

Results: business sector.

Variables:

$\boldsymbol{x}^*$ – the share of R&D financed by private sector

$\boldsymbol{y}$ – the number of patent applications filed with the national Patent Office

$$\boldsymbol{H_0: p = 0}$$

(There is no any relationship between the share of business sector R&D expenditures and the number of patent applications)

$$\boldsymbol{H_1: p > 0}$$

(There is a positive relationship between the share of business sector R&D expenditures and the number of patent applications)

Further, t-statistics is calculated using formula (2):

$$\boldsymbol{T.S.} = \frac{\boldsymbol{r_{xy} \times \sqrt{n-2}}}{\sqrt{\boldsymbol{1-r_{xy}^2}}}, \tag{2}$$

where,

$\boldsymbol{r_{xy}}$ – the correlation between variables $\boldsymbol{x}$ and $\boldsymbol{y}$;

$\boldsymbol{n}$ – the number of observations.

$$\mathrm{T.S.} = 4.1268$$

Next, we need to compare the results of t-statistics and t critical (this value is available from statistical tables). Thus, we have:

$$\mathrm{t}_{n-2,\alpha} = \mathrm{t}_{8,0.05} = 3.3550$$
$$4.1268 > 3.3550$$

Because t-statistics is bigger than the absolute value of t critical ($T.S. > t_{n-2,á}$), we reject H_0 and with 95% confidence and accept H_1 according to which there is a positive relationship between the share of business sector R&D expenditures and the number of patent applications.

Results: public sector.

Variables:

$\boldsymbol{x}^{**}$ – the share of R&D financed by public sector

$\boldsymbol{y}$ – the number of patent applications filed with the national Patent Office.

$$\boldsymbol{H_0}: \boldsymbol{p} = \mathbf{0}$$

(There is no any relationship between the share of public sector R&D expenditures and the number of patent applications)

$$\boldsymbol{H_1}: \boldsymbol{p} < \mathbf{0}$$

(There is a negative relationship between the share of public sector R&D expenditures and the number of patent applications)

If t-statistics turns out to be less than t critical we will reject H_0. To calculate t-statistics we have selected a 97.5% significance level.

$$T.S. = -2.6803$$
$$t_{n-2,á} = t_{8,0.025} = -2.306$$
$$-2.6803 < -2.306$$

Because t-statistics is smaller than the absolute value of t critical ($T.S. < -t_{n-2,á}$,), we reject H_0 and with 97.5% confidence and accept H_1 according to which there is a negative relationship between the share of public sector R&D expenditures and the number of patent applications.

Statistical analysis proved the veracity of the hypotheses about the relationships between the number of patent applications and the shares of R&D expenditures by business and public sectors. Based on this finding we may claim that the larger the share of business sector in financing of science the greater the number of patent applications, which subsequently leads a high innovation performance in the country. Conversely, a significant share of R&D funding by public sector does not lead to an immense increase in the number of patent applications.

Our results are not consistent with the successful experience of Hong Kong where the share of public R&D expenditures is more than 50%. Despite the prevailing government funding, there is a large number of patent applications. In addition, Hong Kong is one of the leading counties in innovations. The success of the country can be explained by the fact that Hong Kong, as well as China, proceeds along own path which is directly connected with the country’s history. There are still many signs of centralized state regime; the government tries to keep control over all the processes and intervenes if there is a need, for example, to support R&D. Just in several decades Hong Kong managed to achieve incredible success and get a status of a developed economy.

In a country with a market economy like Kazakhstan, the emphasis of R&D funding should be made on business sector. The government should focus on developing policy which would provide companies with market incentives to finance R&D. Moreover, Kazakhstan’s government should concentrate on establishing the tradition of public-private partnerships, or university-industry collaboration. The country already has the needed prerequisites: the legislative framework and the innovation infrastructure. The latter is discussed in details in the next section.

2.3 Innovation Infrastructure for the Transfer of Knowledge

The innovation infrastructure is an important element of the national innovation system. The effective functioning of the infrastructure increases scientific capacity of the nation and fosters the development of innovations within a country. Innovation infrastructure is usually considered as a set of intermediary units bridging business, education, and science. For example, technology parks, science parks, and many other similar establishments can be considered as knowledge transfer organizations [90].

As was mentioned in our research paper [167], in order to recognize the impact of these intermediary units on the innovativeness of an economy it is vital to go deeper into the analysis of the national innovation systems.

The idea of a national innovation system was born in the early 1980s and is traced through the works of Nelson, Lundvall, and Freeman. The full concept of "National Innovation System" (NIS) was first used by Christopher Freeman in his book "Innovation in Japan" in 1987 [168]. Freeman (1987) describes NIS as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" [169]. These interactions are "either located within or rooted inside the borders of a nation state" [170]. They impact not just innovative performance of national firms [171] but also technological change in the society [172, 173]. The interactions basically occur between private and public firms, universities and government [174] to create and disseminate new knowledge and technologies [170, 175]. NIS approach involves networks of policies, institutions and people that mediate knowledge flows [176].

NIS consists of the elements that continuously interact with each other including political, bureaucratic, regulatory, social, educational, knowledge-oriented, and bridging bodies as well as non-profit organizations and public agencies [177]. Briefly, these are networks of policies, institutions and people that support creation, diffusion and application of new knowledge.

In Kazakhstan, national innovation system started being shaped in 2003 in the form of institutional and physical infrastructure (*Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014*). The initial institutional infrastructure was represented by National Innovation Fund, Center for Engineering and Technology Transfer, and a number of venture funds. The physical infrastructure was composed of four technology parks and a park of innovative technologies named "Alatau".

A legislative framework for the development of NIS on its early stage was represented by the *Innovative Industrial Development Strategy of the Republic of Kazakhstan for 2003-2015* and the *Program for the Formation and Development of the National Innovation System of the Republic of Kazakhstan for 2005–2015*[4], both of which became the cornerstones for the formation of NIS in Kazakhstan. The Strategy

[4] Kazakhstan was foremost among CIS countries in introducing the Program to create the national innovation system [178].

reports proactive state research and describes policies encouraging research and innovation activity in the country. The Program outlines an effective scheme for knowledge creation, dissemination, and commercialization. It also elaborates on the elements, or subsystems, of Kazakhstani NIS which comprises the following: scientific capacity, innovative entrepreneurship, innovation infrastructure and financial infrastructure.

1. *Scientific capacity* of Kazakhstan focuses on applied research and is represented by public research organizations (such as national research centers, research institutes, universities, and project institutes); research organizations and laboratories in large enterprises; private research and project institutes; small and medium-sized enterprises engaged in scientific research; scientific brain-power and individual inventors; and material and technical basis.
2. *Innovative entrepreneurship* is a linkage between Kazakhstani science and industry by means of business angels, enterprises, and innovation managers. The ultimate goal of innovative entrepreneurship is the creation and development of enterprises able to quickly respond to a changing market environment by producing high-tech, new generation products.
3. *Innovation infrastructure* is multilevel and comprises a set of interrelated industrial, consulting, educational and informational structures designed for the implementation of innovations. Kazakhstani Innovation infrastructure includes special economic zones (SEZ), industrial zones, technology parks (technoparks), and business incubators.
4. *Financial infrastructure* provides comprehensive a funding for research and production in the field of innovative and technological development of Kazakhstan. It is based on a combination of different mechanisms of direct and indirect government support for innovative entrepreneurship and innovation infrastructure. Financial infrastructure consists of state development institutions, venture capital funds, commercial enterprises, individual entrepreneurs, second-tier banks, and others.

Innovation infrastructure is a vital element of a national innovation system as it provides the economy with the services and facilities needed for the transfer of knowledge and transformation of ideas and into a final product. A rich innovation infrastructure offers greater opportunities to firms and other agents to access or test knowledge [179].

Typically, innovation infrastructure is represented by bureaus of standards and patent offices [180] as well as domestic investment and government policies that support innovative activity [181]. In contrast, Dutta (2012) describes the innovation infrastructure as comprising business incubators, technology parks, engineering centers, and the collective use of research equipment and science and technology (S&T) information [182].

Some authors split the innovation infrastructure into subcomponents. For example, Galli and Teubal (1997) and Stejskal and Matatkova (2011) distinguish between hard and soft elements of the innovation infrastructure [180, 183].

A hard element includes physical infrastructure (industrial areas, technology parks, science and development parks and innovation centers) and technological infrastructure which is represented by the latest equipment and tools in organizations (e.g. testing and research centers, academy of science institutions or research and development (R&D) centers and laboratories).

Soft infrastructure, referred to as ‘knowledge infrastructure’, includes educational institutions, universities and other bridging organizations enabling horizontal or vertical transfer of knowledge among individual organizations and companies. Business incubators that are established within universities to promote links with the business sector are university interfacing units [180] hence, may be considered as a composite of soft infrastructure.

Despite the numerous definitions of the ‘innovation infrastructure’, no author provides a clear explanation of the concept. The definitions are rather specific in their nature describing the elements of the innovation infrastructure. Though, dividing infrastructure into hard and soft elements [180, 183] is warranted. Drawing such a distinction may allow policy makers to recognize whether these are hard or soft elements that hold back or drive the development of innovations.

More broadly, according to our opinion, the *innovation infrastructure* can be defined as *a set of knowledge and technological organizations performing innovation activities as well as science and technology intermediaries promoting and facilitating innovation within a particular nation*. It should be noted that country-specific definitions may be narrower focusing on the elements of the innovation infrastructure, which is the case of Kazakhstan.

In Kazakhstan, development of the innovation infrastructure began in 2003 with the establishment of the Center for Engineering and Technology Transfer and founding several technoparks in 2004 [184]. As of today, the innovation infrastructure is represented by eight technology parks, four design bureaus and two international technology transfer centers. Although these are the elements of innovation infrastructure as reported by the National Agency for Technological Development – hereinafter, NATD (2013), a thorough policy review showed that there is still no consensus on what is included in innovation infrastructure of Kazakhstan. This issue will be addressed later in this chapter.

According to Galli and Teubal (1997), the fact that the innovation infrastructure has been created does not guarantee its effective functioning [180]. However, Hekkert and Negro (2011) outline that too weak or too strong interactions between the elements of the innovation infrastructure may restrain the entire subsystem[5] [185]. Nurmukhanova (2007) argues that in Kazakhstan these interactions are weak due to the inappropriate quality of organizations and institutes that make up the country’s innovation infrastructure [186]. Woolthuis et al. (2005) adds that the elements of the innovation infrastructure are isolated from each other. Such isolation results in ineffective innovation infrastructure which in turn prevents the whole innovation system from functioning well [187].

It is vital to note that the United Nations Commission for Europe in its report underlines that the existing infrastructure in Kazakhstan does not yet support easy ac-

[5] Innovation infrastructure is viewed as a subsystem of a national innovation system (*Innovative Industrial Development Strategy of the Republic of Kazakhstan for 2003-2015*; Hekkert and Negro (2011)).

cess to knowledge and its dissemination [184], plus, the statistical indicators of national innovation performance have not improved much since the 2000s.

As the data on the effectiveness of specific elements of the innovation infrastructure is unavailable, we evaluated it using several quantitative indicators of innovation performance. Previous studies have already made attempts to measure the effectiveness of innovation infrastructure. Thus, Porter and Stern (2001) used the number of employed scientists and engineers, the overall level of R&D expenditures, the share of Gross Domestic Product devoted to expenditures on higher education, a measure of the effectiveness of intellectual property protection, and a measure of the economy's openness to international trade to estimate the quality of common innovation infrastructure in 17 OECD nations [188]. Later, Kelly (2008) compared the innovation infrastructure of Jamaica, Singapore and Norway by employing such indicators as adult literacy, expenditures on education, percentage of tertiary graduates, expenditures on R&D, and the number of patents filed [189].

Taking into account the preceding studies, we develop own methodology for measuring effectiveness of the innovation infrastructure. We agree with Porter & Stern (2010) and Kelly (2008) that expenditures on R&D is an important indicator of the effectiveness of innovation infrastructure. Moreover, the number of scientists and researchers employed [188] and the quantity of patents filed [189] allow one to judge about human capital inputs to innovative development of a country and the effectiveness of R&D activities, respectively. The other two indicators offered which we included in the methodology of measuring effectiveness of the innovation infrastructure are the share of innovation output in GDP and the quantity of joint R&D activities in an economy. The latter indicator is extremely important for the evaluation of innovation infrastructure as it shows how well its elements interact with each other at the turning-point when innovation inputs are transformed into outputs. In Figure 8 we reflect the main indicators which measure the effectiveness of the innovation infrastructure at different stages of innovation development.

On the basis of our research we propose to include five innovation input-transition-output indicators as a measurement instrument of the effectiveness of innovation infrastructure: (1) expenditures on R&D, (2) the number of scientists and researchers employed, (3) the quantity of joint R&D activities, (4) the share of innovation output in GDP, and (5) the number of patents filed. Additionally, these indicators

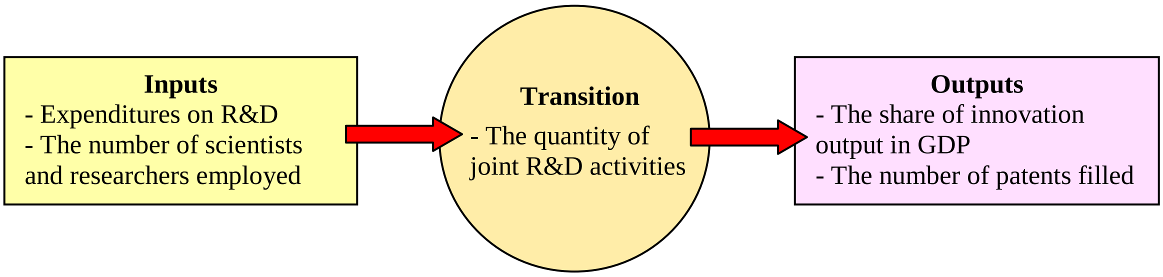

Figure 8 – Measuring Effectiveness of Innovation Infrastructure

Note – Drafted by the author

should be evaluated on a timeline of at least 5-7 years to make up for the negative or positive tendencies. Following the proposed methodology we have drafted Table 12 to observe how each of the indicators changed during a 9-year period.

One can notice that most indicators shown in Table 12 have deteriorated over the years instead of improving. There was a positive tendency almost in all indicators until 2007 but after that many of them continuously went down. It is important to note that the global financial crisis negatively influenced most indicators in 2009 and in subsequent years.

Table 12 – Measurement of Innovation Infrastructure Effectiveness in Kazakhstan

Indicators	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Expenditures on R&D, in % of GDP	0.25	0.25	0.29	0.24	0.21	0.22	0.23	0.15	0.16
Number of scientists and researchers, per 1000 employed	1.12	1.12	1.25	1.28	1.15	1.05	0.99	1.05	1.09
Quantity of joint R&D activities	n/a	n/a	n/a	n/a	609	553	235	386	390
Share of innovation output in GDP	1.4	1.27	1.58	1.53	1.19	0.69	0.49	0.65	0.85
Number of patents filed, per mln. of population	120.9	124.8	107.8	102.3	119.3	107.1	106,6	114.1	97.3
Note – Compiled by the author based on [190, 191, 192]									

The level of expenditures on research and development in 2011 was established as being 0.16% of GDP which is much lower as compared to the level of 0.25% of GDP in 2003. The distribution of R&D spending by sectors has also changed but for better. Thus, the greatest share of expenditures on R&D now belongs to the private sector (51.6%) as it was in 2008 and some earlier years. The rest part of expenditures is distributed among public sector (25%), education (16.4%), and private not-for-profit organizations (7%). However, in the preceding two years to 2011, the government played a key role in financing R&D. This may be attributed to the incapability of many companies to do and finance research due to the consequences of the global financial crisis which hit Kazakhstan in 2008. Coming from the above mentioned we offer to keep the dominating position of private sector's R&D expenditures which can be done by introducing more attractive tax incentives for firms financing R&D.

Additionally, other innovation infrastructure indicators such as the number of scientists and researchers employed, quantity of joint R&D activities, share of innovation output in GDP, and the number of patents filed show a decreasing trend, as well (see Table 12).

Thus, the number of scientists and researchers in Kazakhstan in 2011 was 1.09 per thousand employed which is lower than in 2003. The faculty involvement in R&D was only 8.4%. The incidence of joint R&D activities in the country decreased almost twice since 2007. This might be explained by the absence of any fiscal incentives for joint R&D activities and a small share of innovation active firms (5.7%) in Kazakhstan.

It should be noted that the very involvement in R&D does not guarantee a commercialization of projects. The share of commercialization of innovative projects is very low in Kazakhstan at only 1.2%, with radical innovations being 1.1% and incremental – 0.1%. This results in a low share of innovation output in GDP which was 0.85% in 2011. Interestingly, but this share is even lower than in 2003 (1.4%) which is marked as the beginning of the implementation of Kazakhstan's industrial and innovation development strategy.

Finally, an indicator of the innovation infrastructure's effectiveness – the number of patens filed – again falls short of its figure in 2003 (Table 12). We attribute this fall to the decrease in inputs to the innovation infrastructure which include R&D expenditures and the number of scientists and researchers employed as well as to the lack of linkages between the elements of innovation infrastructure such as limited number of joint R&D activities.

Given the above analysis, one may conclude that the pace of innovation development of Kazakhstan is very slow and its innovation infrastructure looks somewhat ineffective. This ineffectiveness of the innovation infrastructure can to a greater or lesser extent be explained by limited inputs to its development. But on the other hand, the problem may lie much deeper – in persistent change of the innovation infrastructure definition in Kazakhstan and the lack of the synergy between the elements of the innovation infrastructure.

As previously noted, Kazakhstan has started pursuing its proactive innovation policy since 2003. One might suppose that the appearance of the concept of innovation infrastructure in Kazakhstan is attributed to the *Program for the Formation and Development of the National Innovation System of the Republic of Kazakhstan for 2005–2015* that was developed on the basis of the *Innovative Industrial Development Strategy of the Republic of Kazakhstan for 2003-2015.* However, the first mention of this was in the law entitled "On innovation activities" enacted in 2002. The law defines innovation infrastructure as "a number of organizations performing work and providing services necessary to implement innovations". It emphasizes a need for the creation of such organizations but does not specify which ones should become the elements of Kazakhstani innovation infrastructure. Instead, the law defines technology towns, technology parks, and technological incubators as the subjects of innovation activity (Article 7).

While looking at other legislative documents we noticed that the elements of the innovation infrastructure diverge. For example, in the *Innovative Industrial Development Strategy of the Republic of Kazakhstan for 2003-2015*, innovation infrastructure is represented by technology parks, business incubators, design offices, engineering organizations, and business-centers. It is assumed that technology parks host research and educational institutions, business incubators, engineering organizations, business centers and social infrastructure.

The *Program for the Formation and Development of the National Innovation System of the Republic of Kazakhstan for 2005–2015* describes Kazakhstani innovation infrastructure as a multilevel one consisting of 'national and regional technology parks, technological business incubators, technology cities, etc. The use of the word "etc." here does not seem very appropriate as it indicates that Kazakhstani government has no clear understanding of what else might qualify for the innovation infrastructure.

Interestingly, the *Law "On state support of innovation activities"* (2006) mentions only technoparks and business incubators as the elements of the innovation infrastructure. Moreover, the *Concept of formation and development of industrial and innovation infrastructure (special economic zones, industrial zones, technological parks, and business incubators)* elaborated on in 2007, combines the industrial infrastructure and innovation infrastructure into a single entity. Drawing attention to this confusion, we offer either distinguish between the two types of infrastructure or merge them into one concept.

In 2012, a number of new elements were added to the industrial and innovation infrastructure of Kazakhstan, such as stock funds for risk investment, commercialization centers, industry design offices, international centers for technology transfer, and innovation clusters (*Law "On state support of industrial and innovation activities"*) while business incubators fell out of the list. One of the possible reasons of business incubators disappearing from the list might have been the creation and development of business incubators within the other elements of the innovation infrastructure.

The *Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014* looks at the innovation infrastructure from a different perspective and claims that its composition will change by 2015. It is planned to create two industrial centers, five design offices, eight technology parks (already established), and seventy commercialization centers. This program shows that the country is indeed informed about contemporary Western innovation policies and keeps track of the world's best practices but is not exactly sure of the final composition of Kazakhstani innovation infrastructure, as its elements vary from one program or regulation to another. Based on the analysis of the programs we have systematized the evolution of the legislative definition of innovation infrastructure (see Table 13).

Although there is no consensus on the official definition of 'innovation infrastructure' in Kazakhstan, we may refer to the definition given by the National Agency for Technological Development which is assigned a key role in the development and implementation of innovation strategies, policies and programs in the country.

The Agency was established in 2003 to assist with the coordination of innovation development process in Kazakhstan. The main activities of the Agency include informational and analytical support for innovations, development of commercialization system and effective innovation infrastructure, administration of service tools designed to support innovations, investment support for innovative projects, and the promotion of innovation processes.

According to the National Agency for Technological Development (2013), the current innovation infrastructure of Kazakhstan is represented by the following elements:

- ✓ Eight regional technology parks (technoparks);
- ✓ Four design offices;

✓ Two international technology transfer centers [193].

Although the innovation infrastructure has been physically shaped in Kazakhstan, its performance is still poor. The quality of organizations that constitute the innovation infrastructure does not conform to the level which would allow the agents to freely interact with each other [186]. The elements of the innovation infrastructure for the most part are isolated from each other. Furthermore, the access to and dissemination of knowledge is still limited [184].

To further assess the innovation infrastructure of Kazakhstan and understand what holds it back from effective functioning, it is necessary to examine each of its elements separately.

Table 13 - The Evolution of Legislative Definition of Innovation Infrastructure

Laws, Programs, Strategies and Government Regulations	**Definitions of Innovation Infrastructure**
Law "On innovation activities" (2002)	- does not specify the elements of innovation infrastructure. - defines the <u>subjects</u> of innovation activity: **technology towns, technology parks, and technological incubators**
Innovative Industrial Development Strategy of the Republic of Kazakhstan for 2003-2015	- Innovation infrastructure defined: **technology parks, business incubators, design offices, engineering organizations, and business-centers**.
Program for the Formation and Development of the National Innovation System of the Republic of Kazakhstan for 2005–2015	- Innovation infrastructure defined: **national and regional technology parks, technological business incubators, technology cities, etc.**
Law "On state support of innovation activities" (2006)	- mentions only **technoparks** and **business incubators** as the elements of the innovation infrastructure.
The concept of formation and development of industrial and innovation infrastructure ' (2007)	- mixes the industrial infrastructure and innovation infrastructure into a single entity and defines it as consisting of **special economic zones (SEZ), industrial zones, technological parks, and business incubators**
Law "On state support of industrial and innovation activities" (2012)	- industrial and innovation infrastructure is represented by **stock funds for risk investment, commercialization centers, industry design offices, international centers for technology transfer, and innovation clusters**
Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014	- innovation infrastructure by 2015 will comprise **- 2 industrial centers,** **- 5 design offices,** **- 8 technology parks (already established), and** **- 70 commercialization centers.**

Note – Compiled by the author

Technology parks. Technology parks are considered the main element of Kazakhstani innovation infrastructure which serve as the basis for the creation and implementation of innovations. The purpose of their establishment is to integrate science and industry [194]. They are legal entities established by the National Institute of Development in the field of technological development to facilitate promotion and realization of industrial and innovative projects (*Law 'On state support of industrial and innovation activities'*, 2012). However, instead of performing their primary function, technoparks mostly play the role of business centers providing the agents with office rentals, laboratories, administrative support, consulting services, lecturing and exhibition facilities [184, p. 75] and small workshops. This is not surprising, as some technology parks located within Special Economic Zones provide companies with long-term benefits such as corporate income, land, and property taxes bonification, fewer restrictions and smaller quotas on investment, and no customs duties on imported and exported goods. These benefits naturally attract many firms not directly involved in innovations. This results in technopark firms that are no more innovative than other firms in Kazakhstan [195].

In addition to the above described issues, technology parks in Kazakhstan face a number of specific problems such as the lack of highly qualified employees, limited spending by business sector on the development of technoparks, restricted autonomy of innovative universities, absence of any information about the market of new technologies, and absence of technology parks specialized in processing of raw materials [196]. All these problems prevent Kazakhstani technology parks from effective functioning.

As prescribed by the *Concept of formation and development of industrial and innovation infrastructure* (2007) technology parks in Kazakhstan may operate at either national or regional level. National science and technology parks are being created to ensure the accelerated development of certain sectors which are a priority for the social and economic development of Kazakhstan (*Program for the Formation and Development of National Innovation System of the Republic of Kazakhstan for 2005–2015*). National technoparks are assigned a status of Special Economic Zones with the preferential tax regime. To date, six SEZ have been created in Kazakhstan.

Regional technology parks are being established to discover, disclose and develop innovative capabilities of specific regions (*Program for the Formation and Development of National Innovation System of the Republic of Kazakhstan for 2005–2015*). They create favorable conditions for small and medium knowledge-intensive businesses and serve as a link between local industrial enterprises and scientific and academic organizations. Currently, eight regional technology parks have been created which are functioning in the cities of Almaty, Uralsk, Karaganda, Astana, Ust-Kamenogorsk, Shymkent, and Pavlodar (Table 1A, Appendix A).

It is assumed that each regional technopark has its own specialization, but in reality, neither functions efficiently. Existing technology parks' specializations do not cover all the seven priority sectors outlined in the *Strategic Plan for the Development of the Republic of Kazakhstan till 2020*, which namely: oil refining and oil-and-gas sector infrastructure; metallurgy and production of finished metallurgic goods; chemical, pharmaceutical and defense industries; processing of agricultural products; construction industry and production of construction materials; power engineering; and transport and telecommunications. Moreover, some of the technoparks' specializations overlap. Thus, four technoparks are involved in mining and metallurgy, six – in the machine industry, four – in information technologies, six – in environmental technologies, and two – in the chemical industry. In addition, the activities of a single technopark may severely diverge, beginning from information technologies and ending with the production and refining of non-ferrous metals.

One of the main activities of regional technology parks is technological business incubation. Business incubation is an interactive process aimed at supporting innovative start-ups [197]. Business incubators allow companies to start fast and accelerate their development seven- to twelve-fold in comparison with firms launched in any other place. They are considered to be among the most effective tools to support small innovative companies (via free legal, accounting, economic support services and covering such expenses as licensing, promotion of the project, testing and certification) at risky stages of their development, even when it is difficult to determine the probability of success (*Program for the Formation and Development of National Innovation System of the Republic of Kazakhstan for 2005–2015*). However, this practice is not widely accepted it the international arena. Granting R&D activities at the preliminary stage and working with projects before their market potential can be clearly recognized as risky [184, p. 97].

The *Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014* suggests that by the end of 2014, each technopark will accommodate at least one business incubator. These business incubators will provide start-ups with moral and material support in the form of premises, equipment, accounting, legal and consulting services as well as investment opportunities to implement innovative ideas (Law "*On state support of industrial and innovation activities"*, 2012).

Under the *Program for Formation and Development of the National Innovation System of the Republic of Kazakhstan for 2005–2015*, technological business incubators may also act as independent legal entities or be a part of leading technological universities. Thus, in order to facilitate the collaborative development of science and business, business incubators were created within six universities: East Kazakhstan State Technical University "Serikbaev", Karaganda State Technical University, Kazakh National Technical University "Satpaev", Kazakh-British Technical University, West Kazakhstan Agricultural & Technical University "Zhangir-Khan", and South Kazakhstan State University "Auezov" [198].

Design offices. The concept of design offices is not new in Kazakhstan. They have existed since the era of the USSR in the form of industry organizations engaged in the development of new technology. After collapse of the Soviet Union, many design offices were privatized or ceased their operations due to a shortage of money.

Contemporary, new format industrial design offices were launched in 2010. In the present-day context, a design office corresponds to "a legal entity created by the National Institute of Development in the field of technological development to assist innovative companies in the production of new or improved products" (*Law "On state support of industrial and innovation activities"*, 2012).

Design offices help domestic companies to link with both technology suppliers and potential markets [184, p. 91]. They also facilitate the availability of technological documentation needed by local engineering companies in order to manufacture products [199]. Other functions of industrial design offices include the analysis of market supply and demand for engineering products, integration of orders from heavy buyers, placing them in Kazakhstani engineering enterprises and the provision of financial assistance for the accelerated development of a new range of popular products (*Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014*).

As stipulated by the *Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014*, the authorities intend to create five industrial design offices by 2015. Four of them have already been established and they specialize in transport machine building (Astana), mining and metallurgical equipment (Ust-Kamenogorsk), oil and gas equipment (Petropavlovsk), and agricultural engineering (Astana). A fifth design office of instrument engineering is expected to be created by 2015 in Almaty city.

International technology transfer centers. "Technology transfer is the process of adopting new or improved technology by innovative enterprises or institutions by means not prohibited by the law of the Republic of Kazakhstan" (*Law "On state support of industrial and innovation activities"*, 2012).

A first attempt to develop technology transfer in Kazakhstan was through the creation of Centers of Excellence which supported innovation activities by providing technological, financial, legal and organizational assistance (*Program for the Formation and Development of National Innovation System of the Republic of Kazakhstan for 2005–2015*). Today, this process operates through Kazakhstan's Technology Transfer Network (hereinafter – KTTN) including selected technoparks, and STI (scientific and technological information) centers in chemistry, biotechnology and nuclear technologies [184, p. 76].

KTTN fostered the establishment of two international technology transfer centers to support the implementation of projects carried out in cooperation with foreign partners. The first international technology transfer center in Kazakhstan was founded in 2010 on the basis of the agreement on strategic partnership signed by the Presidents of Kazakhstan and France. The Kazakh-French Center for Technology Transfer aims to create favorable conditions for academic, scientific, technological cooperation and technology transfer between Kazakh and French subjects of innovation [200].

Korea-Kazakhstan Technological Cooperation Center was created in 2011 under the support of the Ministry of Knowledge Economy of South Korea. It plays a crucial role as it spearheads the building of a wide range of industry-academy-research institute-government network and vitalizing mutual communications. These activities will pave the way for contributions to the both countries' industrial and economic development by unleashing joint technology research, commercialization, and transfer, corporate investment, marketing and personal exchanges, and support for overseas investments. Currently, the Korea-Kazakhstan Technological Cooperation Center is involved in the realization of three innovative projects in the field of biotechnologies, information technologies and renewable and alternative energy.

Both the Kazakh-French and Kazakh-Korean centers are supported by the Kazakhstan Technology Transfer Network (KTTN) which is an element of the national information space assisting in promotion of their activities. The interest to create similar structures was expressed by the organizations from China and Germany [199].

As stated above, the ineffectiveness of the innovation infrastructure is caused by the lack of inputs to its development such as limited R&D expenditures and lack of researchers and scientists. Other key problems include the inability of the country to precisely define the innovation infrastructure and integrate its elements.

In many developed as well as some developing nations, universities play a vital role in innovation infrastructure. However, in contrast, in Kazakhstan universities play a minor role here; they are simply not integrated into the whole system well enough. Thus, the innovation infrastructure of Kazakhstan involves only six out of 144 universities, which is clearly not enough for the integration of science and business. In addition, many technology parks [201] and design offices have weak or nonexistent linkages with knowledge producing institutions, i.e. universities and research & development institutes.

One possible solution to improve interrelations between the agents is to create innovation clusters[6] (Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014) which will finally lead to a special form of innovation – «aggregate innovation product» [186]. Thus, the government plans to create two clusters by 2015 which will focus on different fields so that there will not be any duplication of specializations.

The clusters will strengthen ties between large universities, research centers, business, local and foreign investors, as well as other entities involved in the innovation process and transfer of technology. The development of innovation clusters will provide a synergy of education, science, finance and business.

The Program for the Development of Innovations and Promotion of Technological Modernization in the Republic of Kazakhstan for 2010-2014 elaborately describes a new structure of innovation infrastructure but does not explain how the elements of industry clusters will be linked to each other. The program asserts that research, industrial testing and introduction of new technologies will be conducted via technology parks, business incubators, innovative firms, as well as through the help of grants from different foundations. It is also planned to involve several leading universities in the innovation infrastructure such as Nazarbayev University[7], Al-Farabi Kazakh National University, and Kazakh National Technical "Satpaev".

[6] *Innovation cluster* is defined by the law of the Republic of Kazakhstan "*On state support of industrial innovation activities*" (2012) as "a union of scientific and technical institutes as well as other elements of industrial and innovation infrastructure designed to encourage industrial and innovation activities through collaboration and sharing of existing capacity, tacit and explicit knowledge transfer, effective transfer of technology, establishing long-term partnerships and distribution of information".

[7] *Nazarbayev University* is a new university established in 2010 by the President of the Republic of Kazakhstan Nursultan Nazarbaev. In 2011, the university changed its legal status and became an autonomous organization of education operating under its own educational standards.

It should be noted that the cluster initiative is a good direction for improving the effectiveness of innovation infrastructure. At the same time, we would like to underline several issues that could arise. Firstly, it is necessary to take into consideration that some technoparks duplicate specializations. Secondly, many technology parks, design offices, and universities are geographically remote from each other. This may cause some difficulties in putting the elements with same/similar specializations together into one cluster. But if clusters were to be created somehow, other technology parks or design offices which will not be able to join clusters should be restructured in order to avoid duplicating activities.

To summarize, the creation of the innovation infrastructure in Kazakhstan did not result in an increase of innovation activity as it is evidenced by current statistical indicators. In other words, the innovation boom which was expected did not happen. The current spending on R&D is still minimal and comparable to the level of a decade ago. Business entities are innovation passive which results in a low share of innovation output in GDP. Policy analysis showed that Kazakhstani innovation infrastructure is still being shaped and is not yet clearly defined.

Technology parks, which are considered to be the main elements of current innovation infrastructure, do not cover Kazakhstan's priority sectors, and they tend to duplicate each other in specializations. In addition, the primary activity of today's technoparks is business incubation which does not involve enough scientific capabilities for the development and implementation of innovative projects.

In our opinion, the government's initiative to create industry clusters might provide a solution to this problem but only if some factors are taken into consideration, particularly: specializations and geographical remoteness of the elements of innovation infrastructure. The issue of the geographical remoteness may be to a greater extent resolved by developing the ICT. Knowledge society can be well connected via modern ICTs to the digital economy by having access to the relevant and usable information [202].

2.4 Sector of Telecommunications as One of the Priority Sectors for the Competitive Development of Kazakhstan

In 1997, the government of Kazakhstan identified telecommunications sector as one of the priority directions for the country's growth. In the subsequent years, the government ran a number of programs to foster the development of ICT industry, and in particular telecommunications sector.

The first government's product was the *Program for the Development of the Telecommunications Industry of the Republic of Kazakhstan for 2003-2005* which aimed at the creation of mechanisms which would support further development of the telecommunications sector of Kazakhstan and its competitive integration into the global information infrastructure.

The succeeding *Program for the Development of the Telecommunications Industry of the Republic of Kazakhstan for 2006-2008* intended to create informational and technological prerequisites in the telecommunications industry which would allow the country to enter top 50 most competitive countries worldwide by 2012.

Among its most important tasks were innovative development of the industry and improvement of education in the telecommunications sphere.

In 2010, the government introduces a *Strategic Plan for the Development of the Republic of Kazakhstan till 2020* and *State Program for Accelerated Industrial Innovative development of the Republic of Kazakhstan for 2010-2014* which emphasize the role of the telecommunications sector in innovative development of the country. On the basis of the Plan and State Program, the Ministry of Transport and Communications and the Ministry of Communications and Information[8] develop *State Program "Informational Kazakhstan - 2020"* and *Program for the Development of ICT in the Republic of Kazakhstan for 2010-2014*, respectively. The former emphasizes the creation of favorable conditions for the transition to the information society as well as the development of the national information space. The latter program stresses transition to the innovative economy and creation of competitive export-oriented national sector of ICT.

With the help of these programs and other instruments the government continues to stimulate the development of this sector, form a modern infrastructure of ICT, expand telecommunications and electronic distribution services, and lay the foundations of a dynamic information society.

2.4.1 Telecommunications Sector Analysis

In a knowledge-based economy which Kazakhstan aims to create, access to information and the speed of its exchange play an important role. The more developed the ICTs within a particular country, the easier the process of information exchange.

ICTs in Kazakhstan's context is understood as a set of methods, processes, and software and hardware tools that are integrated with the aim of collecting, processing, storage, distribution, display and use of information for the benefit of its users. The key subsectors of ICT industry in many former Soviet Union countries are telecommunications, mail service, and information technologies.

The definition of ICT used in western countries is substantially different. It is based on the classification of ICT goods offered by OECD in 1998 [203] which includes manufacturing (television and radio transmitters, receivers; instruments and appliances for measuring, checking, and testing; insulated wire and cable; industrial process equipment; etc.) and services (telecommunications; computer and related activities; wholesale of computers, computer peripheral equipment and software; wholesale of electronic and telecommunications parts and equipment; renting of office machinery and equipment).

The definition of ICT industry in western countries is somewhat similar to Kazakhstan's interpretation of what constitutes to telecommunications sector. The main segments in Kazakhstan's telecom sector are: mobile communications, Internet provision, and data transmission [204]. These mostly include sales and installation of the equipment and some aftersales support services.

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[8] The Ministry of Communications and Information was created on 12th March 2010, and was abolished on 14th January 2012. Upon the abolishment, the functions of the Ministry were transmitted to the Ministry of Transport and Communications and Ministry of Culture and Information.

In our opinion, the differences in interpretations and definitions of ICT industry present a challenge for making international comparisons. Thus, the organizations which prepare annual country reports use their own approach to analyze the development of ICTs. For example, in the *Global Innovation Index 2013 report* the ranking of ICT is based only on four indicators: ICT access, ICT use, government online service, and e-participation. According to this report, Kazakhstan has achieved a great success in the development of ICT industry and is ranked 23rd worldwide. One can also observe a good performance in ICT access (ranked 50) and ICT use (ranked 52) indicators in which Kazakhstan improved by 13 and 27 positions, respectively, as compared to 2012.

The other report entitled *Global Competitiveness Report 2012-2013* provides less optimistic rakings concerning the ICT industry of Kazakhstan. Accordingly, the report ranks the country quite poorly in availability of latest technologies (ranked 90), individuals using Internet (ranked 62), and broadband Internet subscriptions (ranked 67). The only ICT indicator in which Kazakhstan shows good performance is mobile broadband subscriptions (ranked 27). Indeed, the overall number of clients as well as demand for telecommunications services have increased lately.

Over recent years, Kazakhstan has been experiencing a rapid growth in the telecommunications sector (Figure 9), despite that many other sectors faced a slowdown. The revenue of the telecommunications sector has increased by 33% since 2008. The growth of this sector in 2012 as compared to 2011 was 7%. The main share of revenues in telecommunications sector belongs to mobile services (48.5%). The share of revenue from other services is as follows: long-distance and international calls (7%), local telephone services (8%), data transmission (2.5%), Internet services (17.7%), and the rest share belonging to other communications services. The main consumer of telecommunications services is population (66.8%); the share of consumption of the corporate sector fell from 56.3% in 2009 to 33.2% in 2012.

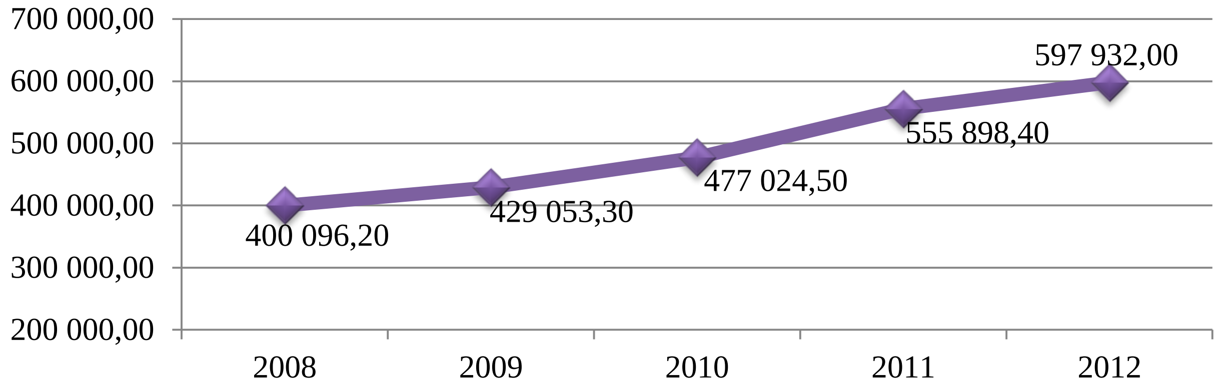

Figure 9 – The Dynamics of Telecommunications Sector Revenue (in mln KZ tenge)

Note – Drafted by the author based on [205]

In 2012, the number of fixed-line subscribers was 4.4 million in 2012. The number of mobile subscribers reached 30.2 million which is almost 2 times more than the number of population. Moreover, the number of internet users has nearly doubled in the last two years and reached 1.6 million of users. Over the recent years there has been a dynamic development of additional range of telecommunications services such as chargeable TV, web-hosting, IP-telephony, television and radio broadcasting, and other services.

The development of Kazakhstani telecommunications sector is elaborately described in the "Review of Telecommunications Industry of Kazakhstan" published by RFCA Rating Agency in 2011 [206]. So, the subsequent discussion in this section will be based on this report.

The main mobile operators in the telecommunications market of Kazakhstan are JSC Kazakhtelecom, LLP GSM Kazakhstan, LLP Kar-Tel, and JSC Altel. Kazakhtelecom is the representative of the two mobile operators. Tele2 was introduced in Kazakhstan in April 2011. Tele2 is a European communications operator which was launched in Sweden in 1992. In December 2009, Tele2 acquired the stake (51%) of Kazakhstani GSM-operator NEO from the national fixed-line operator Kazakhtelecom. NEO is a Kazakhstan operator providing mobile communication services at GSM 900 standard. The operator NEO appeared in the market of Kazakhstan in February 2007.

LLP GSM Kazakhstan known for its brands Activ and K'cell provides services according to GSM-900/1800 standard. The company was founded in 1998, and in February 1999 began to offer cellular services under the brand name K'cell, and in September of the same year introduced an alternative mobile brand Activ. LLP Kar-Tel is one of the leading mobile operators in Kazakhstan today which also provides communications services in accordance with GSM-900 standard. The company is known for its brand Beeline. Finally, Altel is known for the brands Pathword and Dalacom. Pathword appeared in the market of Kazakhstan in February 2004 and was the first telecom firm in the country to use CDMA2000 1X mobile communication standard which operates in the frequency range of 800 MHz. Another brand of Altel – Dalacom was founded in 2003. This is the third generation mobile communications which works on the basis of advanced CDMA2000 1X standard in the frequency range of 800 MHz.

Internet services segment is one of the fastest growing in the telecommunications market of Kazakhstan. In 1991, an Almaty-based firm Parasat opened the first regional network node in Kazakhstan which began to provide e-mail services via UUCP protocol. In 1994, the Republic of Kazakhstan authorized its account for the TLD - .KZ in IANA database. Subsequently, Kazakhstan companies providing internet access were classified into two types: first-tier and second-tier. First-tier companies, in other words ISPs (Internet Service Providers) had their own channels of communication integrated into the worldwide network: JSC Kazakhtelecom (brand Kazakhstan Online), Nursat, Astel, and SA Telcom. Second-tier firms rented channels for the internet access from first-tier companies. The number of providers that provide access to the Internet was growing year after year. In 1998, Kazakhtelecom established a subsidiary Kaznet to provide data transmission services. Since 2005 Kazakhtelecom has started to provide broad band access to the Internet using the latest Metro Ethernet technology under the brand name – Megaline.

In addition to telephone lines, the data can be transmitted through cable television networks. Alma-TV was the first company to offer its customers a new service – access to the Internet via cable networks. Also, one of the biggest players in the market of Internet sales Ducat company introduced a new service to customers in the form of domestic leased lines called Homenet. Today, mobile operators offer the cheapest Internet access based on GPRS technology data transmission. GPRS allows one to connect to the Internet using a mobile phone. Among the Internet service providers the three leaders are Kazakhtelecom, Nursat, and Astel.

Fast development of the telecommunications market in Kazakhstan is accompanied by inter-firm and segment-specific competition. An increase in the number of new market entrants makes competition fiercer, especially when these alternative operators have substantial financial resources to build a competitive advantage through the implementation of innovative technologies. A rapid expansion of mobile communications is the best example of segment-specific competition. IP-telephony penetrates the market at a sheer pace and replaces fixed-line services ad it tends to be significantly cheaper than the latter. A broadband access to the Internet is intensively developing which allows basic operators to compensate for the slowdown in fixed telephony segment. The main players in the mobile market are GSM Kazakhstan and Kar-Tel.

At present time, the government defines the scope of services in the segment of local networks as a natural monopoly and regulates the tariff rates. In 1996, the government of the Republic of Kazakhstan established a national telecom operator JSC Kazakhtelecom and gave it exclusive rights to provide public telecommunications services. At the same time, Kazakhtelecom is obliged to ensure the widespread use of socially significant forms of communication in unprofitable fields (e.g. rural telecommunications services, telegraph and cable broadcasting). In addition to the national telecom operator, local telephone services are provided by the owners of local networks mainly for the purpose of satisfying their production needs. The market share of local telephone services occupied by other operators of communication does not exceed 15%. In order to reduce the economic concentration of JSC Kazakhtelecom, the government decided to sell the company’s shares to its affiliated telecom operators. In 2010, Kazakhtelecom sold 51% of its shares to the LLC Mobile Telecom-Service.

In our opinion, the liberalization of telecommunications market is an important prerequisite for the development of the industry. It will create opportunities for new companies to enter the market; competition between firms will become fairer; as well as it will stimulate further innovative development of telecommunications industry.

2.4.2 Innovations and University-Industry Linkages in Telecommunications Sector of Kazakhstan

Innovative development of ICT industry, and particularly of telecommunications sector, is an important condition for the transition to a knowledge-based economy in which access to and transmission of information is crucial. In this kind of economy ICTs penetrate every aspect of people’s lives such as education, health care, public services.

Christensen (1997) notes if companies do not innovate or do not offer new solutions, they will fail to exist [207]. This is specifically relevant to ICT industry which is built on new technologies that continuously evolve. Most innovations in ICTs have a systemic nature and only few are product-related. Systemic innovations imply that different operators try to supply best services to the customers at the lowest cost [208]. However, it is vital for ICT firms in Kazakhstan to focus on product or process innovations; they need to spend more time and resources on R&D.

Several state programs and strategies in Kazakhstan underline the importance of conducting R&D and developing innovations in ICT industry. Thus, within the framework of the *State Program for Accelerated Industrial Innovative Development of the Republic of Kazakhstan for 2010-2014*, the government provides support to local IT companies which are involved in R&D. The *Program "Productivity – 2020"* relies on the use of the following instruments: interest rate subsidies on loans and leasing; innovation grants; creation of design offices; introduction of management technologies. So far, to foster the development of ICT sector, the government created a number of new establishments: SEZ "Park of Innovative Technologies", industrial ICT research institute, and R&D laboratories in the areas of "open source software" and "information technologies."

The *State Program "Informational Kazakhstan – 2020"* describes the current situation in the ICT industry as favorable for rapid development of science and technology transfer. One can observe an increase in the volume of investment in R&D and university-industry collaboration as well as implementation of science intensive ICTs in the production process. Given this positive tendency, the government of Kazakhstan plans to achieve the following targets in the future:

- increase expenditures for innovations in ICT up to 0.5% of GDP by 2017 and up to 0.9% of GDP by 2020;
- increase the share of innovation active ICT firms up to 7% by 2017 and up to 10% by 2020;
- increase the number of ICT parks up to 2 by 2017 and up to 4 by 2020;
- increase the number of business incubators in the field of ICT up to 2 by 2017 and up to 4 by 2020;
- increase the number of research laboratories up to 4 by 2017 and up to 8 by 2020;
- increase the number of ICT specialists with PhD degree up to 200 by 2017 and up to 300 by 2020 (*State Program "Informational Kazakhstan – 2020"*).

Additionally, within the framework of the *Program for the Development of Information and Communications technologies for 2010-2014*, the government plans to increase the number of students getting education in ICT up to 8000; increase the number state grants for ICT programs; develop cooperation of local universities with foreign higher education institutions in order to transfer new education technologies and new international standards of IT-education; and develop International University of Information Technologies as a regional leader in IT field, center for R&D in ICT.

In our opinion, the achievement of the above described targets will not bring the expected results in terms of the innovative development unless companies start establishing long-term relationships with universities and other public research organizations. The most effective way to achieve innovative development is to integrate science, universities and industry [209].

As was stated earlier in Chapter 1, universities create, store and transmit knowledge to other members of the society. However, there is no a university in our country which could carry out all these functions simultaneously [210]. The other problem is limited demand for R&D and implementation of innovations [211]. On the one hand, this happens due to the lack of competition between producers which reduces the need for scientific research. It’s only healthy competition which created a demand for R&D to optimize production and improve the quality of goods. On the other hand, there is no mechanism in Kazakhstan for the implementation of the research results.

Based on our observations we may argue that the most common ways of university-industry collaboration in Kazakhstan are recruitment of graduates for work and recruitment of students for internship. Indeed, employers prefer younger candidates as they tend to be more receptive to learning and better conform to the aggressive market environment than their older counterparts [212]. This is a good start but the relationships between the universities and enterprises should expand into more sophisticated forms of collaboration. In the end, this could become companies’ social responsibility to contribute to education, science, and innovative development of the nation. But, in our opinion, companies are mostly concerned with their profits. In this regard, we underline that fulfilling legal responsibility is perceived to be the most important in Kazakhstan [213]. This suggests that companies may be influenced to collaborate with universities by a legislative framework, for example to make it obligatory to collaborate with at least 1 or 2 universities. Of course, this can hardly be applied to small firms where the number of employees does not exceed 10 members. So, maybe this can be considered as an option for medium and large companies.

The government currently provides some fiscal incentives for companies to engage in R&D but only few firms use this opportunity. Thus, according to the *Tax Code of the Republic of Kazakhstan*, costs associated with scientific research and development operations, except costs associated with the purchase of fixed assets, their installation and other capital costs, are referred to deductions (Article 108). Very often fixed assets (e.g. experimental equipment) may be more costly than the research itself. This suggests that this kind of deductions may not always motivate firms to engage in research.

It is important to note that in 2013, the government made few positive adjustments concerning R&D which reflected in the latest edition of the *Tax Code of the Republic of Kazakhstan*. Thus, a firm’s taxable income is subject to deductions at the rate of 50 per cent of the expenses actually incurred in respective tax periods in connection with the performance of works recognized by the authorized body in the field of science (e.g. scientific research, research engineering, and/or experimental development works). Deductions are applied only if there is a protection document for the utility models or industrial designs granted by the authorized body and provided that the result of the specified works is implemented in the Republic of Kazakhstan (Article 133).

There are no any incentives to stimulate R&D collaboration between universities and firms. The implementation of such incentives was proposed eight years ago by Kenzheguzin *et al*. [31, p. 32]. However, until today their suggestions haven't been taken into consideration. Moreover, the problems that prevent both universities and firms from collaboration, in particular in telecommunications sector, are not yet known. Plus, there hasn't been any exploratory study on the preferences of knowledge transfer channels by both parties. So, in the next Chapter we present the results of the empirical study which was aimed to reveal the intensity and the forms of university-industry collaboration in telecommunications sector, the attitudes towards knowledge transfer, the preferences for channels, the obstacles to relationships, and the benefits of collaboration.

3 METHODOLOGICAL AND EMPIRICAL APPROACHES TO KNOWLEDGE TRANSFER PROCESS IN KAZAKHSTAN

We aim to achieve our goal – to reveal the intensity and forms of university-industry collaboration and knowledge transfer in telecommunications sector of Kazakhstan. For this, we have developed a specific methodology and research methods. In our opinion, without appropriate methodology and research methods it is very difficult and almost impossible to get reliable results. Thus, in this part of our research we describe the specificities of our research methodology. We discusses the research process, design of sampling methods, research instruments, methods of data collection, questionnaire design, as well as data analysis tools used in our study. Next, we present the implementation of our research methodology and research methods to the empirical study and discuss the research results. Finally, we generalize and propose our view of the knowledge transfer process in Kazakhstan context.

3.1 Methodological and Methodical Bases of the Study of University-Industry Knowledge Collaboration

It is necessary to note, although some authors use the terms research methodology and research methods interchangeably, they have different meanings. While research "methods" usually refer to specific instruments used to collect data like questionnaires, interviews, observations, and focus groups, research "methodology" is more about a philosophy or attitudes the researcher has to the study [214]. The adopted philosophy underpins the research strategy and the methods to be chosen for the study.

The methodology of our study has been built upon a research "onion" offered by Saunders *et al*. (2006) [215]. The layers that make up the 'onion' include philosophies, approaches, strategies, choices, time horizons, and techniques and procedures (Figure 10).

The philosophy of our study is based on the doctrine of *positivism* which is usually associated with the natural science research and involves empirical testing. Positivists suggest that this kind of research can be 'value free', i.e. objective; and only the objective statements are seen to be the proper domain of scientists [214, p. 16]. Positivism promotes the idea of experimentation and testing to prove or disprove hypotheses (deductive logic) and then generates a new theory by putting facts together to generate "laws" or principles (inductive logic). In other words, positivism involves the use of both *deductive* and *inductive approaches* to research.

"A deductive approach begins by looking at theory, produces hypotheses from that theory, which relate to the focus of research, and then proceeds to test that theory" [214, p. 16]. The deductive process appears very linear—one step follows the other in a clear, logical sequence. In contrast, an inductive approach involves drawing generalizable inferences out of observations or inferring the implications of findings for the theory [214]. To put it differently, deduction entails a process in which theory formulation results in observations/ findings and induction generates theory from the research.

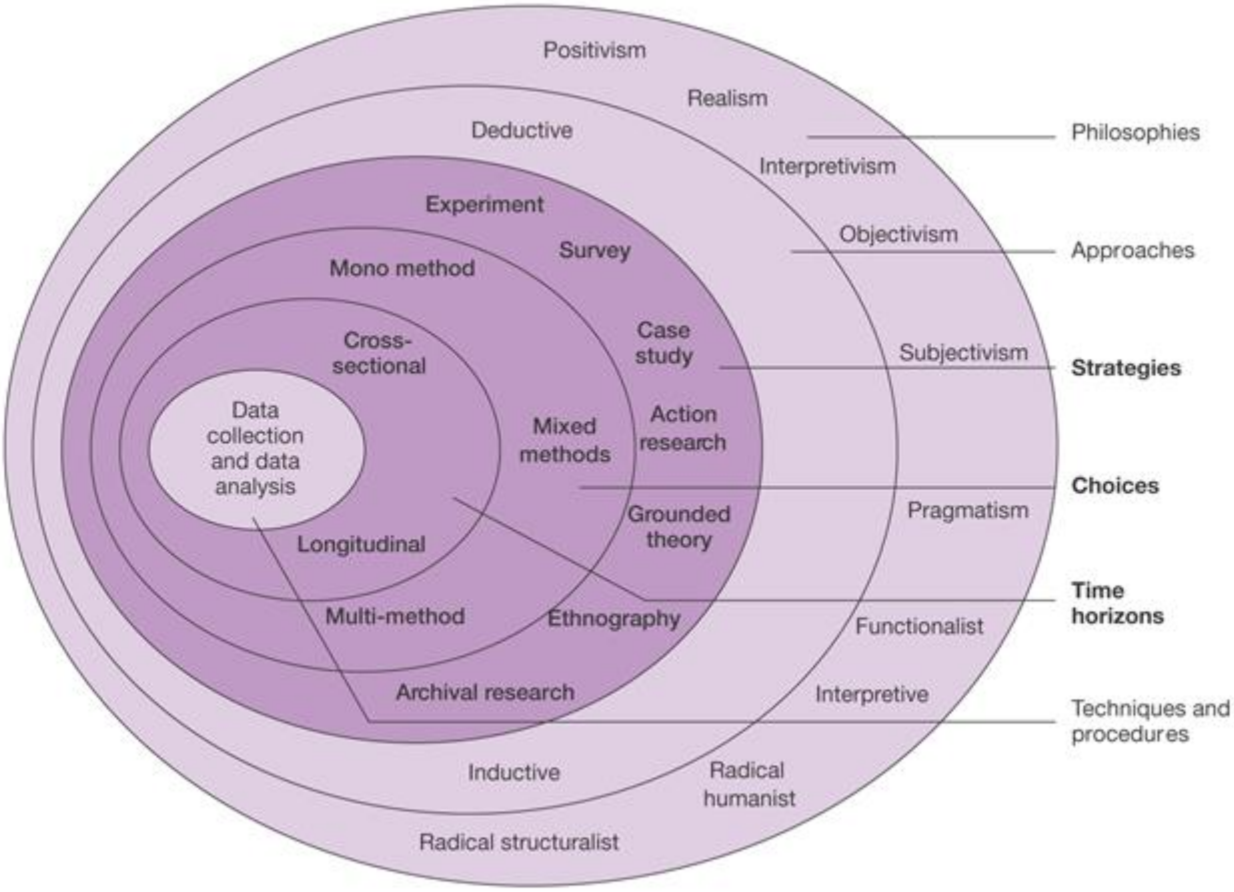

Figure 10 – The Research "Onion"

Source – [215]

In our thesis, we implement both of the approaches. A combination of inductive and deductive approaches to the research is called *hypothetico-deductive method* which consists of seven stages [216]. The authors of this approach Davies and Beaumont (2007) argue that inductive logic is applied to stages 1-3 and deductive logic is used further in stages 4-7. We add to this method an eighth stage which employs the inductive approach again; we called it a "new theory proposition" stage. So, adapted from Davies and Beaumont (2008) we proposed an eight-stage model which is described below.

First, based on our observations we noticed that "things are not as they should be" – there is a lack of collaboration between academia and industry. Second, we made initial data gathering, i.e. talked to academic staff, scientists and business representatives about knowledge transfer and collaboration issues, reviewed the literature related to the problem, identified how the problem is tackled in similar situations, noted a "gap" in the research regarding this issue in Kazakhstan, and began the process of initial data collection. Third, we conducted a thorough literature review and identified the main characteristics of university-industry collaboration, most important channels of knowledge transfer, benefits of and obstacles to collaboration. Fourth, based on theoretical framework we analyzed the specificities of university-industry knowledge collaboration in the context of innovative development of Kazakhstan. Fifth, we made further data collection using the methods recommended for this kind of studies. Sixth, we conducted statistical and qualitative analysis of the results. Seventh, by using deductive approach we conducted the data analysis concerning the attitudes towards knowledge transfer, forms of collaboration, barriers, benefits, etc. Eighth, based on our findings we developed a model of university-industry knowledge transfer by employing deductive approach.

The research can be classified into four types from its objective perspective: descriptive, correlational, exploratory, and explanatory [217, p. 10]. Descriptive research aims to describe a situation, problem or phenomenon and seeks to "determine the answers to who, what, when, where, and how questions" [218, p. 38]. Correlational research or causal research [218, p. 39] attempts to identify the relationships or interdependencies between two or more aspects of a situation expressed in variables. Explanatory research attempts to clarify why and how there is a relationship between two aspects of a situation or phenomenon which is expressed in variables [218]. Exploratory research explores the problem or phenomenon about which little is known or investigates the possibilities of undertaking a subsequent research in the area of the study [217, p. 10].

Although the purpose of our study is to describe the nature of collaboration between academia and industry and understand how the process of knowledge transfer occurs in a local context, our research is designed using a mixed approach. Firstly, it is a descriptive study. But at the same time, it is a pilot exploratory research which investigates the problem of university-industry knowledge transfer which hasn't yet been researched in Kazakhstan. We aim to identify the issues that exist and which may become a focus of a subsequent research.

Sampling. The empirical research has been conducted in the largest city of Kazakhstan – Almaty which is the country's biggest financial, educational and cultural center. The samples of both universities and telecommunications companies were selected using purposive nonprobability sampling [215]. This sampling technique implies the selection of a sample is based on judgment of a researcher about appropriate characteristics which serve the purpose of the study [218].

According to the Youth Policy Department of Almaty, the total number of higher education institutions (represented by universities, academies and institutes) in Kazakhstan in 2012 was 146; 43 of which were located in Almaty – this constitutes to the population of universities used in our study [219] (Figure 11). As we were interested only in universities which provided training related to telecommunications we carefully examined the websites of all 43 universities in Almaty. The universities offering programs in *Information systems (5B070300)* and/or *Radio engineering, electronics and telecommunications (5B071900)* were included in the sample. The sampling size resulted in 26 HIEs in Almaty (Table 1.B, Appendix B). Out of 26 universities 24 participated in the research which constituted to a 92% response rate.

The sampling of telecommunications companies was based on the list of firms provided by the Department of Statistics of Almaty city. The number of firms operating in telecommunications sector in Almaty in 2012 totaled 172 (Figure 12). As telecommunications sector deals with the broad spectrum of activities for transmitting messages, information, and data [208] and can involve manufacturing, services, and

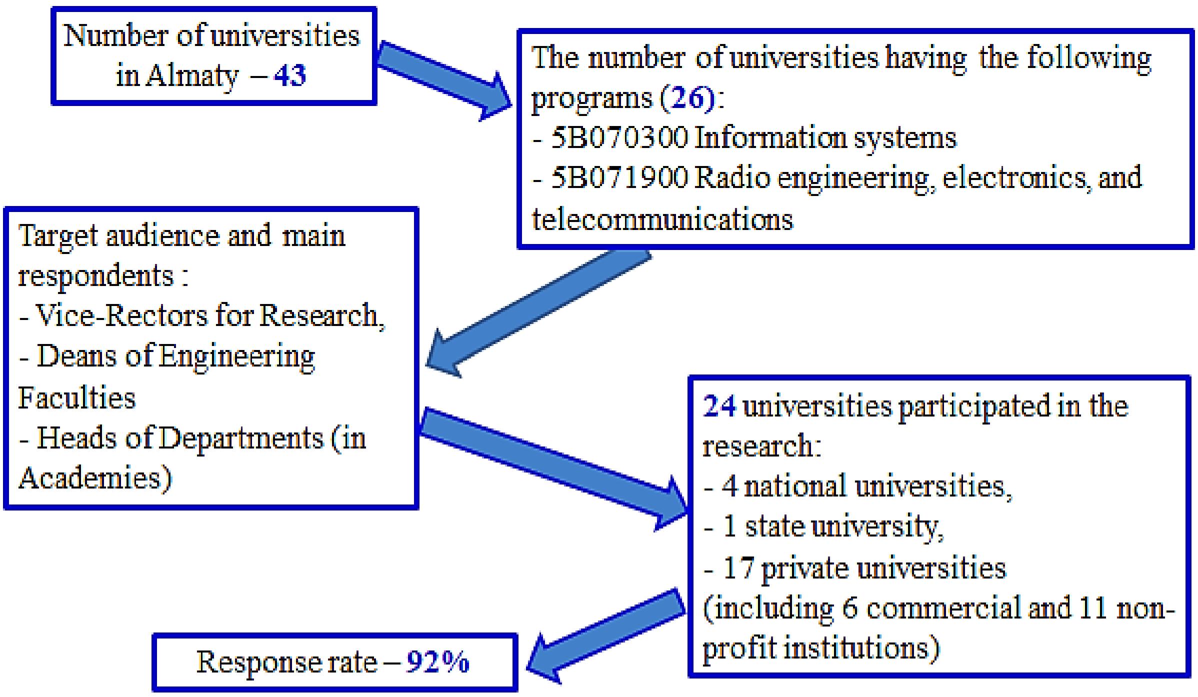

Figure 11 – Sampling: Universities

Note – Drafted by the author

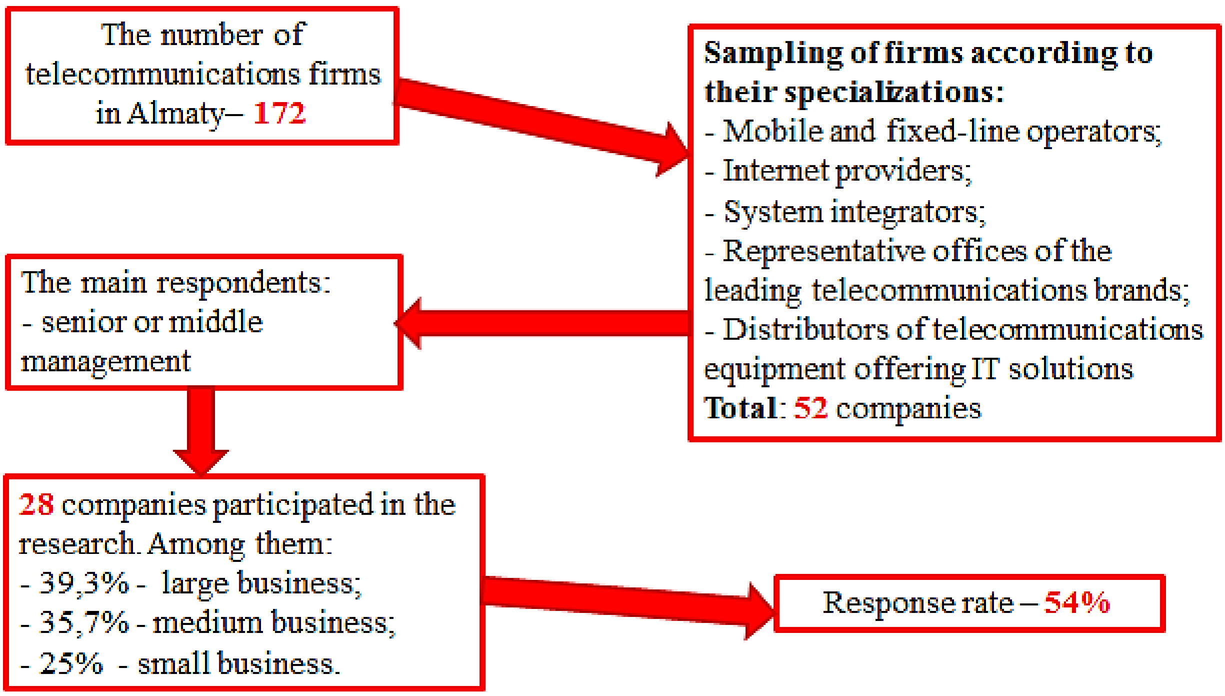

Figure 12 – Sampling: Telecommunications Firms

Note – Drafted by the author

trade operations, we decided to use purposive nonprobability sampling. Thus, based on our judgment about the characteristics of firms which might not collaborate with universities we excluded from our sample the following firms: distributors of cell phones and telecommunication equipment, television and radio broadcasting companies as well as firms focusing solely on construction of fiber-optic channels were excluded from the sample. The resulting sample consisted of 55 companies ranging from mobile operators, communications service providers, internet providers, and system integrators to distributors of telecommunication equipment offering IT solutions (Table 1C, Appendix C). As the activities of these companies are more sophisticated and their focus is mostly on building networks, it is possible to expect them to engage in some kinds of collaborations with universities. Overall, 28 telecommunications companies took part in the survey which constitutes to 54% response rate. The profile of firms-participants is the following: 39.3% - large business, 35.7% - medium business, and 25% - small business.

Data Collection and Methods. The process of data collection consisted of two stages. The first stage involved the collection of secondary data via scrutinizing published articles and books discussing theories and past empirical studies on knowledge transfer and university-industry collaboration as well as reviewing statistical bulletins, government publications, industry and country reports, and press releases.

The second stage of the data collection process included gathering primary data through surveys. Surveys were conducted by contacting one representative at the administrative position from each university (head of engineering faculty/department or vice-rector) and from each company (general director, executive director, administrative director, head of engineering department, head of human resources department or head of public relations department). The respondents from the academia were interviewed on a one-to-one basis using standardized interviewer-administered questionnaires. Business representatives were firstly contacted by telephone for an appointment. In case of the appointment semi-structured interviews were run[9]. Other survey participants from companies filled in self-administered internet-mediated questionnaires. Overall, the study is cross-sectional aimed at obtaining a ‘picture’ as it stands at the time of the study.

Questionnaire design. On the basis of studies conducted in five countries Mexico [88], Canada [108], the Netherlands [94], Thailand [97], and Slovenia [114] we developed and adapted to Kazakhstan two similar but not identical questionnaires for universities (see Appendix D) and companies (see Appendix E). Each questionnaire can be implicitly divided into three parts: the introductory part aimed at identifying the characteristics of the respondents, the main part, and supplementary part answered only by those firms and universities which were involved in any kind of collaboration.

The introductory part (questions 2-4 in both questionnaires) intended to identify the demographic characteristics of the respondents such as: form of ownership,

[9] Totally, 16 telecommunications firms participated in face-to-face interviews. The list of interview participants is as follows: Ericsson Kazakhstan, Kazakhtelecom, Kcell, Astel, TNS Service, Tandem, NewTech Distribution, ZYXel, Aspan Telecom, Bazis-Telecom, TC Company, Asia Intercommunications, Tegra Kazakhstan, Kaztranskom, RRC Kazakhstan and Obit Telecommunications.

size, and programs offered (for universities); size, business origin, and specializations (for companies). The first question asked both firms and universities to provide their names to assist the researcher to keep track of the respondents[10].

The main part of the questionnaire was built on the previous studies and included questions 5-7 developed for universities and questions 5-9 constructed for companies. Questions 5-7 were developed to be identical for both groups of the respondents in order to compare the answers. These questions employ an attitudinal Likert scale which is "based upon the assumption that each item on the scale has an equal "attitudinal value" or importance in terms of reflecting the attitude" of the respondent towards the investigated issue [217, p. 145]. The questions were testes for internal validity which showed quite high reliability with Cronbach's Alpha equal to 0.758.

Question number five adapted the statements from the research conducted by Meredith & Burke (2008) in Mexico [88]. This question asked the respondents from both firms and universities to rate the statements on a five-point scale from strongly disagree to strongly agree. This section mainly aimed to measure the attitudes of both parties towards knowledge transfer, in particular the role it plays for the academic staff, students, and firms.

Question number six was developed on the basis of the study conducted by Renko (2004) in Slovenia [114] who also investigated the obstacles to university-industry collaboration from both academicians' and firms' perspectives. In this question the respondents were asked to rank eight statements which might reflect the barriers to knowledge collaboration in Kazakhstan.

The seventh question in both questionnaires combined a set of knowledge transfer channels which typically serve as forms of collaboration between universities and firms proposed by Bekkers and Freitas (2008) and Lakpetch (2009) [94, 97]. We offered the respondents to evaluate a wide range of knowledge transfer channels on an importance scale although we supposed that some of them did not exist at all in Kazakhstan. This question was useful for identifying the attitudes of both firms and universities to knowledge transfer channels by revealing the most important ones from each perspective.

Questions number eight and nine which were constructed only for companies built upon the study by Board of Trade of Metropolitan Montreal (2011) in Canada [108]. The multiple-response questions aimed to identify firms' perceptions about benefits that collaboration with universities might bring them, as well as to find out companies' opinion about possible measures which might improve the likelihood and the effectiveness of university-industry knowledge collaboration.

The last part of questions which we called supplementary was asked only from companies and universities which collaborated on a permanent basis. The respondents were offered a list of their possible partners to select the ones which whom they had relationships. Firms were additionally asked to specify the forms of collaboration they used to interact with universities.

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[10] The answers of all the respondents are confidential and are not disclosed to a bystander.

Interview planning. As it was mentioned above, some companies which agreed to hold face-to-face meetings with the researcher were asked to reply to four semi-structured questions. We were interested in exploring the opinions of telecommunications firms regarding the quality of education, their interest in collaboration with universities, possible reasons of firms' unwillingness to build relationships with higher education institutions, and the ways how universities may attract firm to engage in any kinds of interactions. Therefore we came up with the following interview questions:

1) Does the quality of education in technical disciplines in Kazakhstan conform to the requirements of telecom companies?
2) Do telecommunications firms in Kazakhstan show any interest in establishing linkages with universities?
3) What could be the main reason(s) of telecommunications firms' reluctance to cooperate with universities in Kazakhstan?
4) How can higher education institutions make telecommunications companies be interested in collaboration?

Data Analysis. Since our study is designed as a combination of exploratory and descriptive research we approach data analysis by using descriptive statistics to summarize the data set and bivariate statistics to make comparisons between two data sets, i.e. between universities and telecommunications firms.

Descriptive statistics commonly involves the use of frequencies, percentage, mean, mode, median, range, standard deviation, variance, and ranking. In our study we employ only percentage, mean, mode, and standard deviation which we believe are sufficient to elaborately describe the data set.

Percentage is a measure of categorical outcomes. Percentage is calculated by taking the frequency in the category divided by the total number of participants and multiplying by 100% [220]. This descriptive tool allows one to identify which category has the highest share in its construct of data. Percentages can be depicted by means of graphs, histograms, charts, pies, etc.

Mean is the measure of a central tendency, the arithmetic average [218, p. 450]. Because we don't have enough data to calculate the population mean, so we have calculated a sample mean $\bar{X}$ with the following formula:

$$\bar{X} = \frac{\sum_{i=1}^{n} X}{n}, \tag{3}$$

where,

i – the initial value of the index;

n – the number of observations in the sample;

X – values of the respondents' answers.

After making calculations we have gotten the means' values of sample 1 – universities ($\bar{X}_1$) and sample 2 – companies ($\bar{X}_2$). To find out the mean values of all the respondents, we used the formula of the weighted average for two sample means:

$$Weigheted\ \bar{X} = \frac{w_1 \times \bar{X}_1 + w_1 \times \bar{X}_2}{w_1 + w_2}, \tag{4}$$

where,

w_1 and w_2 – the weights of sample 1 and sample 2, respectively.

Although calculating mean is important to understand the central tendency, this measure doesn't show the whole picture. So, we decided to use mode which identifies the value that occurs most often [218, p. 452], in other words, mode shows the maximum frequency of the values in a sample. For a large data set, one of the easiest ways to calculate mode is by using Excel program. The ready formula calculates the frequencies of the values and displays the value that occurs most often. This value represents the mode of the data set.

Standard deviation is a measure of dispersion which shows how spread out the numbers from the mean value [218, p. 455]. In our case, standard deviation has shown the extent to which the answers of the respondents were dispersed from the mean value of the responses. The higher the standard deviation the higher is the variation between the answers, and vice versa.

$$s = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}}, \tag{5}$$

where,

n – sample size;

X_i – sample data;

$\bar{X}$ – sample mean.

After analyzing the data by using descriptive statistics, we make comparisons and measure the differences between the two independent samples. This type of measurement is called bivariate statistics. Bivariate statistics may be run through a number of tests including t-test, Z-test, Mann-Whitney U-test, Wilcoxon test, Chi-square test, Kruskal-Wallis test, and one-way ANOVA [218, p. 587].

To measure the difference of means of our two samples (universities vs. firms) we have selected a t-test which allows us to test a hypothesis that the mean of universities' responses is significantly different from the mean of companies. This instrument is the most suitable in our case because it is applied when samples are small ($n_x < 30$; $n_y < 30$) and independent [221]. The main two assumptions that we make here are: (i) the samples are drawn from normally distributed populations and (ii) homoscedasticity – the variances of the populations are equal [218, p. 591]. Since the variances of the two populations are equal and unknown, we have used sample variances to compute a pooled variance estimator (S_p^2) [221]:

$$S_p^2 = \frac{(n_x - 1) \times S_x^2 + (n_y - 1) \times S_y^2}{(n_x + n_y - 2)}, \tag{6}$$

where,

S_x^2 – variance[11] of the first sample denoted as *X*;

S_y^2 – variance of the second sample denoted as *Y*;

n_x – size of sample X;

n_y – size of sample Y.

Now the pooled variance estimator may be used to compute the value of t-statistic:

[11] Variance is to be found using the same formula as for calculating standard deviation except taking the root of the formula.

$$T.S. = t = \frac{(\bar{x}-\bar{y})-(\mu_x-\mu_y)}{\sqrt{\frac{s_p^2}{n_x}+\frac{s_p^2}{n_y}}}, \tag{7}$$

Our next step was the selection of a significance level α at which we tested the null hypotheses (based on [221]. Null hypothesis states that there is no difference between two population means. In contrast an alternative two-sided hypothesis states that there is a significant difference between means of two populations. Thus, in statistical terms the hypotheses are expressed to be as follows:

$$H_0: \mu_x - \mu_y = 0$$
$$H_1: \mu_x - \mu_y \neq 0$$

The decision about whether to reject or accept the null hypothesis depends on t-statistics as compared to t-critical which available from statistical tables. So, if $T.S. > t_{n_x+n_y-2,\ \alpha/2}$ or $-T.S. > -t_{n_x+n_y-2,\ \alpha/2}$ then we reject H_0 and accept H_1 which states the difference of population means is significant.

The above described methods were applied to conduct descriptive and statistical analyses of our dataset.

3.2 Empirical Analysis of University-Industry Knowledge Collaboration in Telecommunications Sector

On the basis of our research, we have gotten the results which reveal how to improve university-industry collaboration in the telecommunications sector of Kazakhstan. Studying the viewpoints of the respondents was important as the scope of knowledge transfer depends on their attitudes. Thus, the first objective of the empirical study was to identify and contrast the opinions of universities and firms regarding knowledge transfer. The answers of the respondents are summarized in Table 14. The participants rated six statements regarding the benefits of knowledge transfer on a 5-point Likert scale, where 1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, and 5 – strongly agree.

The study revealed that both universities and telecommunications companies have positive attitudes towards knowledge transfer. However, the representatives of universities (mean value = 4.72) think of knowledge transfer more optimistically than the respondents from companies (mean value. = 4.28).

According to the unanimous opinion of the respondents, the transfer of knowledge is beneficial not only to companies and academic staff but also to students. Practical experience allows students to get a full understanding of theoretical knowledge gained at the university. But the transfer of knowledge in the form of consultancy by faculty members and students seems to the respondents from telecommunications industry not quite appropriate. For the most part, this is due to the fact that in case of a need for consultations companies prefer to refer to professional consulting firms.

The opinions of telecommunications companies were dependent on their size (Table 15). Large firms have higher mean (4.48) and mode (4.67) in comparison with medium and small firms which means they have more positive attitudes towards knowledge transfer and, therefore, higher propensity to collaborate.

Table 14 – Attitudes towards University-Industry Knowledge Transfer

	Statements	Universities		Companies	
		Mean	**St. Dev.**	**Mean**	**St. Dev.**
a)	Establishing links between universities and business is/can be beneficial for both parties through transferring knowledge and ideas and giving students practical experience	4.79	0.41	4.11	0.78
b)	Having an opportunity to provide consultancy to companies is/can be a useful practice for university students and academic staff	4.67	0.70	3.64	0.91
c)	Closer relationships between universities and industry enable business to influence courses so that universities produce students more prepared for the world of modern business	4.67	0.56	4.36	0.99
d)	Encouraging academic staff and students to do research in business is useful for both of them in that they are able to gain first-hand practical experience	4.71	0.46	4.21	0.69
e)	Practical experience is essential for students to gain full understanding of theories and abstract concepts learned in a classroom	4.87	0.34	4.71	0.53
f)	Students already acquainted with the realities of industry and the business world become better employees	4.58	0.65	4.64	0.56
	Average	***4.72***	***0.52***	***4.28***	***0.74***

Note – Compiled by the author

Table 15 – Attitudes of the Respondents towards University-Industry Collaboration Pending on Business category

Category	Mean	Standard Deviation	Mode
Large business	4.48	0.48	4.67
Medium business	4.15	0.54	4.00
Small business	4.14	0.48	4.00

Note – Compiled by the author

The analysis of telecommunications firms' attitudes from the perspective of their origin (Table 16) didn't reveal large difference in population means but found that mode of representative offices was higher than that of local companies. This implies that foreign firms ranked the statements more positively greater number of times than their local counterparts.

Table 16 – Attitudes of respondents towards university-industry collaboration pending on origin of business

Origin of business	Mean	Standard Deviation	Mode
Representative office	4.29	0.63	4.67
Kazakhstan company	4.28	0.47	4.00
Note – Compiled by the author			

Despite the results of the descriptive analysis showed some tendencies in the answers of the respondents, statistical tests for the difference in population means (Table 15) did not reveal any significant differences in the opinions of large vs. small vs. medium businesses. So, our findings are consistent with the results of Mohnen and Hoareau (2002) who also didn't find any size effect [75].

Another test for the difference in means of foreign vs. local firms didn't find any significant difference in their opinions, too. This means that the attitudes of firms towards university-industry knowledge transfer do not depend on business origin. Given this, it is possible to conclude that both foreign and local firms are equally willing to establish collaboration with universities.

The only significant result was for the difference between means of universities' and telecommunications companies' answers (Table 17). Universities have more positive attitudes towards knowledge transfer rather than firms. This might be explained by the fact that universities have traditionally performed the functions of creating and disseminating knowledge. Therefore, universities expect all the parties to get enormous benefits from the knowledge transfer process.

Table 17 – Statistical Significance of the Difference in Attitudes towards Knowledge Transfer

The objects	Two-tailed t-test
Telecommunications companies vs. universities	0.0181*
Large business vs. medium business	0.1545
Large business vs. small business	0.1620
Medium business vs. small business	0.9692
Foreign company vs. local company	0.9387
Note – Compiled by the author	

Note: $^{*}p<0.05$

To determine the degree of collaboration between higher education institutions and telecommunications companies, the representatives of firms were asked whether their companies have any linkages with universities. 64.3% of the respondents positively replied to this question, and 35.7% answered they didn't have any contacts with universities. Among the collaborating firms, 89% of the respondents indicated that they have long-term relationships with 1-3 universities, and 11% of firms responded that they cooperate with either 4-6 or 10 or more universities. Most of the telecommunication companies (77.8%) collaborate with the Almaty University of Power Engineering and Telecommunications, 22.2% have relationships with M. Tynyshpayev Kazakh Academy of Transport and Communications, Kazakh-British Technical University and Suleyman Demirel University (Figure 13). A smaller number of companies cooperate with Almaty Technological University (11.1%) and International Academy of Business (5.6%).

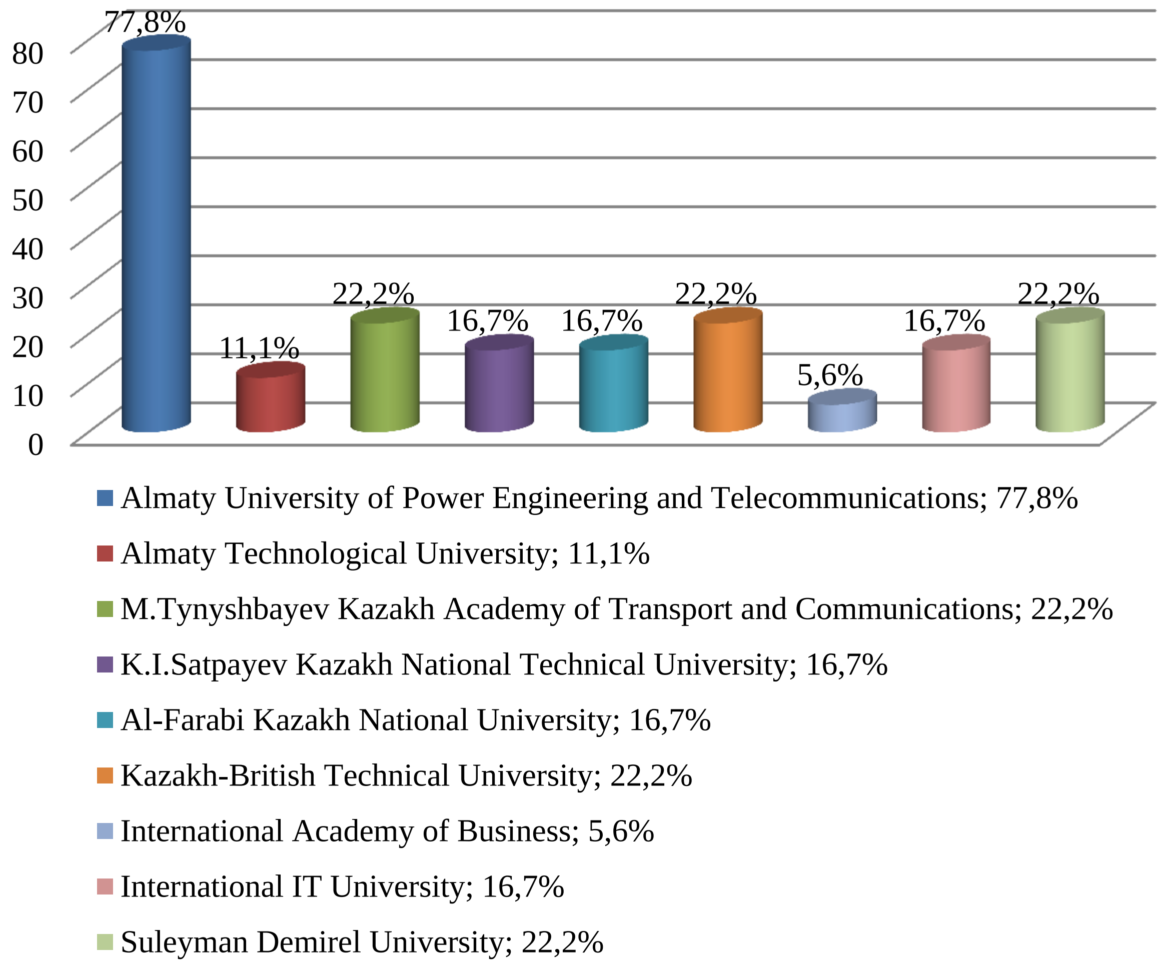

Figure 13 – Collaboration of Telecommunications Companies with Higher Education Institutions of Almaty (in percentage)

Note – Drafted by the author

At the same time, the respondents from universities were asked a similar question: “Does your university have any relationships with telecommunications companies?” Among 26 universities, 58.3% responded that they collaborated, and 41.7% replied negatively. Among the collaborating universities, 71.4% of higher education institutions indicated that they have permanent relationships with 1-3 telecommunications companies, and 28.6% universities answered that they cooperate with 4-6 firms in the same industry. Most universities cooperate with the national telecom operator "Kazakhtelecom" (86%), mobile operators «GSM Kazakhstan" (64%) and Beeline (64%) and telecommunications operator "Transtelecom" (50%) (Figure 14). These companies are among the largest in the telecommunications market of Kazakhstan; they have a steady demand for staff and, hence, they need to collaborate with universities. Yet these companies do not reflect the whole list of telecommunications companies in Almaty. There are still many firms that have a certain capacity and the necessary resources to collaborate but don’t have any linkages with universities.

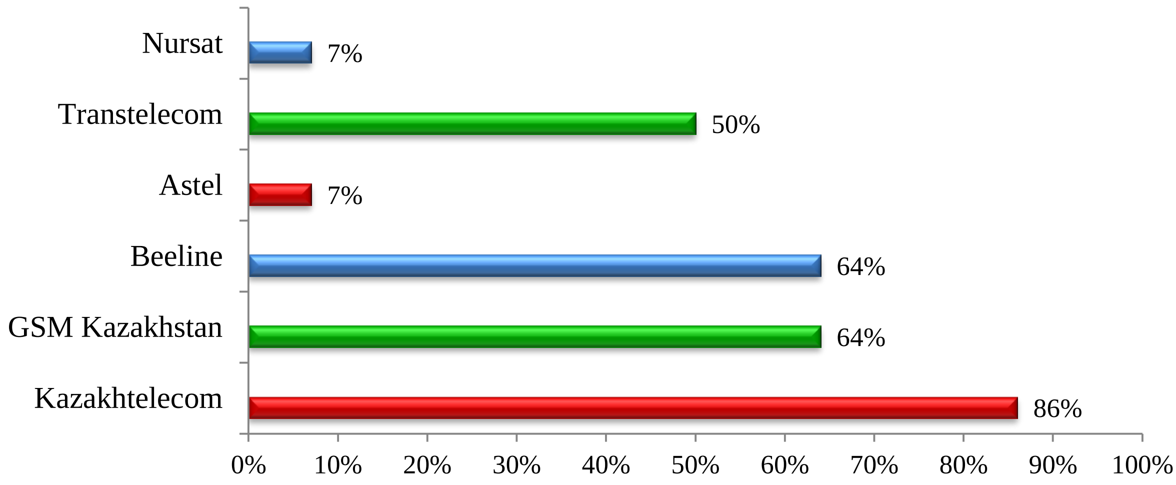

Figure 14 – Collaboration of Almaty Universities with Telecommunications Firms (in percentage)

Note – Drafted by the author

We have seen that more than half of telecommunications firms are engaged in collaboration with universities. Still there is significant share of companies which do not have any relationships with higher education institutions. What might hold them back from establishing linkages with academia? What could be the main reason(s) of firms’ reluctance to cooperate with universities in Kazakhstan? An interview conducted with the respondents from telecommunications companies helped to answer these questions. Among the factors holding companies back from with universities were: lack of resources, time, or no need for cooperation, lack of tradition, absence of a well-functioning system of interaction, and no vision of real benefits. In addition, the respondents claimed that few companies would have liked to have obligations to universities, as well as to invest in long-term and risky projects. “Shareholders need profits today and now”.

Another objective of our study was to identify the most common forms of collaboration between telecommunications companies and universities in Almaty. As revealed from our interviews, it turns out that telecommunication companies in Kazakhstan show a reasonable interest in cooperation with universities, but this interest is mainly due to the need for personnel. These are mostly large companies who are interested to cooperate with universities in hiring graduates to work and students for internship with subsequent employment. Some enterprises are willing to transfer knowledge to higher education institutions through lectures, workshops and master classes, while others are ready to assist universities in establishing laboratories. At the same time, according to the respondents, some companies are interested in collaboration with universities only to improve their image and reputation.

The results of questionnaire responses showed confirmed the findings from the interviews that the most common forms of collaboration between firms and universities include recruiting students as trainees (61.1%), recruiting graduates as employees (50%), as well as participation in conferences and seminars (33.3%). Among the "other" forms of collaboration the respondents called giving lectures and tutorials to students by employees of firms, and annual summer school project (ZyXEL). It should be noted that most collaboration between the parties is informal that doesn't bind them with the obligations.

The least popular forms of cooperation between higher education institutions and telecommunications companies were found to be the following (Figure 15): joint R&D projects, contract-based in-business education and training delivered by universities, consultancy by university staff members, staff holding positions in both a university and a business, funding education of students with further employment, and

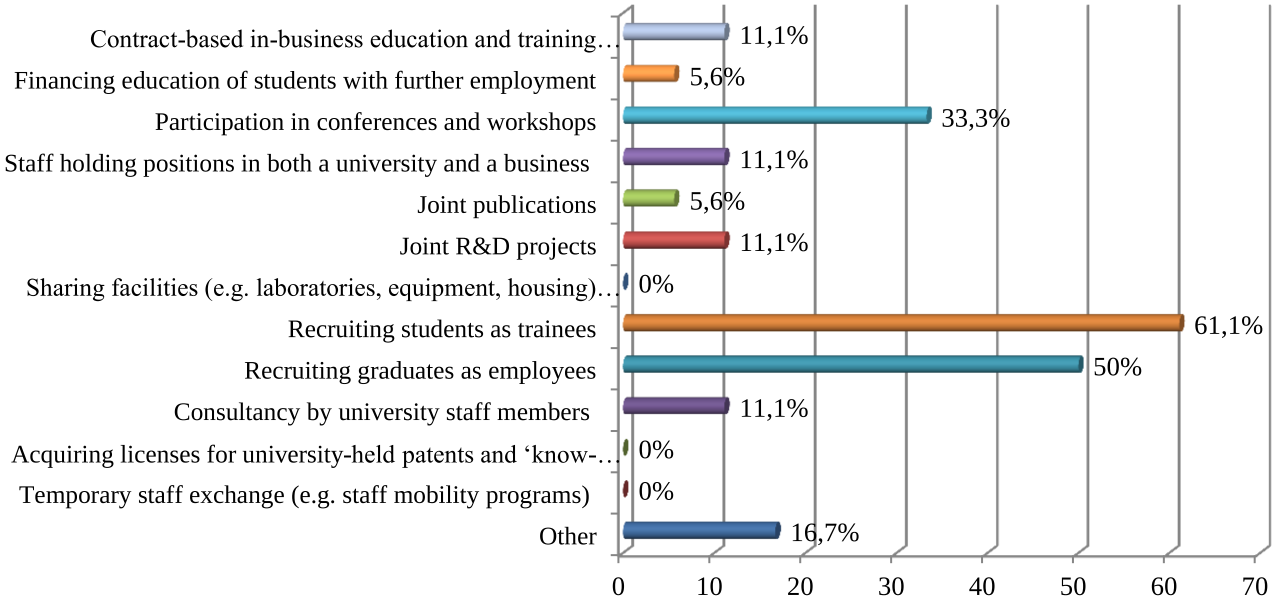

Figure 15 – Forms of Collaboration between Telecommunications Companies and Universities

Note – Drafted by the author

joint publications. And such forms of collaboration as sharing facilities, temporary staff exchange, and acquisition of licenses for university-held patents and "know-how" did not prove to exist between universities and telecommunications companies of Almaty.

One of the objectives of our research was to determine the most important channels of knowledge transfer as perceived by universities and telecommunications companies (Figure 16). The respondents were asked to rate the importance of knowledge transfer channels on a 5-point scale, where 1 – unimportant, 2 – of little importance, 3 – moderately important, 4 – important and 5 – very important.

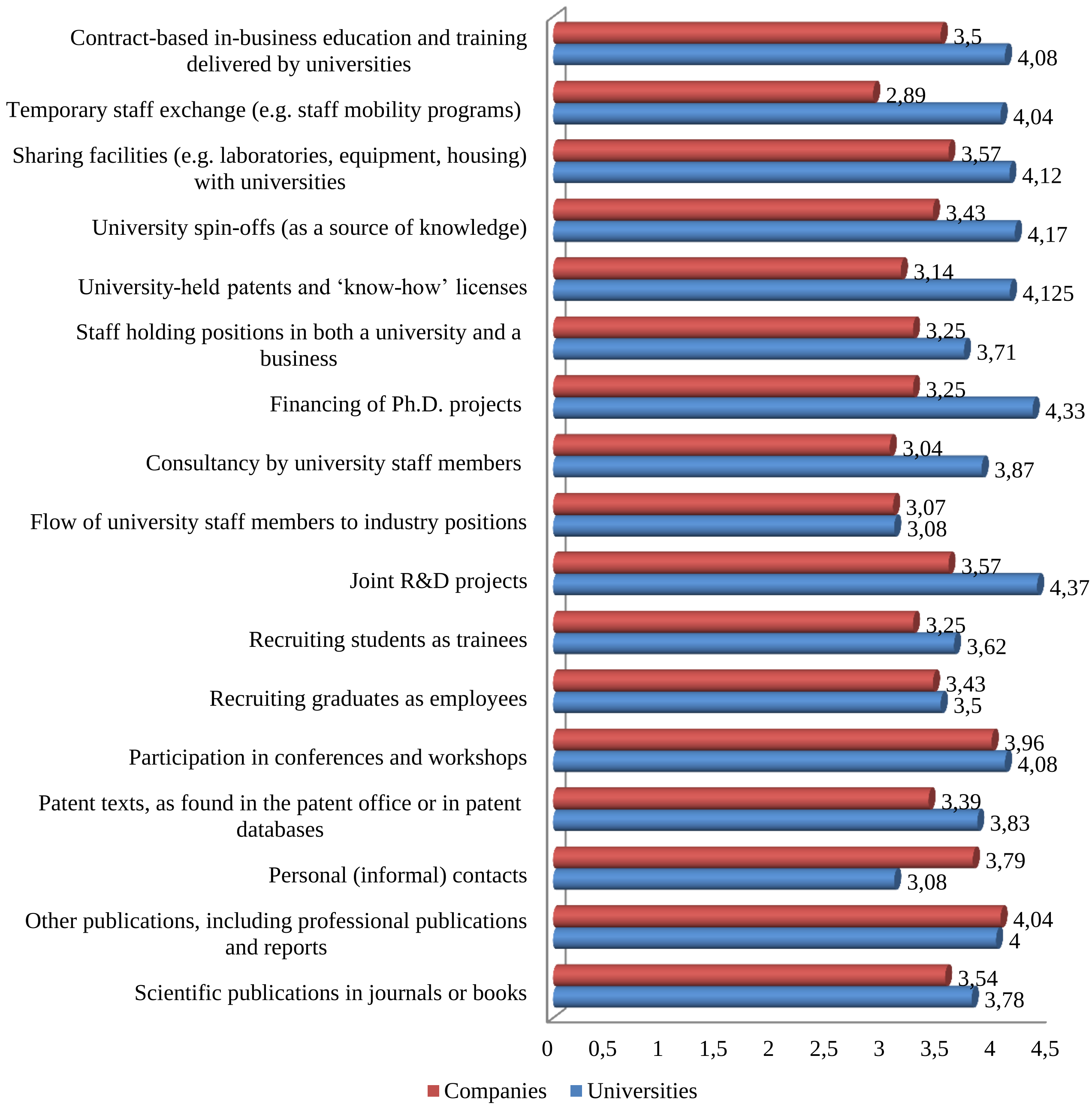

Figure 16 – Channels of Knowledge Transfer

Note – Drafted by the author

As seen from Figure 16, the most important channels of knowledge transfer for universities are joint R&D projects and financing of Ph.D. theses. Joint R&D involves an exchange of theoretical and practical knowledge between universities and enterprises. While financing doctoral dissertations companies assist Ph.D. students in obtaining information about the firm or industry. Doctoral students in return provide enterprises with the results of their research. At the same time, according to telecommunications firms, the most important channels of knowledge transfer are professional publications and reports such as market surveys, analysis and trade publications, participation in conferences and seminars, and personal (informal) contacts.

The least important channels of knowledge transfer for universities include personal (informal) contacts and flow of university staff members to industry positions; and for telecommunications companies –temporary staff exchange (for example, personnel mobility) and consultancy by university members. According to the representatives of business sector, temporary staff exchange is not appropriate due to the irretrievable loss of time which is required for the participants of personnel mobility programs to adapt to a new workplace. Consultancy by university members and flow of university staff to industry positions will not bring much good to a company because academic staff mostly has theoretical knowledge and is not familiar with the realities of the business world.

As it has been mentioned above, knowledge transfer and knowledge collaboration are beneficial to both education and business sectors. In order to identify the benefits as perceived by the industry, the respondents from telecommunications companies were asked a question "What benefit(s) do companies gain from collaboration with universities?"

Firstly, as shown in Figure 17, collaboration with universities allows companies to access highly qualified workers (46.4%) and innovative technologies (32.1%) and to jointly develop a new product or service (32.1%). Among “other” benefits of collaboration, the respondents called access to potential employees because only few

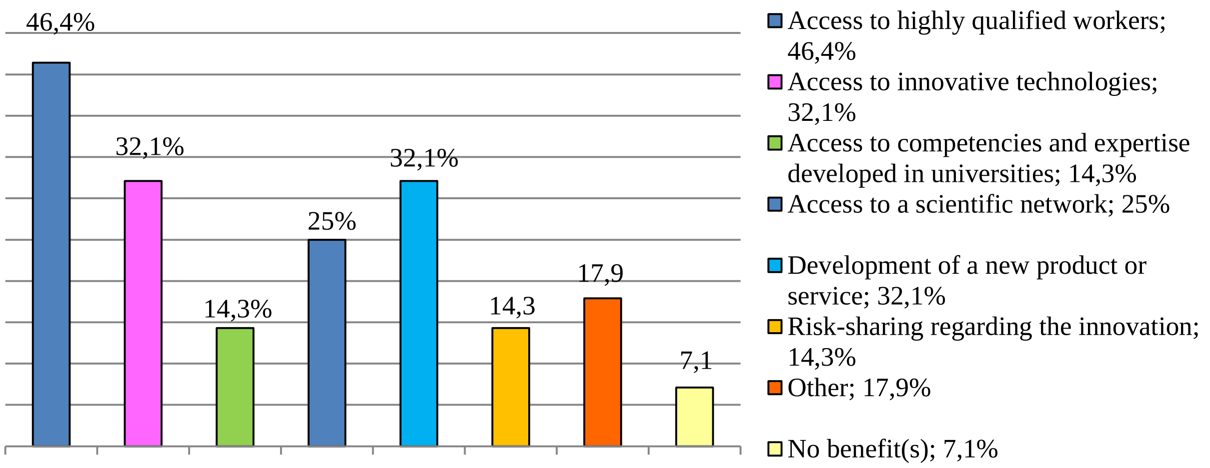

Figure 17 – Benefits of Companies from Collaboration with Universities

Note – Drafted by the author

universities can provide high quality training in accordance with the needs of companies. In addition, it was noted that linkages with universities contribute to a company's corporate social responsibility. However, some respondents believe that such collaborations do not bring any benefits to firms at all (7.1%).

One of the other objectives of our research was to identify factors hindering university-industry collaboration. The respondents from both universities and telecommunications companies were asked to rate the statements listed in Table 3 on a scale from 1 to 5, where 1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, and 5 – strongly agree.

Data analysis showed that the main factor hindering university-industry interactions according to both firms and universities is the absence of any policy in Kazakhstan aimed to stimulate companies to collaborate with universities (Table 18). One more factor which is considered as an important obstacle to university-industry collaboration by both universities and companies is the lack of researchers and scientists involved in the work at enterprises.

Table 18 – Factors Hindering University-Industry Collaboration

	Statements	Mean Values		
		Universities	Companies	Weighted Average
a)	Enterprise management is often negatively disposed towards cooperation with universities	3.21	2.67	2.92
b)	New knowledge is too expensive for enterprises	3.12	3.39	3.27
c)	University-industry relationships are always established on the basis of personal contacts	3.5	3.07	3.27
d)	Enterprises in Kazakhstan lack market orientation	3.42	2.68	3.02
e)	There are few researchers and scientists in enterprises	4.17	3.71	**3.92**
f)	Researchers and scientists from universities are not familiar with industry's actual needs	3.08	3.54	3.33
g)	Research conducted in Kazakhstani universities is usually of low quality	2.71	3.54	3.16
h)	State doesn't provide appropriate tax relief to enterprises engaged in research and development	4.33	4.29	**4.31**
Note – Compiled by the author				

Statistical tests revealed that the mean values for a number of statements rated by universities and companies differ significantly (Table 19). Thus, concerning the statement about the lack of researchers and scientists on enterprises, this seems a much greater obstacle to universities. Limited amount of university staff working in companies may be explained by negative attitudes of companies towards collaboration with universities. In contrast, telecommunications firms disagree that management of their companies is often negatively disposed towards cooperation with universities and claim that they are open but universities do not show any interest in cooperation.

Table 19 – Significance of the Difference between Telecommunications Companies' and Universities' Means: Factors Hindering University-Industry Collaboration

	Statements	**Two-tailed t-test**
a)	Enterprise management is often negatively disposed towards cooperation with universities	0.0524*
b)	New knowledge is too expensive for enterprises	0.3010
c)	University-industry relationships are always established on the basis of personal contacts	0.1784
d)	Enterprises in Kazakhstan lack market orientation	0.0119**
e)	There are few researchers and scientists in enterprises	0.0816*
f)	Researchers and scientists from universities are not familiar with industry's actual needs	0.1213
g)	Research conducted in Kazakhstani universities is usually of low quality	0.0009***
h)	State doesn't provide appropriate tax relief to enterprises engaged in research and development	0.8679
	Note – Compiled by the author	

*Notes: *p<0.1, **p<0.05, ***p<0.01*

According to the opinion of universities, another factor hindering university-industry collaboration is the lack of market orientation of Kazakhstani enterprises. As evidence shows, the goal of most business entities in Kazakhstan is solely profit maximization; and they are not ready to bear the costs associated with research and development. However, the representatives of companies do not agree with this argument and claim that enterprises in Kazakhstan are engaged in research but mostly on their own (e.g. the study of customers' needs). Low quality of university research holds back companies from collaboration with higher education institutions. In contrast, the respondents from education sector believe that quality of research at Kazakhstani universities is quite high, and the reluctance of firms to cooperate with universities is not related to the quality of scientific work.

As shown by our interviews, in addition to the above stated, telecommunications firms have negative perceptions of the quality of education in technical disciplines. The interviewees argue that in most cases university graduates do not correspond to the requirements of telecommunications companies or meet them only partially. Students receive a lot of theoretical knowledge but they lack practical skills. At the same time, the received theoretical knowledge does not always correspond to the realities of the business world. Telecommunications sector is developing much faster than universities can adapt the curriculum. In addition, many representatives of telecommunications companies argue that the level of training in universities has dropped significantly since the collapse of the Soviet Union. Moreover, some respondents believe that current students have no interest in studies.

To develop linkages between industry and universities it is necessary to take appropriate measures. According to the respondents from telecommunications firms, collaboration with higher education institutions will be more likely and more effective if scientific and educational activities of universities will be aligned with the objectives of companies (39.3%), enterprises will have greater awareness of collaboration opportunities (28.6%), tax incentives will be generous (14.3%), and partnerships will involve less administrative red tape (7.1%) (Figure 17). "Other" (10.7%) possible measures to improve the likelihood and effectiveness of collaboration include creation of laboratories belonging to companies in the premises of universities, improvement of quality of teaching and growth of experience in university research.

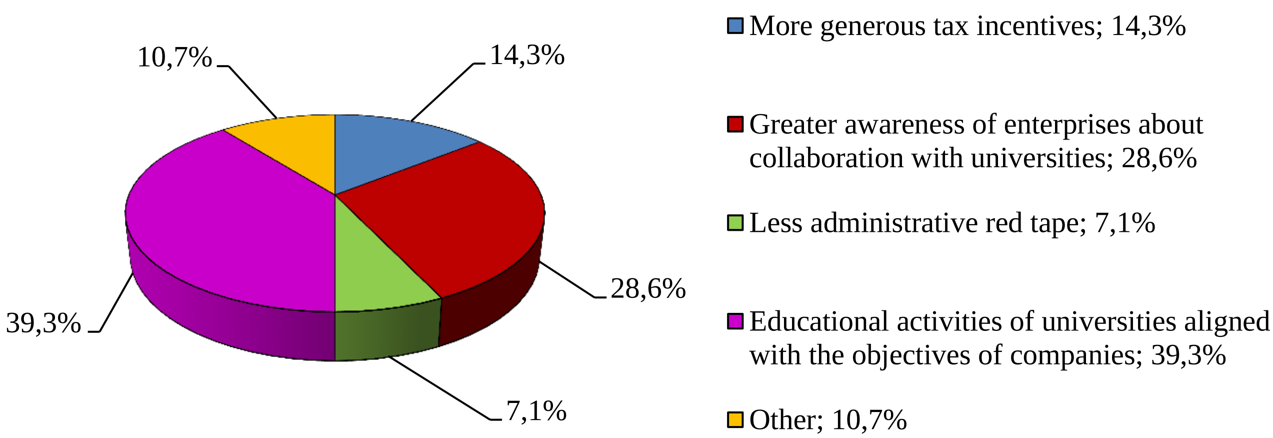

Figure 17 – Measures to Be Taken in Order to Increase the Likelihood and Effectiveness of Collaboration with Universities (in percentage)

Note – Drafted by the author

Finally, the interviewees were asked about how higher education institutions could make telecommunications companies be interested in collaboration. The representatives of telecommunications sector argued that in order to raise their interest in collaboration, universities must be the first to take some steps forward. For example, university members can prepare a presentation on possible options for cooperation to be delivered to a company. Additionally, they may invite the representatives of companies to participate in a variety of activities held at the universities, such as an open door day, exhibition of vacancies, alumni clubs, seminars, and conferences.

3.4 A Model of University-Industry Knowledge Transfer in Kazakhstan

The results of our research suggest that telecommunications companies have more positive attitudes towards knowledge transfer rather than universities. Statistical tests for the difference in means of foreign vs. local firms and large vs. medium vs. small firms didn't show any significant difference in their answers. Thus, the attitudes of firms towards university-industry knowledge transfer as well as their willingness to collaborate do not depend on company size and business origin. This contradicts the results of an empirical study by Veugelers and Cassiman (2005) and finding of Adams *et al*., (2000), Leiponen (2001), Arundel et al. (2000), and Guena *et al*., (2003) who found that foreign ownership has a negative effect [79] and size has a positive effect on cooperation with universities [72, 73, 74, 78], respectively.

Although the degree of collaboration between higher education institutions and telecommunications companies is quite high, in most cases contacts are informal. A similar tendency was noted by Cohen *et al*. (2002) and Meyer-Krahmer and Schmoch (1998) [70, 91]. University-industry interactions in Kazakhstan telecommunications industry involve a wide use of only few channels of knowledge transfer such as recruiting students as trainees, recruiting graduates as employees, and participation in conferences and seminars. This constitutes to Arza's (2010) "*traditional*" channel category [95], Bekkers and Freitas' (2008) "*scientific output, informal contacts and students*" channel [95], and Fuentes and Dutrenit's (2010) "*InfoChannel*" and "*HRChannel*" categories [100]. Additionally, the transfer of knowledge through "*commercial*" channels [94] did not prove to exist between universities and telecommunications companies of Almaty.

Firms and universities have different perceptions of the importance of knowledge transfer channels. For example, "*collaborative and contract research*" category is the most important for the education sector while "*scientific output, informal contacts and students*" is vital for business entities. In contrast, Bekkers and Freitas (2008) found that both "*collaborative and contract research*" and "*scientific output, informal contacts and students*" are crucial for firms [94]. The least important channels of knowledge transfer as perceived by both universities and companies constitute to "*labor mobility*" category. Some inconsistency between the channels used and channels which are important to universities may be observed. Because "*collaborative and contract research*" channels are essential to universities, some policies should be worked out to encourage their development.

As it was revealed by our study, the most important benefits for telecommunications companies are (1) access to highly qualified workers and (2) access to innovative technologies and opportunity to jointly develop a new product or service which are related to short-term production activities and to long-term innovation strategies, respectively, as argued by Dutrenit *et al*. (2010) [116]. The benefits identified in this paper are partially in line with the results of the study conducted by Board of Trade of Metropolitan Montreal (2011). The firms in Canada perceive access to skills and expertise developed in universities and access to highly qualified labor as the most important benefits from university-industry collaboration [108].

The analysis of factors hindering university-industry interactions identified that the absence of any policy aimed to stimulate companies to collaborate with universities is the main obstacle to collaboration in Kazakhstan. This finding is consistent with the results of the study conducted by Renko (2004) in Slovenia [114].

Other factors hindering university-industry knowledge collaboration vary substantially for universities and telecommunications companies. As was noted by the respondents from business sector, companies in Kazakhstan do not trust local education system. Low knowledge levels of graduates point out to the low quality of training at the universities. There hasn't been any sound research conducted by university researchers which would contribute to the development of telecommunications industry except of Tomanov (2010) [204]. In case companies need consultations or any research to be carried out (e.g. marketing study or economics forecasting) they prefer to recruit professional organizations.

The above described problems of knowledge collaboration from the perspective of firms can be depicted as a vicious circle (Figure 18). Researchers and scientists from universities are not familiar with the industry needs (in line with the findings of Renko (2004)); this results in a low quality research with no or little practical implication. At the same time, low quality research augments mistrust of companies to science and education system leading to few researchers and scientists in the enterprises. Without having access to enterprises researchers and scientists cannot become familiar with industry needs and solve real-world problems. At this point a new cycle starts.

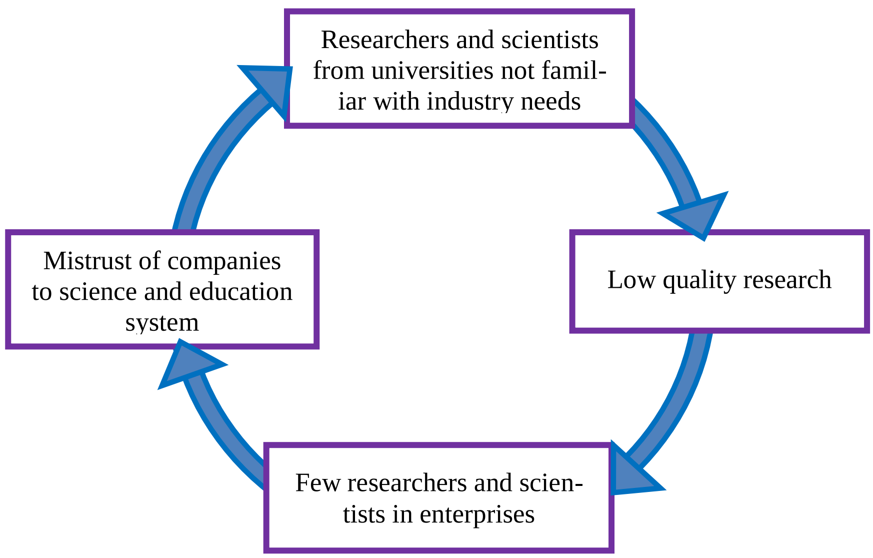

Figure 18 – A "Vicious Cycle" of Factors Hindering University-Industry Collaboration: Firms' Perspective

Note – Drafted by the author

In contrast, factors hindering university-industry collaboration from universities' perspective include the following (excluding the absence of tax relief): enterprises in Kazakhstan lack market orientation, enterprise management is negatively disposed towards cooperation with universities, university-industry relationships are established on the basis of personal contacts, and there are few researchers and scientists in enterprises. These problems can be depicted as a cluster implying that there is a central obstacle which is a consequence of other problems – few researchers and scientists in enterprises (Figure 19).

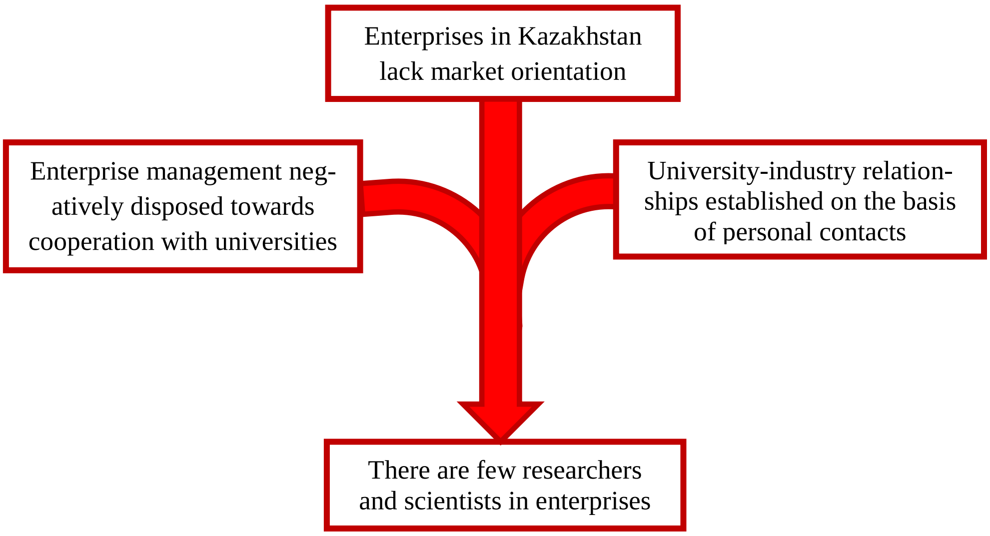

Figure 19 – The "Cluster" of Factors Hindering University-Industry Collaboration: Universities' Perspective

Note – Drafted by the author

We suppose that the above described factors hindering collaboration are related to the choice of governance forms for university-industry interactions in Kazakhstan. As suggested by Rossi (2010), the choice of governance forms depends on two factors: (1) knowledge appropriability and (2) knowledge complexity and uncertainty [50].

Although marginal research collaboration occasionally occurs between firms and universities, the majority of telecommunications companies in Kazakhstan do not conduct any research. Knowledge produced at universities is characterized by low appropriability as it usually qualifies to "fundamental" or "basic" research which is difficult to patent. Plus, knowledge that is more general is often highly uncertain. Knowledge complexity is low as only few universities possess knowledge which might be important to external agents. Therefore, with the reference to Rossi's framework we can conclude that "*university research without industry involvement (publicly funded)*" is the current governance form of university-industry interactions in Kazakhstan.

As found by the Board of Trade of Metropolitan Montreal (2011) firms are more willing to cooperate with universities when there is greater awareness of collaboration opportunities [108]. This is consistent with the results of our study but the most important impetus to collaboration for telecommunications firms in Kazakhstan is better alignment between university activities and business objectives. This creates a need for closer dialog between the agents.

Based on the analysis conducted in Chapters 2 and 3 and the literature reviewed in Chapter 1, it is possible to build a model of university-industry knowledge transfer in Kazakhstan (Figure 20).

As our study showed, there is an adequate level of collaboration between universities and enterprises. There is a continuous exchange of academia's explicit knowledge and industry's tacit knowledge. However, the greatest part of knowledge is transferred via students or graduates who are recruited as trainees for internship or as employees, respectively. Additionally, some exchange of knowledge occurs during companies' participation in academic conferences and workshops. Other forms of collaboration such as joint publications, joint R&D projects, consultancy, etc. are rare and are constrained by university- and industry-specific barriers described earlier in this Chapter.

University-industry collaboration and knowledge transfer process are greatly influenced by the environment in which the agents operate. For example, in our opinion, the most important environments to consider are economic, legal-political, and socio-cultural which may either positively or negatively affect knowledge transfer. First, a poor ability of companies to earn money or economic recession in a country would typically prevent firms from collaboration with universities. High living standards and high quality of education system would allow both agents to engage in activities other than their primary functions such as conducting scientific research and continuous learning. Second, the unstable political situation and imperfect legislative framework (e.g. lack of fiscal incentives, weak IPR protection policy) may hinder both agents from establishing linkages with each other. At the same time, strong governments and all-encompassing legislative frameworks may motivate both firms and universities. Third, a socio-cultural dimension which includes a society's values, beliefs, attitudes, customs, traditions, culture, and demographic characteristics may either negatively or positively influence the process of knowledge transfer. For example, universities and industry may have a historical tradition of collaborating with each other which is built on mutual trust. And vice versa, there may be no such kind of tradition and both universities and firms may have some negative perceptions about each other.

Based on our observations we may claim that socio-cultural and legal-political dimensions of the environment have a greatest impact on university-industry knowledge collaboration in Kazakhstan. First of all, the legal framework does not support linkages between the agents. Additionally, firms typically mistrust the whole education system and consider research in local universities to be of low quality. The situation is worsened by the absence of historical tradition to cooperate with universities.

The government of Kazakhstan is not yet enough powerful to stimulate both universities and firms to engage in extensive research. The government offers grants to universities which are distributed based on a tough competition. But the amount of grants is still limited, plus, only few research proposals submitted are high quality works. Firms also have an opportunity to apply to some government departments for R&D grants. The only limitation is that grants are mostly provided to companies per

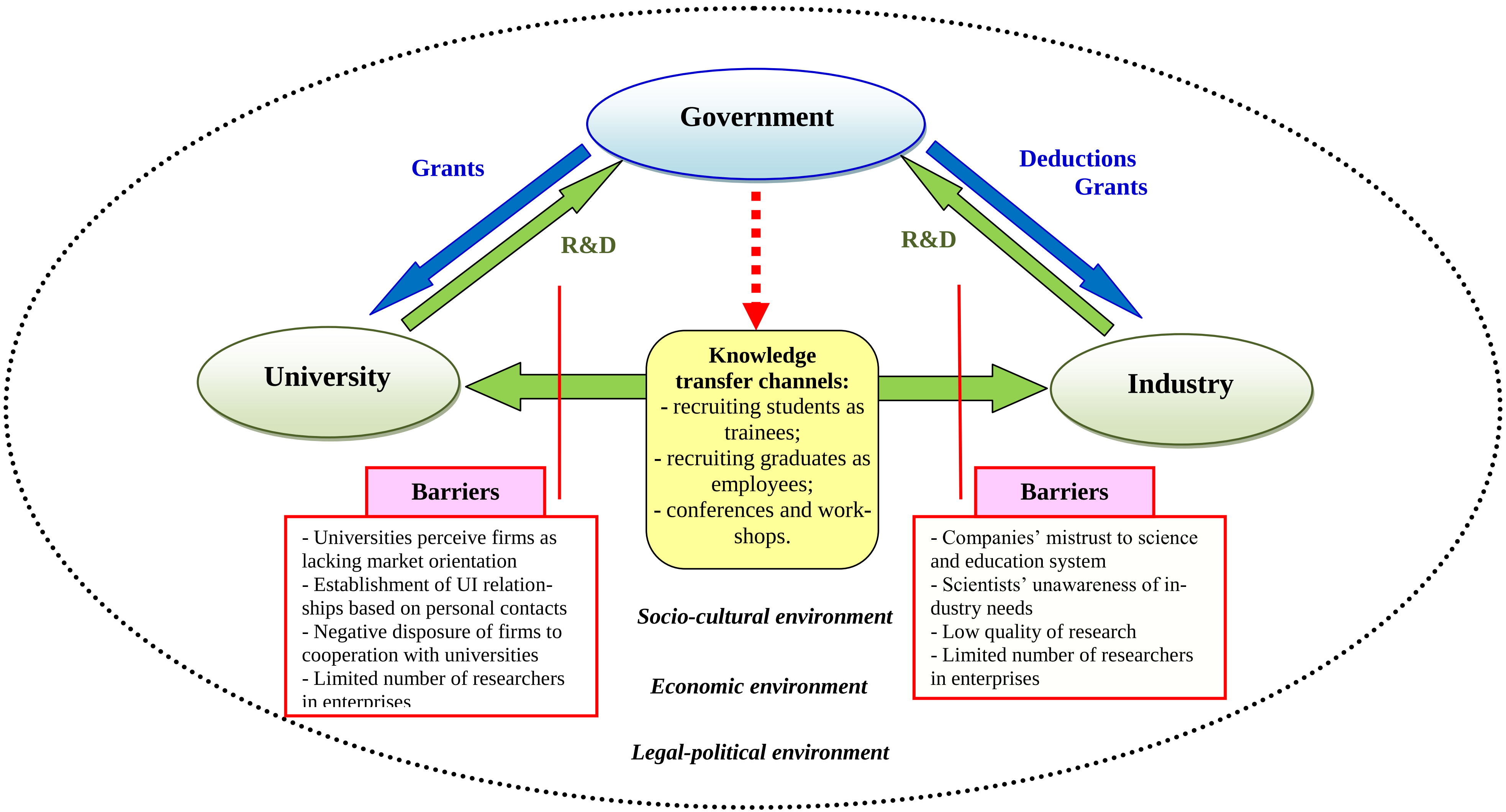

Figure 20 – A Model of University-Industry Knowledge Transfer in Kazakhstan

Note – Drafted by the author

forming high-tech research. Additionally, a more recent initiative of the government to stimulate industrial R&D which was reflected in the latest edition of the *Tax Code* (2013) which offers 50% income tax deductions to firms conducting R&D stipulated that the invention has been already patented. Such a requirement restricts the number of firms participating in R&D.

Government stimulation of university-industry collaboration is shown as a dotted red line in Figure 20 meaning that it virtually doesn't exist today in Kazakhstan. There are no any fiscal or monetary incentives which would motivate both parties to engage in knowledge collaboration. But if the government wants to increase the quality and the quantity of research, stimulation of university-industry linkages should become a concern of future policies.

Given that the government has no any direct influence on university-industry collaboration we can claim that the Triple Helix model is inappropriate in the context of Kazakhstan. The Triple Helix implies balanced interactions between universities, government, and industry. In case of Kazakhstan, there is a balance between no elements, i.e. universities do not actively interact neither with firms nor with the government, companies do not intensively collaborate neither with universities nor with the government, and the government does not provide sufficient support and motivation to neither universities nor firms.

3.5 Main Directions for Improvement of University-Industry Knowledge Transfer in Telecommunications Sector

Our analysis of university-industry collaboration and knowledge transfer in Kazakhstan and in particular in telecommunications sector has identified several global and local issues. Among the global issues are: (i) the lack of integration between science, education, and industry and (ii) the absence of any policies to stimulate university-industry collaboration. These issues are underpinned by some local challenges in the telecommunications sector:

- ✓ Mistrust of companies to science and education system;
- ✓ Low quality of research;
- ✓ Lack of researchers' and scientists' awareness about industry needs;
- ✓ Limited number of researchers and scientists involved in work at enterprises;
- ✓ Establishment of university-industry relationships on the basis of personal contacts;
- ✓ Lack of market orientation of Kazakhstan enterprises.

In the previous section, we described the local problems from universities' and telecommunications firms' perspectives that occur in the forms of a "cluster" and a "vicious cycle". We discovered that these issues are interrelated and one gives rise to another. So, in order to resolve local issues it is necessary to use a complex approach. Addressing local problems would help to deal with global issues. Coming from our research we have summarized our recommendations in Table 20.

First of all, Kazakhstani education system and science have a poor image in the eyes of the representatives of telecommunications firms. Companies are not satisfied with knowledge of graduates which they get for a job. Additionally, many telecommunications firms are not interested in scientific research as they perceive it too theoretical and remote from business realities. To solve this problem the government should develop appropriate policies.

The Ministry of Science and Education of the Republic of Kazakhstan should continue developing reforms to improve the quality of education. The current strategy of enlarging of universities is very relevant, in our opinion. However, decreasing the number of universities by abolishing them or merging into one is not enough to improve the quality of teaching at universities. The government should expand its budget to invest funds into training of academic staff. This can be done by providing both private and public universities with funds on a year by year basis for training their staff in neighboring and western countries.

Table 20 – Author's Recommendations to Resolve the Issues with Collaboration and Knowledge Transfer in the Telecommunications Sector

Challenges	Solutions
Low quality of research	- Continue enlargening of universities; - Provide government funds to universities for training of academic staff in neighboring and western countries; - Modernize standards for writing scientific articles and dissertation theses, adopt international standards; - Focus on empirical research.
Mistrust of companies to science and education system	- Improve the quality of research and education; - The government might involve motivational speakers to foster the dialog between business and education.
Lack of market orientation of Kazakhstan enterprises	- Revise government policies regarding tax deductions and other fiscal incentives to motivate firms engage in R&D
Lack of researchers' and scientists' awareness about industry needs	- The government should develop compulsory personnel mobility programs for large telecommunications firms; - Universities should align their scientific and educational activities with the objectives of telecommunications companies; - Universities should disclose the information about collaboration opportunities
Limited number of researchers and scientists involved in work at enterprises	- The government should develop compulsory personnel mobility programs for large telecommunications firms.
Establishment of university-industry relationships on the basis of personal contacts	- Universities should increase publicity (e.g. disclose universities' or separate researchers' achievements, report on current trends in scientific research, make studies of universities' researchers free available on the websites,
Note: Compiled by the author	

Additionally, the Ministry of Education and Science of RK should modernize the standards for writing scientific articles and dissertation theses and adopt international experience which would result in higher quality studies. Universities should focus on empirical research rather than simple analysis of tables and expression of ideas. These measures would help to improve the quality of research in Kazakhstan.

One of the other problems identified in our study was the lack of market orientation of Kazakhstani enterprises. Excessive profit-orientation without proper identification of customers' needs holds back many industries from rapid growth. Focusing on research to develop new products, services, marketing and competitive strategies would allow companies to become more competitive. However, companies are not much motivated to engage in R&D under the current policy. Therefore, the government should revise it and consider offering 100-200% tax deductions to companies conducting R&D.

Firms can turn to universities to get some research services. However, linkages between the agents are still too weak. The representatives of telecommunications companies claim that universities' researchers and scientists are not familiar with industry needs. We suppose, this is very natural if they don't work closely with telecommunications industry. Universities can increase the probability of collaboration by aligning their scientific and educational activities with the objectives of telecommunications companies and disclosing collaboration opportunities. At the same time, to resolve this issue the government should emphasize personnel mobility programs. For example, at the initial stage such programs may become compulsory for large firms under which both the representatives of universities and firms could give lectures and get access to each other's information.

Additionally, the representatives of universities complained that in case the relationships with telecommunications firms are established they are mostly based on personal contacts rather than merits of the researchers. This is a cultural barrier which is hard to eliminate but it is possible to influence it. Universities with the assistance of the government may increase publicity – disclosure of universities' or separate researchers' achievements, reporting on current trends in scientific research, making studies of universities' researchers free available on the websites, etc. Moreover, the government might involve motivational speakers to foster the dialog between business and education and assist in establishing direct linkages with universities for the transfer of knowledge. This all could help to increase trust of business sector to the education system in general and to universities in particular.

Although there is a lack of direct university-industry collaboration, indirect linkages between the agents which are typically established through the intermediaries are rare, as well. Universities are simply not well integrated into the innovation infrastructure system which holds them back from transferring new knowledge. As has been discussed earlier, the government's latest initiative to create industry clusters might provide a solution to this problem. Moreover, the elements of the innovation infrastructure (technology parks, design offices) should perform their intermediary function better and undertake some proactive actions to involve universities and telecommunications firms in knowledge transfer and the whole innovation system.

CONCLUSION

The results of the dissertation study showed that the creation of effective and rational university-industry collaboration and knowledge transfer is vital for innovative development of Kazakhstan. In this case the role of the government is very important.

The Government of Kazakhstan should focus on developing policy which would provide companies with market incentives to finance R&D. Moreover, the government should concentrate on establishing the tradition of public-private partnerships, or university-industry collaboration. The country already has the needed prerequisites: the legislative framework and the innovation infrastructure, however both are not enough effective.

The analysis of Kazakhstan's legislative framework revealed that one of the main limitations of current innovation policy is excessive focus on technology transfer and complete neglect of knowledge transfer. Yet, it is important to remember that effective technology transfer may be impossible without knowledge transfer. Thus, our research has identified a need for introducing the concept of "knowledge transfer" in the context of Kazakhstan which was defined as follows: the process of exchanging information, ideas, research results, and experiences between firms, universities, research organizations, government and other communities framed by sociocultural characteristics of the agents which fosters the development of innovations in all spheres of the economy.

Based on close scrutiny of theoretical and methodological approaches to the analysis of knowledge transfer between universities and enterprises, we identified and classified channels of knowledge transfer, benefits and barriers which tend to vary depending on the country and/or economic sector. Moreover, in our research we made a theoretical contribution to the literature by grouping the barriers into three categories: common, firm-specific, and university-specific, which have a systemic impact on university-industry knowledge transfer.

The examination of international experiences showed that good governance of university-industry collaboration facilitates production of knowledge which positively contributes to the creation of a knowledge-based society. The governance forms of knowledge transfer may range from the simple use of openly disseminated academic knowledge on the part of firms through long-term university-industry contractual arrangements and technology transfer offices to financial incentives provided by the government. Moreover, the results of our research have shown that the government may be the main facilitator of university-industry relationships. However, the roles played by the governments in developed counties significantly differ from those in developing nations. Thus, the experiences of developed countries in university-industry collaboration showed that the interactions between industry and science have become one of the characteristics of their cultures. The role of the government in these countries diverges from providing direct funding and tax incentives to minimum intervention which is shaped by political and cultural aspects when the parties realize the benefits of mutual collaboration of knowledge transfer.

The governments in emerging economies are less powerful and supportive than those in developed countries which can be partially explained by insufficient policies to foster knowledge transfer between public and private sectors.Companies in developing economies lack absorptive capacities and universities due to limited funding are merely focused on raising skills of the population and acquiring already existing knowledge from industrialized countries. In order to increase funds universities try to substitute government funding by funding through students, donors, and companies but this does not provide higher education institutions with significant financial strengths and improved quality of research which would result in new knowledge. Hence, we agreed with Shiller and Leifner (2007) that the popular concepts of "National Innovation Systems" (Lundvall, 1992) and "Triple Helix" (Etzkowitz & Leydesdorff, 2000) could be hardly applied to developing countries because these theories imply that universities are the key producers and disseminators of knowledge which consequently leads to an innovate output.

In addition to the roles of governments, the results of our research have shown that the number of patent applications in developed countries typically greater than in emergent economies. Based on the analysis of the international database we noticed that business sector in industrialized countries has a dominant share of expenditures on R&D while in many developing nations governments have the highest share in R&D expenditures. Taking into consideration these observations we built several hypotheses for the Central Asia and tested them by using statistical tools to identify the best option for Kazakhstan in terms of R&D funding. The results of hypotheses testing showed that the larger the share of the business sector in financing of science the greater the number of patent applications, which subsequently leads a high innovation performance in the country. Conversely, a significant share of R&D funding by public sector does not lead to an immense increase in the number of patent applications. However, we also found unique cases like Hong Kong and China where the government is the major investor in R&D but at the same time the countries are among the world leaders in innovations. On the basis of our research For Kazakhstan, we recommend the following: the emphasis of R&D funding should be made on business sector and the government should focus on developing policy which would provide companies with market incentives to finance R&D.

The other aspect of our research was focused on the innovation infrastructure which bridges education, science and business. Based on analysis of the economic literature on national innovation systems we provided an elaborated interpretation of the concept of the "innovation infrastructure". According to our research, the innovation infrastructure is defined as a set of knowledge and technological organizations performing innovation activities as well as science and technology intermediaries promoting and facilitating innovation within a particular nation. It is important to note that country-specific definitions may have a focus on the elements of the innovation infrastructure. In case of Kazakhstan, the analysis of legislative definition of the innovation infrastructure which included scrutinizing programs, laws, strategies, and concepts proved the definition to be somewhat blurred. The final definition/composition of Kazakhstan's innovation infrastructure is not yet clearly defined and varies from one legislative document to another.

The analysis of Kazakhstan's innovation infrastructure served as the basis for further evaluation of its effectiveness in the local context. We found several studies (Porter and Stern, 2010; Kelly, 2008) offering the methodology for the evaluation of the effectiveness of the innovation infrastructure which became the foundation for the development of the methodology adapted to Kazakhstan's realities. As a result of our research, we recommend to use five innovation input-transition-output indicators as a measurement instrument of the effectiveness of innovation infrastructure: (1) expenditures on R&D, (2) the number of scientists and researchers employed, (3) the quantity of joint R&D activities, (4) the share of innovation output in GDP, and (5) the number of patents filed. We also suggest evaluate these indicators on a timeline of at least 5-7 years to make up for the negative or positive tendencies.

Finally, taking into consideration the prior analysis of the definition of the innovation infrastructure and the evaluation of its effectiveness we argue that the very creation of the innovation infrastructure in Kazakhstan did not result in an increase of innovation activity. Current spending on R&D is still minimal and comparable to the level of a decade ago. Business entities are innovation passive which results in a low share of innovation output in GDP. Policy analysis showed that Kazakhstani innovation infrastructure is still being shaped and is not yet clearly defined. We support the government's cluster initiative to resolve the issue of the innovation infrastructure, however at the same time to recommend take into consideration geographical remoteness of the elements of the innovation infrastructure and duplication by technoparks each other's specializations.

World experience shows that the attitudes of firms and universities towards collaboration and knowledge transfer differ among countries and among sectors. Both firms and universities recognize enormous benefits that close relationships bring them. In many countries no matter whether developed or developing the agents show positive attitudes towards knowledge collaboration, however, still in every country there is a part of companies that do not want to collaborate for a number of reasons.

In case of Kazakhstan, our findings revealed that there is a significant difference in the opinions of telecommunications companies and universities. The latter are more positively disposed towards university-industry collaboration. Universities which continuously deal with knowledge and typically want to share it are supposed to have more positive attitudes than firms. Companies have less positive attitudes towards knowledge transfer because they may not perceive it as useful as universities do.

Additionally, our research has *revealed* that firms of large vs. medium vs. small sizes have different propensities to collaborate in different countries. Thus, in some nations large firms tend to collaborate more often because they have enough resources and R&D capabilities to do that. Still in other economies firms of medium and small sizes tend to collaborate with universities more frequently because they seek for additional capital to enlarge their limited resources and look for external competencies to compensate for their low capability to undertake R&D. In contrast, our empirical study did not reveal any significant differences in the propensity of telecommunications firms of different sizes to collaborate with Kazakhstani universities. This implies that the attitudes of telecommunications companies in Kazakhstan towards knowledge collaboration do not depend on their sizes. *This finding may be very useful for policy makers developing incentives for firms to collaborate with universities.*

In addition to size effect, some scholars found that business origin may also be a factor influencing firms' attitudes towards knowledge transfer with universities. For example, Veugelers and Cassiman (2005) found that foreign subsidiaries are less willing to engage in relationships with local universities because their central R&D department is located abroad. At the same time, foreign companies operating in developing countries may be more eager than their local counterparts to engage in relationships with universities as this may be their tradition to work close with academia. Concerning foreign firms in Kazakhstan, it seems that they have only their marketing facilities here so their interest in collaboration may be lower than this of local firms. But statistical analysis of the data we collected again didn't show any significant differences in the propensity of foreign and local firms to collaborate with universities. Therefore, the government should develop policies to motivate both resident and non-resident firms in Kazakhstan to build partnerships with educational institutions.

Knowledge between universities and firms may be transferred through a variety of channels: joint R&D, contract research, recruiting graduates or students, lecturing, etc. Typically, universities and firms have different views about the most important channels of knowledge transfer. For example, contract research, employment of graduates, supervision and financing of PhDs and masters' theses are considered to be vital from universities' perspective. In contrast, firms perceive writing masters' thesis as part of a company project are in line with those for firms, lectures by firm members at universities, contract research, joint research, employment of university researchers in business sector to be the most important channels of knowledge transfer. Additionally, the preferences of both universities and firms for the channels vary across sectors and across countries substantially. Therefore, the development of government policies to stimulate university-industry collaboration should take into account the perceptions of both firms and universities about the importance of knowledge transfer channels and the characteristics of knowledge and knowledge transfer in specific sectors / industries.

The results of our research have shown that despite the prevailing traditional channels of knowledge transfer in telecommunications industry, universities perceive joint R&D projects and financing of PhD projects as the most important ones. In contrast, firms consider professional publications and reports, participation in conferences and seminars, and personal (informal) contacts to be essential for the transfer of knowledge.So, there is inconsistency between the knowledge transfer channels employed and the channels perceived to be the most important by both parties.

Our research has shown there are numerous obstacles that hinder university-industry collaboration and knowledge transfer. For example, the main common barriers include the lack of communication between the parties, the lack of information about possibilities for interaction, the lack of mutual trust, the lack of academicians' and industrialists' interest in interactions, and differing cultures.

Similar to the perceptions of knowledge transfer channels, the obstacles perceived by firms are different from those perceived by universities. Thus, the primary firm-specific barriers comprise the lack of time and financial resources, inefficient bureaucracy and red-tape at universities, and the lack of state support to enterprises (e.g. fiscal incentives). The main university-specific barriers include the lack of culture for entrepreneurship at universities, few incentives for researchers to undertake more applicable research, insufficient publicity, and limited state funding of education and research. *In order to reduce the impact of existing obstacles to university-industry knowledge transfer we recommend that the government' role shouldn't be only in developing fiscal incentives for stimulation of collaboration and knowledge transfer between higher education institutions and companies but also in promoting the benefits of such interactions for firms who still neglect the importance closer ties with universities. At the same time, higher education institutions should be proactive in their collaboration strategies and inform companies and society as well about latest scientific research.*

In case of telecommunications sector of Kazakhstan, the main factors hindering university-industry knowledge collaboration (except the absence of any policy in Kazakhstan aimed to stimulate companies to collaborate with universities) are: mistrust of companies to science and education system, low quality of research, insufficient researchers' and scientists' awareness about industry needs, limited number of researchers and scientists involved in work at enterprises, establishment ofuniversity-industry relationships on the basis of personal contacts, and the lack of market orientation ofKazakhstanenterprises. Additionally, our study revealed significant difference in companies' and universities' perceptions of the majority of factors hindering university-collaboration.

The development of the adapted to Kazakhstan model of governance of university-industry knowledge transfer became the concluding part of our dissertation study. We visually depicted the process of knowledge transfer between universities and industry, the channels knowledge transfer practiced in the telecommunications sector, the obstacles to collaboration from both perspectives, and the role of Kazakhstan's government as a facilitator of university-industry relationships. The government of Kazakhstan currently provides some grants for universities and fiscal incentives for companies to engage in R&D but only few firms use this opportunity. For example, one of the incentives for companies is associated with scientific research and development operations which are subject to deductions. Thus, a firm's taxable income is subject to deductions at the rate of 50 per cent of the expenses actually incurred in respective tax periods in connection with the performance of works recognized by the authorized body in the field of science (e.g. scientific research, research engineering, and/or experimental development works). However, there are no any incentives to stimulate R&D collaboration between universities and firms the implication of which was first proposed by Kenzheguzin et al. (2005) eight years ago. Thus, we may claim that Kazakhstan's government is still not enough powerful and does not provide enough instruments to motivate both universities and firms to collaborate with each other. Additionally, the proposed model showed that a widely used in the developed world Triple Helix model in which the government actively facilitates university-industry interactions and knowledge transfer cannot be applied to Kazakhstan.

Given this all, we recommend the state bodies of the country take into account the results of this study to introduce more attractive incentives.

The other important explanation provided by the proposed model includes environmental factors affecting the nature and the process of knowledge transfer. Thus, for example, in addition to economic and legal-political dimensions socio-cultural environment in an economy has one of the most important impacts on the development of university-industry linkages. For example, there is no tradition of close university-industry relationships as well as knowledge transfer in Kazakhstan. It may take years for the state bodies to change this tradition.

With the aim to make collaboration between universities and firms more likely and more effective if educational activities of universities are not aligned with the objectives of companies we recommend the following: (i) state bodies should foster the dialog between business and education sectors, (ii) government policy should be revised to offer fiscal incentives to firms to encourage them to participate in joint research projects with universities, (iii) universities, in turn should focus on high quality applied research rather than just fundamental and improve the quality of teaching to build an image of trustworthiness.

Finally we can conclude that the dissertation is one of the pioneer studies in the field of university-industry knowledge transfer and collaboration in Kazakhstan. Therefore, this exploratory study can serve as a strong basis for future research and, in particular, it may be helpful in formulating relevant hypothesis for more definite investigation. Future research may also focus on similar exploratory studies in other industries such as oil and gas, mechanical engineering, construction and health care.

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APPENDIX A

Table 1.A – Kazakhstan Technology Parks by Activities

No	Name of Technology Park	Year of Establishment	City	Activities
1.	Regional technology park KazNTU named after K. Satpayev/	2004	Almaty	Oil and gas industry, metallurgy, machine industry, information technologies, environment technologies
2.	Regional technology park ‘Algorithm’	2004	Uralsk	Machine building for oil & gas industry, instrument engineering, petrochemistry, environmental technologies
3.	Regional technology park “Sary-Arka” (old name - ‘UniScienTech’)	2004	Karaganda	Mining and metallurgical industry, production of new materials, machine industry, chemical industry, environment and energy saving
4.	Almaty regional technology park	2005	Almaty	Construction technologies, production of building materials, chemical industry, metals industry, and machine industry
5.	Regional technology park of Astana	2007	Astana	Development of technologies in the construction and production of new materials, machine industry
6.	East Kazakhstan regional technology park ‘Altai’	2008	Ust-Kamenogorsk	Production & refining of non-ferrous metals, information technologies, machine industry, environmental technologies, production of new materials
7.	Regional technology park of South Kazakhstan oblast	2008	Shymkent	Chemical technologies of building materials, production and processing of agricultural output, processing of raw hydrocarbons, environmental technologies
8.	North Kazakhstan regional technology park ‘Kyzylzhar’	2009	Petropavlovsk	Resource & energy saving, ecologically pure technologies, new construction materials, information technologies, creative technologies, environmental technologies, astrophysical technologies, research in economics, mining and metallurgy, geology, machine industry, power production, construction, architecture, agriculture and other fields
Note – Compiled by the author based on				

Sources: UNECE. *Innovation performance review of Kazakhstan*. Geneva: United Nations, 2012; NATD. *Report on the state of innovation processes in the Republic of Kazakhstan*. Astana: Analytical Center for Support of Innovative Projects, 2011.

APPENDIX B

Table 1.B – A List of Universities Participated in the Survey

№	Name of the University	Availability of Programs	
		5B070300 Information Systems	5B071900 Radio Engineering, Electronics, and Telecommunications
1	Abai Kazakh National Pedagogical University	v	-
2	Al-Farabi Kazakh National University (KazNU)	v	-
3	Almaty Academy of Economics and Statistics	v	-
4	Almaty Banking Academy	v	-
5	Almaty Technological University	v	-
6	Almaty University of Power Engineering and Telecommunications	v	v
7	Central Asian University	v	-
8	Eurasian Institute of Market	v	-
9	International Academy of Business	v	-
10	International IT University	v	v
11	K.I. Satpayev Kazakh National Technical University (KazNTU)	v	v
12	Kainar University	v	-
13	Kazakh National Agrarian University	v	-
14	Kazakh State Women's Pedagogical University	v	-
15	Kazakh University of Railway Transport	-	v
16	Kazakh-American University	v	v
17	Kazakh-British Technical University	v	-
18	Kazakh-German University	v	-
19	Kazakhstan Engineering and Technological University	v	-
20	Kazakhstan Multidisciplinary Institute “Parasat”	v	-
21	L. Goncharov Kazakh Automobile Road Academy	v	-
22	Suleyman Demirel University	v	-
23	Turan University	v	v
24	University of International Business	v	-

APPENDIX C

Table 1.C – A List of Telecommunications Firms Participated in the Survey

No.	Company Name	Business Origin	Market Positioning
1	JSC "Transtelecom" – affiliate in Almaty “Al-matytranstelecom”	Local company	Systems integrator
2	JSC “ASTEL”	Local company	Communications operator
3	JSC “KazTransCom”	Local company	Internet-provider, telephony services
4	JSC “Kazakhtelecom”	Local company	Communications operator
5	JSC “Kcell”	Local company	Mobile operator
6	LLP “Alcatel – Lucent Kazakhstan”	Foreign representative office	Distributor of telecommunications equipment
7	LLP “Almaty IT Telecom”	Local company	Distributor of telecommunications equipment
8	LLP “Aspan ProTech”	Local company	Internet-provider
9	LLP “ASPAN Telecom”	Local company	Internet-provider
10	LLP “D-LINK INTERNATIONAL PTE Ltd (Singapore)”	Foreign representative office	Representative office of the producer of telecommunications equipment
11	LLP “Ericsson Kazakhstan”	Foreign representative office	Systems integrator, distributor of telecommunications equipment
12	LLP “Newtech Distribution”	Local company	Systems integrator
13	LLP “RRC Kazakhstan”	Local company	Distributor of telecommunications equipment
14	LLP “Skymax Technologies”	Local company	Systems integrator
15	LLP “Tandem TVS”	Local company	Systems integrator
16	LLP “TEGRA Kazakhstan”	Local company	Systems integrator, distributor of telecommunications equipment
17	LLP “TNS-Service”	Local company	Systems integrator
18	LLP “ZyXEL Kazakhstan”	Foreign representative office	Representative office of the producer of telecommunications equipment
19	LLP “Asia Intercommunications”	Local company	Systems integrator
20	LLP “Bazis-Telecom”	Local company	Communications operator
21	LLP “Iskracom”	Local company	Systems integrator, distributor of telecommunications equipment
22	LLP “KKInterconnect”	Local company	Production and repair of telecommunications equipment
23	LLP “Mobile Telecom-Service”	Local company	Mobile operator
24	LLP “Obit Telecommunications”	Foreign representative office	Systems integrator, internet-provider
25	LLP “Representative Office of Cisco in Kazakhstan”	Foreign representative office	Representative office of the producer of telecommunications equipment
26	LLP “Resolution”	Local company	Integrators – construction of communication networks
27	LLP “TC Compan”	Local company	Systems integrator
28	LLP “Huawei Almaty”	Foreign representative office	Distributor of telecommunications equipment

APPENDIX D

Questionnaire for Universities

1. Provide the name of your university ____
____

2. Specify the type of ownership of your university
   - ○ National University
   - ○ State University
   - ○ Private commercial university
   - ○ Private Non-Commercial University

3. What is the number of students at your university?
   - ○ Less than 2000
   - ○ 2000-4000
   - ○ 4000-6000
   - ○ 6000-8000
   - ○ More than 8000

4. Mark the programs offered at your university
   - ☐ 5B070300 Information systems
   - ☐ 5B071900 Radio engineering, electronics and telecommunications

5. To what extent do you agree or disagree with the statements below concerning the impact of knowledge transfer on students and academic staff? (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree)

	Statements	**Strongly disagree**	**Disagree**	**Undecided**	**Agree**	**Strongly agree**
a)	Establishing links between universities and business is/can be beneficial for both sides, through the transferring of knowledge and ideas, and giving students practical experience	1	2	3	4	5
b)	Having an opportunity to provide consultancy to companies is/can be a useful practice for our university students and academic staff	1	2	3	4	5
c)	Closer relationships between universities and industry enables business to influence courses so that universities produce students more prepared for the world of modern business	1	2	3	4	5
d)	Encouraging academic staff and students to do research in business is useful to students and researchers, in that they are able to gain first-hand, practical experience	1	2	3	4	5
e)	Practical experience is essential for students to gain full understanding of the theories and abstract concepts learned in the classroom	1	2	3	4	5
f)	Students already acquainted with the realities of industry and the business world creates better employees	1	2	3	4	5

6. To what extent do you agree or disagree with the statements below concerning university-industry research collaboration?

	Statements	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
a)	Enterprise management is often negatively disposed towards the cooperation with universities	1	2	3	4	5
b)	New knowledge is too expensive for enterprise	1	2	3	4	5
c)	University-industry relationships are always established on the basis of personal acquaintances	1	2	3	4	5
d)	Enterprises in Kazakhstan lack market orientation	1	2	3	4	5
e)	There are few researchers and scientists in enterprises	1	2	3	4	5
f)	Researchers and scientists from universities are not familiar with industry's actual needs	1	2	3	4	5
g)	Research conducted in Kazakhstani universities is usually of low quality	1	2	3	4	5
h)	State should provide appropriate tax relief to enterprises engaged in research and development	1	2	3	4	5

7. Rate the channels of knowledge transfer on an importance scale, where 1 – unimportant, 2 – of little importance, 3 – moderately important, 4 –important, 5 – very important

	Statements	Unimportant	Of little importance	Moderately important	Important	Very important
a)	Scientific publications in journals or books	1	2	3	4	5
b)	Other publications, including professional publications and reports	1	2	3	4	5
c)	Personal (informal) contacts	1	2	3	4	5
d)	Patent texts, as found in the patent office or in patent databases	1	2	3	4	5
e)	Participation in conferences and workshops	1	2	3	4	5
f)	University graduates as employees	1	2	3	4	5
g)	Students working as trainees	1	2	3	4	5
h)	Joint R&D projects	1	2	3	4	5
i)	Flow of university staff members to industry positions	1	2	3	4	5
j)	Consultancy by university staff members	1	2	3	4	5
k)	Financing of Ph.D. projects	1	2	3	4	5
l)	Staff holding positions in both a university and a business	1	2	3	4	5
m)	Licenses of university-held patents and 'know-how' licenses	1	2	3	4	5
n)	University spin-offs (as a source of knowledge)	1	2	3	4	5
o)	Sharing facilities (e.g. laboratories, equipment, housing) with universities	1	2	3	4	5

Table for question 7 continued

	Statements	Unimportant	Of little importance	Moderately important	Important	Very important
p)	Temporary staff exchange (e.g. staff mobility programs)	1	2	3	4	5
q)	Contract-based in-business education and training delivered by universities	1	2	3	4	5
r)	Other_____________________________ (specify)	1	2	3	4	5

8. Does your university have any relationships with telecommunications companies?
   - ○ Yes
   - ○ No

Please, proceed answering the questions if you responded 'Yes' to question 5 and stop here if you responded 'No'

9. With how many telecommunications companies does the university collaborate permanently?
   - ○ 1-3
   - ○ 4-6
   - ○ 7-9
   - ○ 10 or more

10. List the names of telecommunications companies with which you collaborate
   - ☐ Kazaktelecom
   - ☐ Kcell
   - ☐ Beeline
   - ☐ Astel
   - ☐ Transtelecom
   - ☐ Other (specify):
   - ☐ ______________________________
   - ☐ ______________________________
   - ☐ ______________________________
   - ☐ ______________________________

11. Do you plan to continue collaborating with these companies in the future?
   - ○ Yes
   - ○ No
   - ○ Don't know

Thank you!

APPENDIX E

Questionnaire for Telecommunications Firms

1. Provide the name of your company ____
____

2. To which category of business does your organization refer?
   - ☐ Small Business
   - ☐ Medium Business
   - ☐ Large Business
   - ☐ Other

3. Specify the origin of your business
   - ☐ Local company
   - ☐ Foreign representative office

4. How is your company positioned in the market of Kazakhstan?
   - ○ Systems integrator
   - ○ Communications service provider
   - ○ Internet-provider
   - ○ Distributor of telecommunications equipment
   - ○ Other ____

5. To what extent do you agree or disagree with the statements below concerning the impact of knowledge transfer on students and academic staff? (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree)

	Statements	**strongly disagree**	**disagree**	**Undecided**	**agree**	**strongly agree**
a)	Establishing links between universities and business is/can be beneficial for both sides, through the transferring of knowledge and ideas, and giving students practical experience	1	2	3	4	5
b)	Having an opportunity to provide consultancy to companies is/can be a useful practice for our university students and academic staff	1	2	3	4	5
c)	Closer relationships between universities and industry enables business to influence courses so that universities produce students more prepared for the world of modern business	1	2	3	4	5
d)	Encouraging academic staff and students to do research in business is useful to students and researchers, in that they are able to gain first-hand, practical experience	1	2	3	4	5
e)	Practical experience is essential for students to gain full understanding of the theories and abstract concepts learned in the classroom	1	2	3	4	5
f)	Students already acquainted with the realities of industry and the business world creates better employees	1	2	3	4	5

6. To what extent do you agree or disagree with the statements below concerning university-industry research collaboration?

	Statements	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
a)	Enterprise management is often negatively disposed towards the cooperation with universities	1	2	3	4	5
b)	New knowledge is too expensive for enterprise	1	2	3	4	5
c)	University-industry relationships are always established on the basis of personal acquaintances	1	2	3	4	5
d)	Enterprises in Kazakhstan lack market orientation	1	2	3	4	5
e)	There are few researchers and scientists in enterprises	1	2	3	4	5
f)	Researchers and scientists from universities are not familiar with industry's actual needs	1	2	3	4	5
g)	Research conducted in Kazakhstani universities is usually of low quality	1	2	3	4	5
h)	State should provide appropriate tax relief to enterprises engaged in research and development	1	2	3	4	5

7. Rate the channels of knowledge transfer on an importance scale, where 1 – unimportant, 2 – of little importance, 3 – moderately important, 4 –important, 5 – very important

	Statements	Unimportant	Of little importance	Moderately important	Important	Very important
a)	Scientific publications in journals or books	1	2	3	4	5
b)	Other publications, including professional publications and reports	1	2	3	4	5
c)	Personal (informal) contacts	1	2	3	4	5
d)	Patent texts, as found in the patent office or in patent databases	1	2	3	4	5
e)	Participation in conferences and workshops	1	2	3	4	5
f)	University graduates as employees	1	2	3	4	5
g)	Students working as trainees	1	2	3	4	5
h)	Joint R&D projects	1	2	3	4	5
i)	Flow of university staff members to industry positions	1	2	3	4	5
j)	Consultancy by university staff members	1	2	3	4	5
k)	Financing of Ph.D. projects	1	2	3	4	5
l)	Staff holding positions in both a university and a business	1	2	3	4	5
m)	Licenses of university-held patents and 'know-how' licenses	1	2	3	4	5
n)	University spin-offs (as a source of knowledge)	1	2	3	4	5
o)	Sharing facilities (e.g. laboratories, equipment, housing) with universities	1	2	3	4	5

Table for question 7 continued

	Statements	Unimportant	Of little importance	Moderately important	Important	Very important
p)	Temporary staff exchange (e.g. staff mobility programs)	1	2	3	4	5
q)	Contract-based in-business education and training delivered by universities	1	2	3	4	5
r)	Other_____________________________ (specify)	1	2	3	4	5

8. What are the benefits of companies from collaboration with universities? Choose maximum 3 answers.
- ☐ Access to competencies and expertise developed at universities
- ☐ Access to highly qualified workers
- ☐ Access to innovative technologies
- ☐ Development of a new product or service
- ☐ Access to a scientific network
- ☐ Risk-sharing regarding the innovation
- ☐ Other ____
- ☐ No benefits

9. What would make a future collaboration between companies and universities more likely or more effective? Please, choose only one answer.
- ○ Greater awareness of collaboration opportunities
- ○ Alignment of university activities with business objectives
- ○ More generous tax incentives
- ○ Less administrative red tape
- ○ Other ____

10. Does your company collaborate with any university(-ies)?
○ Yes ○ No

Please, continue with the questionnaire if you answered "Yes" to Question #10.
Go to Question #15 if you answered "No".

11. With how many universities does your company collaborate on a permanent basis?
○ 1-3 ○ 7-9
○ 4-6 ○ 10 and more

12. Choose universities with which your company collaborates.
- ☐ Al-Farabi Kazakh National University
- ☐ Kazakh National Technical University after K.I. Satpayev
- ☐ Almaty Technology University
- ☐ Kazakh-British Technical University
- ☐ Kazakhstan Engineering Technological University
- ☐ International University of Information Technologies
- ☐ Almaty University of Power and Communications
- ☐ Kazakh Academy of Transport and Communications named after M. Tynyshpayev

Other (specify):
- ☐ ____

13. What are the common forms of collaboration between your company and universities? Several answers are possible.

- ☐ Participation in conferences and workshops
- ☐ Joint R&D projects
- ☐ Joint publications
- ☐ Recruiting university graduates as employees
- ☐ Recruiting students working as trainees
- ☐ Consultancy by university staff members
- ☐ Financing education of students with further employment
- ☐ Staff holding positions in both a university and a business
- ☐ Purchasing licenses of university-held patents and ‘know-how’ licenses
- ☐ Sharing facilities (e.g. laboratories, equipment, housing) with universities
- ☐ Temporary staff exchange (e.g. staff mobility programs)
- ☐ Contract-based in-business education and training delivered by universities

14. Do you plan to continue collaborating with these universities in the future?

○ Yes ○ No ○ I don’t know

Stop here. Question #15 is for those who answered “Yes” to the Question #10.

15. Do you plan to engage in any collaborations with universities in future?

○ Yes ○ No ○ I don’t know

Thank you!