MODELLING THE ROLE OF UNIVERSITY-INDUSTRY COLLABORATION IN THE IRANIAN NATIONAL SYSTEM OF INNOVATION: GENERATING TRANSITION POLICY SCENARIOS

By

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DECLARATION

This thesis is submitted in fulfilment of requirements of the degree of Doctor of Philosophy (Management) at the University of Stirling, Scotland, United Kingdom. I declare that this thesis is based on my original work except for quotations and citations which I have duly acknowledged. I also declare that this thesis has not previously or concurrently submitted, either in whole or part, for any other qualification at the University of Stirling or other institutions. I am responsible for any errors and omissions present in the thesis.

Signed

Omid Ali Kharazmi

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ABSTRACT

In a knowledge-based economy the collaboration between university, industry and government is vital for growth and innovation (Etzkowitz, 2008). A conceptual model of the relevant macro and micro environment was developed using the theoretical constructs from the literature on systems of innovation theories including, National Systems of Innovation, Porter's 'Cluster' or 'Diamond' model, and the 'Triple-Helix Model' of university–industry-government interactions. The role of culture and trust in different systems of innovation theories was examined, and the role these elements play in UIC activities was found to be particularly important, though vague on the processes.

A generic model of university-industry-government interrelations was developed to aid a systemic understanding of the mechanisms (primary barriers and drivers) for productive collaboration. This systems model was used in the formation of policy instruments designed to improve university-industry collaboration (UIC), and thereby the means of regional economic development.

These policy experiments are applied to the case of Iran. However, since the future of Iran in this context is highly uncertain due to cultural, political and economic factors there are few assumptions which can be relied upon as a basis for traditional innovation management practice. Instead, it is intended to use the systems model in a series of scenario-based analyses of the effectiveness of policy instruments on the UIC associated with two Iranian cluster industries. A questionnaire survey and a series of semi-structured stakeholder interview methodology were used to build a basis for these scenario techniques. The method of systems modelling to generate policy change scenarios for UIC is a novel feature of this research.

Analysis of the causal relationships of UIC activities in Iran found many were biased to create an established behaviour pattern (culture) which is overwhelmingly negative. This negative behaviour is manifest as a significant lack of trust at all interfaces between the primary actors in the system.

According to the results of this research, trust is influenced by many factors including government activities, institutional structure, institutional culture, and also national culture of the country. The systems model is a complex interaction of reinforcing loops that emphasizes the scale of challenge policy-makers face in creating effective innovation systems, and may explain why few developing countries have been successful in achieving economic transition.

This research shows how a policy development framework was formed using the UIC systems model to understand the structural problems facing Iran. A set of evolved states (exploratory and future-backward scenarios) served to illustrate the effect of these policy choices, and therefore to inform an improvement agenda for UIC activities in Iran.

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ABBREVIATIONS

AST	Asset Management
DSG	Dynamic Scenario Generator
DSM	Dynamic Systems Model
FDI	Foreign Direct Investment
GOV	Government
IPRs	Intellectual Property Rights
KTP	Knowledge Transfer Partnerships
LC	Leadership and Culture
MIM	Ministry of Industry and Mines
MSRT	Ministry of Science, Research and Technology
NGO	Non-Governmental Organization
NIS	National Innovation System
NLS	National Learning System
OC	Organizational Capabilities
OS	Organizational Structures to Coordinate and Support Partnerships
SSM	Soft Systems Methodology
TCO	Technology Cooperation Office
TH	Triple Helix
TNCs	Transnational Corporations
TT	Technology Transfer
TTO	Technology Transfer Office
UIC	University-Industry Collaboration
VC	Venture Capital
WTO	World Trade Organization

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Learning and innovation are critical drivers to economic development and competitiveness (Todtling and Trippl, 2005). Although the role of technological innovation in the economic growth of developed countries has been studied in depth, there has been little examination of the determinants of technological innovation and the critical factors for successful industrial innovation of developing nations. Furthermore, enterprise in developing countries remains technologically underdeveloped due to the absence of a climate of innovation. Creating such a climate is vital in order to promote and support sustained innovation efforts. The establishment of National Systems of Innovation may be seen as vital to create a climate to inter-connect and co-ordinate all relevant agents and manage institutional networking in the country (Baghernejad, 2006).

The innovative performance of firms depends largely on the effectiveness of four types of flow. These include the effectiveness of knowledge flow; effectiveness of financial capital flow; effectiveness of human capital flow; and effectiveness of regulatory flows which include the extent that government design effective policies and regulations in order to facilitate innovation in the country (Rooks and Oerlemans, 2005).

The National Innovation System (NIS) theory was first introduced by Freeman (1987) and Lundvall (1992). According to Sharif (2006) other theories and approaches compete with the NIS concept, including Michael Porter's 'Cluster' or 'Diamond' model (1990), the ‘Triple-Helix Model’ of university–industry-government interactions developed mainly by Henry Etzkowitz and Loet Leydesdorff (1997, 1998, 2000), and the ‘New Production of Knowledge’ approach of Gibbons (1994). From this literature; university, industry and government are identified as the main pillars of many innovation systems theories including NIS, Triple Helix and Porter’s Diamond Model.

According to Etzkowitz (2008) in a knowledge-based economy the collaboration between university, industry and government is vital for growth and innovation. Universities and industry together are the important players in securing competitive advantages for society at both the macro and micro levels; by the way they organize and implement dependent activities. The university-industry relationship bridges the gap between university research, technology development and market application (Mitra and Formica, 1997).

For many decades developing countries obtained technological assets through technology transfer from developed countries to upgrade their industrialization activity. However, sometimes they were faced with difficulties in this process since these transferred technologies did not necessarily lead to economic growth. As a result of these barriers, there is a growing awareness in some developing countries to shift the traditional technology transfer practice to the development of a Triple Helix of university-industry-government relations in order to provide a sustainable basis for their innovation and technological progress (Saad and Zawdie, 2005).

In the Triple Helix model universities play an innovative role in the country and are active in traditional tasks as well as research; entrepreneurial training and community development. In this model, industry engages in the transfer of innovations as well as endogenous innovation. This model also expects government to achieve an appropriate balance between intervention and non-intervention (Dzisah and Etzkowitz, 2008).

Many countries are currently attempting to create and foster a climate for entrepreneurship in order to develop an innovative environment. Such activities include: supporting spin-off formations from universities; creating hybrid and not-for-profit institutions; functioning as interfaces; and developing science and technology parks and incubators (Leydesdorff, 2003).

The current study is of the Iranian context. Diversification is necessary for Iran, for two reasons. Firstly, natural resources do not give a competitive advantage in the long run and are exhaustible, and secondly penetration into world markets requires both knowledge-intensive production and innovation-based competition. Creating comprehensive National Systems of Innovation is a prerequisite of moving towards a more knowledge-based economy (United Nations, 2005; Masoumzadeh, 2006; United Nations, 2006). Although the process of designing a NIS for Iran began in 2003, there are several technology-supporting institutions and policy instruments which function in isolation and occasionally in conflict; there are also many deficiencies in the system (Ghazinoory, 2003; Mani, 2004). This situation leads to the emergence of a fractured innovation system in the country (Mani, 2004). Iran's main concerns regarding the reinforcement of a national innovation system are: how to attract new entrepreneurs, to promote an innovation culture; and finally, what role universities can play to promote innovation and entrepreneurship (United Nations, 2006). In Iran university-industry interaction existed for many decades but it took place in an adhoc manner. In the last ten years this has become an important issue for discussion (Ghaffari, 2000).

A primary objective of Iran is to become a developed nation and the principal economic power in the region by 2025. In order to achieve this and because of the uncertain environment, Iran recently shifted its interest from traditional economic planning to multiple scenario methods (Paya and Baradaran Shoraka, 2009).

1.2 MOTIVATION FOR CONDUCTING THIS RESEARCH

The academic motivation for this study is to address the significant gaps in the literature relating to the completeness of UIC systems theories and their connection to national systems of innovation. These are explained more fully in the following section.

The personal motivation to carry out this research was largely determined by the researcher's previous academic background in technology transfer from universities to industry and relevant working experience on Technology Parks in Iran (Mashhad). Research carried out by Kharazmi (2006) considered a "Bottom-Up" approach, focusing on Micro-Environmental issues of UIC in Iran and revealed the lack of efficient mechanisms for UIC decreased motivation for university and industry to collaborate with each other. Results showed that some of these issues are beyond the capacity of these two organizations to manage the situation, therefore the necessity to conduct a "Top-Down" approach to consider the Macro-Environmental impact and the role of government (Kharazmi, 2006). These two reasons prompted the researcher to evaluate UIC in a wider context and to consider the impact of the Micro and Macro environmental issues on UIC performance in order to build a more comprehensive picture of UIC activities in general and Iran in particular.

1.3 FOCUS OF THE STUDY

Despite the significant progress in both theory formulation and practice, little progress has been achieved in the development of a universal approach that addresses the issues related to UIC activities. Observation of the success or failure in various countries provides evidence of this, where similar methods were used in order to create an environment favourable to UIC activities, resulting varying degrees of success. This study develops a generic model of university-industry-government interrelations with the aim of identifying the basic factors in the system - primary barriers to and potential drivers of industrial development – for subsequent use in the formation of policy instruments for improving university-industry collaboration (UIC), and thereby the means of regional economic development. These policy experiments will be applied to the case of Iran. However, since the future of Iran in this context is highly uncertain due to cultural, political and economic factors there are few assumptions which can be relied upon as a basis for traditional innovation management practice. Instead, it is intended to use identified factors in a series of scenario-based analyses of the effectiveness of policy instruments on the UIC associated with two major Iranian industries (Automotive and Biotechnology). A systems thinking and modelling approach was used to generate policy change scenarios.

Various studies (Lee, 1996; Liu and Jiang, 2001; Siegel et al, 2004; Debackere and Veugelers, 2005; Freitas et al., 2009) introduced different ways that researchers within universities could be motivated to collaborate with industry. Other studies (Laukkanen, 2003; Rene and Heinrich, 2006; Decter et al., 2007) identified different approaches to motivate universities to collaborate with industry. Furthermore, a body of research (James and Casey, 2004; Lee and Win, 2004; Radas, 2005; Decter et al., 2007; Dooley and Kirk, 2007; Freitas et al., 2009) considered different factors that can motivate companies to collaborate with universities. Various studies (Andersson, 2000; Rynes et al., 2001; Siegel et al., 2004; Debackere and Veugelers, 2005; Mowery et al., 2004; Siegel and Phan, in Libecap, 2005; Decter et al., 2007; Kleyn et al., 2007; Woolgar, 2007; Jordan et al., 2009; Sala et al., 2009) have been suggested different factors for promoting UIC, whilst others (Lee, 1996; Liu and Jiang, 2001; WIPO, 2002;

James and Casey, 2004; Bouhamed et al., 2009; Singer and Peterka, 2009) have uncovered major barriers to UIC. The current study focuses on identifying the important drivers and barriers to the motivation of university researchers to collaborate with industry and universities as an institution and companies to collaborate with each other. This study is based on the UIC systems in Iran.

The literature highlights culture and trust as important ingredients which have an impact on overall success of different theories of systems of innovation and UIC activities. For example, Koeszegi (2004), Hoecht (2004), NCURA (2006), Santoro and Bierly (2006), Thune (2007), and Bouhamed et al., (2009) found that trust is a main ingredient for the success of UIC. According to Elmuti et al., (2005) and Plewa and Quester (2007) trust and cultural similarities are the major success factors for UIC. There are important cultural norms, including trust, where commonality can facilitate interactive learning in a regional innovation system (Cooke and Morgan, 1998). Socio-institutional and cultural factors have been identified as having a significant role in shaping science, research and innovation (Ney, 1999). Trust has been uncovered as a key component for success of a regional innovation system (Cooke, in Braczyk et al., 1998; Niosi and Bas, 2001; Chung, 2004). In fact, trust is considered as one of the most critical ingredients for the success of any kind of complex relationships between partners including in the Triple Helix Model (Hakansson and Snehota, 1995). According to Huxham and Vangen (2005) and Karaev et al., (2007) trust is a necessary precondition for collaboration between different actors in every cluster as well. Cultural factors also have a great impact on the success of industrial clusters (Valery, 1999; Koh and Koh, 2002).

Tillmar (2006) mentioned that, trust can be either influenced by national culture of the country or regulations and laws of that country. Doney et al., (1998) found that trust is influenced by national culture, intermediate institutions, relational factor, and also individual circumstances. Williams and McGuire (2008) found each culture supports innovation, risk-taking and team-working activities differently.

A weakness of Porter’s Diamond Model highlighted by O’Shaunghnessy (1996) and the National Systems of Innovation theory (Ney, 1999) is their account of culture. Although the Triple Helix system of innovation theory and its related literature highlights the importance of interactions and trust in UIC activities (Hakansson and Snehota,1995), there is no systematic mechanism to explain these interactions. Furthermore, De Wever et al., (2005) found that Business and Management research generally has been designed based on an assumed steady state of trust. Therefore, in the interest of completeness future research focus should consider the dynamic evolution of trust in inter-organizational networks.

Although the literature (related to NIS, Porter’s Diamond Model and Triple Helix’ concepts) highlights some of the features of university-industry-government collaboration and the role that culture and trust can play; there is a distinct lack of process models that can help politicians, businessmen and researchers who are involved with setting up and designing these collaborations.

Systems thinking is a tool for understanding how things work. It is a framework to look beyond events and scrutinise for patterns of behaviour (Senge, 1990). Various studies (Lee and Tunzelmann, 2005; Galanakis, 2006; Brown and Smith, 2009) confirm that a systems thinking approach can be an appropriate means to illustrate the complexity of innovation and also to understand it more easily. Although some researchers have tried to introduce the dynamic behaviour of NIS and related theories in general (e.g. Galanakis, 2006); no research has focused on the systematic behaviour models for university-industry collaboration.

In a situation where the degree of uncertainty of important factors is increasing (funding, market conditions, policy stability etc.), traditional planning tools are useless (Drucker, 1995). Instead, scenario development would be an appropriate approach in order to increase the quality of our present decision making (Ratcliffe, 2000). Many approaches are recognized in the literature as a base for building scenarios. The Delphi technique and systems thinking are widely accepted as a sound methodological base for scenario development (Garret in Slaughter, 1966; Mercer, 1995). Although scenario development has been employed before on UIC concepts (in simple forms such as scenario matrix e.g. Harper and Georghion, 2005); there is no research related to UIC scenarios based on a systems thinking approach.

Many innovation system theories including Triple Helix, NIS, and Porter's Diamond Model considered a transitional stage for the countries that want to achieve the states of a knowledge-based economy. For example according to Etzkowitz and Leydesdorff (2000), Triple Helix can be considered as an evolutionary model consisting of three stages of evolution (Triple Helix1, Triple Helix2, and Triple Helix3). The most advanced state is Triple Helix 3 in which the relationships between university, industry and government are strong and organically arranged between university and industry, and are encouraged but not controlled by government. Viotti (2002) used different terminology for NIS and suggested that each stage of transition of a NIS could be distinctly recognized, for example, for late industrializing economies the concept of a National Learning System (NLS) is proposed and takes two forms: passive learners (e.g. Brazil) and active learners (e.g. South Korea). Viotti (2002) suggested that only those countries in which the process of technical change is essentially a process of innovation can be considered as countries with strong NIS. Similarly, Porter (1990) identified four evolutionary stages of competitive development (see Section 3.5.1). The current study focuses on developing an accurate systems model of UIC activities and behaviours, and then uses this model to form an Iranian specific set of transition policy scenarios that illustrate a staged evolution of the country towards a knowledge-based economy.

The main research question in this investigation is; "**what policy instruments enhance university-industry collaboration to transit Iran toward a knowledge-based economy?"**

As this question was addressed during the research it became necessary to deconstruct it further into four sets of sub-questions:

1. Understand the problem by establishing the factors from the literature, models and evidence from other countries relating to University Industry collaboration. Can this information be conceptualized into a useable model? What methods can be used to examine policy changes on UIC performance?
2. The second set of questions are to examine the relevant drivers and barriers to collaboration between University research groups and Industry in Iran:
    a. What factors motivates the individual within universities to collaborate with industry?
    b. What factors motivates universities to collaborate with industry?
    c. What factors motivates industry to collaborate with universities?
    d. What factors are barriers to any UIC?
    e. What changes are likely to promote more effective UIC?
    f. What are the uncertainties due to these factors?
    g. What are the roles of culture and trust in these relationships?

This stage concludes with the refinement of the conceptual model from stage one into a detailed systems model using the Iranian UIC case.

3. How can these factors be combined into a coherent dynamic model to understand change impact and plan policies?
    a. How do policy changes affect university- industry collaboration?

b. How would these policy instruments change the behaviour of actors in a UIC system?
c. How are these change forces incorporated into the systems model?
d. How are policy changes for university-industry collaboration enhancement reflected in transition scenarios for the case of Iran's shift toward a knowledge-based economy?

4. How can these policy instruments be tested and validated?

1.4 STRUCTURE OF THE THESIS

This thesis comprises fourteen chapters. Following this Introduction, Chapter 2 provides an overview of the literature related to the context of this study which is Iran. This chapter begins with introducing the country's background, and then evaluates the Iranian National Systems of Innovation. Important Iranian industrial sectors and education establishments are described, and future technological priorities of the country discussed. Finally, the situation of UIC in Iran is evaluated.

Chapter 3 provides a review of the relevant theoretical and empirical literature on different systems of innovation theories and considers the role of UIC in this regards. Furthermore it investigates the role of trust and culture in different systems of innovation theories. The chapter reviews literature and approaches that related to the macro-environment of UIC which are relevant to the research problem identified for this study. Based on the review of the literature, relevant variables and factors affecting UIC activities from macro-environment perspectives are identified.

Chapter 4 provides an overview of the literature and approaches related to the micro economic environment of UIC. This chapter chiefly discusses different mechanisms of technology transfer from universities to industry, and also highlights different motivational factors for various stakeholders in the UIC process, the barriers to and incentives for technology transfer. Based on the review of the literature, relevant variables and factors affecting UIC activities from micro-environment perspectives are identified.

Chapter 5 focuses on the literature related to the role of culture and trust for success of UIC and economic development. Different processes and mechanisms for trust formation are also examined. This chapter also explores the relationship between culture and economic development. It also discusses the role of culture and trust in the Iranian context.

Chapter 6 provides an overview of the literature related to systems thinking and examines the applicability of using this approach in different innovation systems theories.

Chapter 7 provides an overview of the literature related to scenario development. It explains the applicability of scenario development techniques in UIC, and highlights related techniques for developing scenarios including the systems thinking approach.

Chapter 8 discusses research method and methods of data analysis. The research problems and research questions are presented based on the gaps that exist in the literature. This stage is conceptualization, which is required in order to explore the problem. In addition this chapter provides the justification for the research philosophies, research strategies as well as explaining the research process. Furthermore this chapter explains the designs of the questionnaire to validate the conceptualization of the model, the interviews, which are designed to add a dynamic aspect to the research, to confirm the strengths of the components of the model, and to enable construction of future scenarios. The way the scenarios are validated by panels of experts is also discussed.

Chapter 9 presents the results for survey. Findings are presented in tables that identify the crucial scenario driving forces from both university and industry points of view. In addition, major stages which are the prerequisites of scenario development including scenario logics, scenario themes, and patterns of behaviour are developed in this chapter. Two industry sectors considered in this study, and also university and industry are compared together using the Mann Whitney test.

Chapter 10 and 11 present the results of interviews. The former describes the way that a systems model for developing scenarios is constructed based on a systems thinking approach. The latter provides scripts for the first, second and third scenarios. Chapter 12 is designed to validate the results of scenarios developed in chapter 11.

Chapter 13 focuses on discussion of the findings which combine the quantitative and qualitative data sets by comparing and contrasting them with the literature and provides conclusions on the research questions.

The theoretical and practical implications of the study are discussed and outlined in chapter 14, together with the strengths and limitations of the study, and suggestions for future research.

CHAPTER 2

CONTEXT OF STUDY (IRAN)

2.1 INTRODUCTION

The Islamic Republic of Iran has an area equal to that of France, UK, Spain and Germany combined (Nicholson and Sahay, 2003), with a population of approximately 73 million and a literacy rate of over 90% (World Bank, 2009). Iran is the second-largest OPEC oil producer; its gas reserve ranked as 2nd in the world (World Bank, 2001).

The process of designing an NIS for Iran began in 2003. However, there are several technology-supporting institutions and policy instruments which function in isolation and occasionally in conflict and there are also many deficiencies in the system. This situation led to the emergence of a fractured innovation system in the country (Ghazinoory, 2003; Mani, 2004). Mani (2004) found that Iran could learn from the experiences of Malaysia and South Africa in designing an effective innovation policy. Iran's main concerns regarding the reinforcement of a national innovation system are: how to attract new entrepreneurs, to promote an innovation culture; and finally, what universities could do to promote innovation and entrepreneurship (United Nations, 2006).

This chapter provides an overview of the literature related to the Iranian context of this study. Beginning with introduction to the recent history of Iran; furthermore, it evaluates the Iranian National System of Innovation. Iranian industrial sectors as well as universities are described and the future technological priorities of the country are highlighted. Finally, the situation of UIC in Iran is evaluated.

2.2 RECENT HISTORY OF IRAN

The Cultural Revolution in Iran 30 years ago changed the political, social and cultural landscape of the country. After a period of self imposed isolation, the Iranian government is currently designing specific programmes in order to be ready to join the World Trade Organization in the near future (Nicholson and Sahay, 2003). Iran applied for World Trade Organization (WTO) membership in 1996, and in 2005, the WTO General Council established a working party to examine the application (Marossi, 2006). However, because of hostile relations between the US and Iran and the concomitant availability of different sanctions, the United States has consistently opposed Iran joining the WTO (Torbat, 2005; Marossi, 2006). The sanctions imposed by the United States and some other western countries have further consequences on the willingness of investors to invest in the country, it has led to the loss of confidence in investors because of a perceived political risk (Torbat, 2005).

"*Nowadays, a liberalization movement in Iran's legal and economic sector is gradually taking place*" (Marossi, 2006, p167). However, a great deal of action is still required in this regard in order to deal with the challenges of globalization. Liberalization began in 1989 with the impetus from four different five year plans (between 1989-2009) designed to achieve the status of the most developed economy in the region. The most recent completed phase (2004-9 Fourth Economic Five-Year Socio Economic and Cultural Development Plan) mainly emphasizes the demonopolising of the economy and the enhancement of competition through private sector participation (Komijani, 2006; Marossi, 2006). To achieve these objectives there are still major challenges ahead such as the government sector which is too large, the long process of privatisation, the unstable political situation in the region and also the difficult climate for international relations (Komijani, 2006).

A primary objective of Iran is still to become a developed country and the principal economic power in the region by 2025. In order to achieve this and because of the uncertain environment, Iran recently shifted its interest from traditional economic planning to multiple scenario methods; especially in various fields including but not limited to international trade, Iran's macro economy, science and technology and also manufacturing. However, these activities have only recently started (Paya and Baradaran Shoraka, 2009).

The development strategy of Iran centres on self-reliance, and there is evidence which to show some degree of success. Because of abundant oil and gas reserves, Iran has not faced any balance-of-payment constraints regarding its imports. Iran is a middle-income developing country, with a strong and developed science and technology infrastructure, skilled manpower and a broad industrial base (United Nations, 2005; Masoumzadeh, 2006). The number of Iranian published papers in international journals increased from 281 in 1992 to 3349 in 2004, which illustrates an acceptable growth in scientific performance (Masoumzadeh, 2006).

An import-substitution policy was adopted in Iran which "*allowed it to use its oil revenues to acquire foreign technologies to industrialize*" (United Nations, 2005, p1). Iran is recognized as a natural resource-based-economy which is moving towards a knowledge-based economy with a small degree of success (United Nations, 2005). The main component of the knowledge-based economy is the availability of knowledge-based organizations with specific characteristics which make them different from traditional industrial companies. "*Considering the importance of SMEs in the economy, it is crucial that they move towards becoming knowledge-based organizations in order to survive and become competitive*" (Jafari et al., 2007, p215).

Diversification is necessary for Iran, for two reasons. Firstly, natural resources do not give a competitive advantage in the long run and are exhaustible, and secondly penetration into world markets requires both knowledge-intensive production and innovation-based competition. Creating a comprehensive National System of Innovation is a prerequisite to moving towards this knowledge-based economy. The creation of an effective NIS will enable Iran to import and adapt technologies, build upon them and also develop new technologies. In such a situation a better link between the science and technology infrastructure will enhance the capacity of the productive sector e.g. better biotechnology sector and universities interaction. To achieve this position, horizontal and vertical linkage amongst and between economic participants should be reinforced (United Nations, 2005; Masoumzadeh, 2006; United Nations, 2006).

2.3 IRANIAN SYSTEM OF INNOVATION

Many institutions are involved in the Iranian innovation policy process. The most important is the Ministry of Science, Research and Technology (MSRT). Other institutions like the Ministry of Industry and Mines, the Ministry of Jihad Agriculture and the Ministry of Health, Treatment and Medical Higher Education also have a crucial role in the policymaking and the implementation process. Additional influential bodies include the Technology Cooperation Office (TCO) under the presidency, the Iranian Research organization for Science and Technology under MSRT and the Vice-Presidency in Science and Technology, which are largely responsible for financing innovation and supporting university-industry linkage. Finally, the Ministry of Justice for issues related to Intellectual Property Rights (IPR) has an important role in this system (Ghazinoory, 2003; Abbasi and Hajihoseini, 2004; United Nations, 2005).

Government, state-owned enterprises and public universities are the main actors in Iranian NIS which shows a uniqueness of the system compared to other countries (Mani, 2004; United Nations, 2005). Other key participants such as business support organizations, consumer groups and business associations have a weak role in the system (United Nations, 2005). Therefore, "*user-producer linkages are weak and innovation activities in Iran are not demand-driven. The absence of private enterprises that base their innovation strategies on conditions of demand and competition, make it difficult to derive larger economic benefit from innovation. Such larger benefits that Iran is not presently realizing, would include the opportunity for commercializing new products, the emergence of spin-off enterprises and new entrepreneurs*" (United Nations, 2005, p2).

The industrial sectors in Iran do not compete effectively and as a result, government is trying to gradually open up the economy to competition, however, this process is very slow. Foreign companies have a marginal role in the Iranian NIS, except the oil and gas industry which additionally creates a barrier for competition and the upgrading of technology (Mani, 2004; United Nations, 2005).

Iran has built up a substantial technological capacity in terms of universities, scientists and engineers, and production capabilities. Iran has a well-developed manufacturing capacity in the automotive sector, telecommunications and pharmaceuticals and biotechnology. Figure 2.1 shows the NIS in Iran (United Nations, 2005). Some important elements are currently missing in this system. These are: an insufficient Research and Development budget (Ghazinoory, 2003); limited R&D and innovative capacity at the level of companies; a low level of foreign investment; weak supplier network; lack of well financed technology support infrastructure; very weak presence of SMEs and entrepreneurs and very weak linkage between universities and industry. Many universities in Iran built strong capabilities from basic research to product and process development, and they have strong ties with government and industry through sectoral ministries. However, interaction amongst them is not strong (United Nations, 2005).

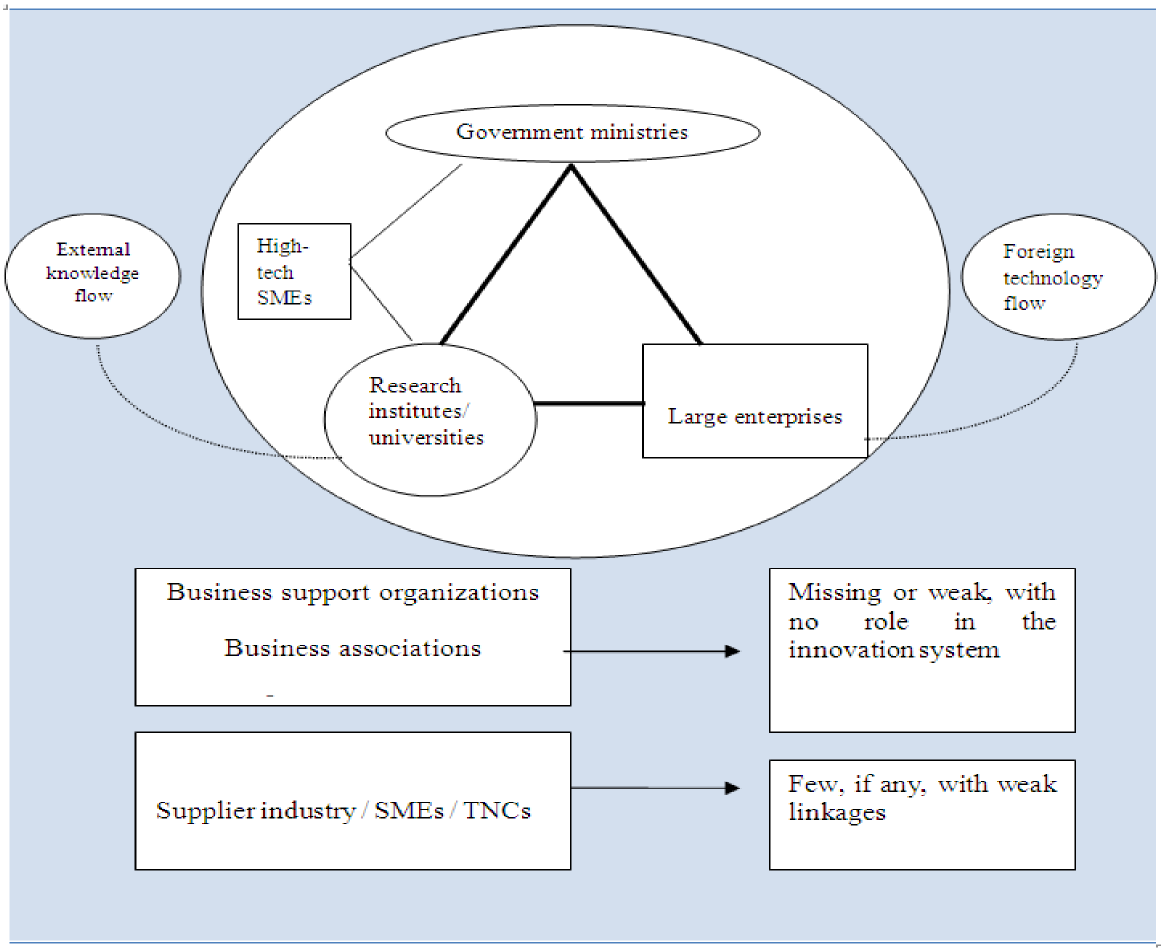


Figure 2.1: National Innovation System in Iran: (Adapted from United Nations, 2005, p21)

The weakness of international relations is a further critical factor that creates barriers for both universities and industry in the system. This factor has a negative impact on universities because of the resultant limitations and difficulties in importing R&D assets that are required for joint collaborations. Industry is also affected in the same way, because of restrictions on importing raw materials from abroad which are needed for both research and product development (Ghazinoory, 2003).

In Iran 0.6% of GDP is spent on R&D, normally distributed as: 20% of the budget is allocated to public universities, 10% to medical universities, 30% to the agricultural sector and the remaining 40% is distributed among other sectors (Abbasi and Hajihoseini, 2004).

Ghazinoory (2003) and Mani (2004) indicated that two factors are critical to the health of any innovation system; the availability of a substantial number of scientists and engineers and the availability of effective financial schemes to aid local technology generation.

Iran has performed well in generating a substantial number of scientists and engineers; since the revolution progress in this area has been very good. However, the brain drain issue, which negatively affects this process, should also be taken into account. Brain drain is a major social problem in Iran, leading to a decrease in the presence of ‘star scientist’ in both universities and industry (Ghazinoory, 2003; Mani, 2004). Statistics shows that 285,000 qualified and well-trained Iranians emigrated to other countries between 1998 and 2002 (The Economist, 2002).

2.3.1 Iranian industrial sector

One major problem for Iran is the dominant role of government in the economy. The Iranian government controls over 80 percent of the economy, with innovation activity in Iran driven by government plans rather than by demand (Masoumzadeh, 2006). The composition of Iranian GDP is as follows: the agriculture, oil and gas industry accounts for 25.1% and industrial sectors account for 23.4%, which shows that Iran’s economy is dependent on the primary sector. Reverse engineering and licensing technology from other countries has shaped the majority of Iranian manufacturing industry. Because of broadly protected domestic markets, products suffered from low quality and high costs (United Nations, 2005). Iran’s industrial sectors have been largely shaped by big state-owned enterprises, whilst the contribution of the private sector and its share in GDP value-added rests at only 15%, which is very low. Private sector companies are mainly in the areas of automotive components, food processing, light manufacturing and textiles and carpets. Unfortunately information regarding SMEs activity in Iran is incomplete. However, statistics show that about 345,000 SMEs employ 1.6 million or around 10% of the total workforce (United Nations, 2005). Nicholson and Sahay (2003) argued that the role of SMEs is insignificant in the economy and that there is a need for promotional policies for such companies together with the availability of an environment which encourages entrepreneurship in Iran e.g. availability of venture capital and effective science and technology parks. According to the Ministry of Industry and Mines' report, activity has begun in order to promote the venture capital industry in Iran. Also evidence shows that the government has a programme to support cluster formation in areas where the capability for this exists (Ministry of Industry and Mines: www.mim.gov.ir, 2003). One of the most important factors discouraging entrepreneurship in Iran is the delay in establishment of effective and comprehensive IPR. The poor macroeconomic environment of high inflation and high interest rates, lengthy and bureaucratic procedures for securing bank loans and an overall sense of discrimination against small enterprises, creates barriers for entrepreneurs and SMEs in Iran (Mani, 2004; United Nations, 2005). Other obstacles to private sector investment are: unsustainable policy making, a lack of stability of regulations, labour laws and regulations, corruption and foreign trade regulations (Khajehpour, 2000).

Becker et al., (2009) compared the level of corruption in 123 countries which placed Iran amongst the nations with highest level of corruption which reflects a poor performance in terms of transparency. Treisman (2000) found democracy and higher level of international integration are critical elements to maintain low level of corruption in a country. Also federal structure of the government system is identified as a crucial factor that can reduce the degree of corruption.

Bulumac and Apostolina (in Bulumac and Bendis, 2001) found it is essential for transition countries (like Iran) to foster entrepreneurship because it is vital to successfully manage structural and social changes during the process of transition from a centrally-planned to a market economy. Many transition countries endure an unfavourable environment which discourages entrepreneurs. Therefore, the availability of effective policies to promote SMEs in these countries is crucial. There are many obstacles and constraints to entrepreneurship and SMEs development in transition countries:

- Imperfect legal framework,
- Lack of financial resources as well as complex procedures in obtaining loans,
- Existence of corruption and slow bureaucratic procedures,
- Lack of accurate and timely information

2.3.2 The university background of Iran

Higher education and research activities have a long history in Iran, starting in the third century when Gondishapour University was established, which was recognized as one of the greatest scientific centres for centuries. In 1910, the Ministry of Education was established, which then evolved into the Central Council for Universities in 1965, finally becoming the Ministry of Science, Research and Technology (MSRT, 2001). Iran has improved its position in research over the last 10 years and was ranked 42nd out of 150 countries by the Institute for Scientific Information (ISI) (Mousavi, 2004).

Since the revolution higher education in Iran has expanded with enhancement of research; widening of access; the use of a wide range of ICT; decentralization and gender equity (Hamdhaidari et al., 2007).

Currently, there are more than 60 public universities active under the MSRT and about 700,000 students study in public universities. Public universities receive financial support from the government. There are also private universities: Islamic Azad University, which consists of 110 branches nationwide, gives half a million students the opportunity to study at different levels with its budget dependent mainly on student tuition fees. There are another 33 private universities active in Iran under the MSRT's supervision (Abbasi and Hajihoseini, 2004).

Alashloo observed in Iranian Higher Education "*as some limitations originate from governmental rules, in some cases, researchers and academic staff cannot directly communicate and contact with industry. In addition, there is a negative social attitude from industrial managers regarding communication and cooperation among the triple helix of university-government-industry*" (Alashloo et al., 2005, p144). However, this situation in Iran is somehow contradictory with the situation in European countries and the US. According to Schmoch (1999) many universities in European countries provide incentives to their staff for providing consultancy services, for example in contracts researchers are free to spend a certain amount of their time, usually about 20 percent on outside activities.

2.3.3 Future technological priorities

Iran seeks to determine technological priorities following the recent President's approval. As a result, it has been decided to emphasize a small number of technological priorities, in which Iran can play an initiative role (Ghazinoory, 2003). These priorities include but are not limited to biotechnology related sectors, automobile manufacturing companies and the telecommunications sector (United Nations, 2005).

2.3.4 Iranian biotechnology sector

Iran has a well-developed infrastructure in terms of biotechnology, with many public institutions and several private companies operate in this sector (Ghareyazie, 1999).

Four different ministries are responsible for upgrading this sector. Nearly 50 research and academic institutes are involved in biotechnology research in Iran, which includes major Iranian universities, and they are active in different fields, including agricultural biotechnology, medical biotechnology, food biotechnology and environmental biotechnology. Some of these institutes have achieved a high level of standards in their field e.g. the Razi Institute which exports its products to more than 19 countries. One of the main actions necessary to upgrade the sector is the support of the private sector and promotion of its activities (Shojaosadati, 2000). In 1996, the Biotechnology Commission began operating under the presidential office- the aim being to design a strategic framework for the systematic promotion and development of the biotechnology sector in Iran (Zargham, 1999). Shojaosadati (2000) posited that some of the major future priorities regarding this sector include the enhancement of interaction between the biotechnology research institution and private sectors, and also the improvement of the commercialization process of biotechnology research in order to establish a significant contribution to the national economy. It is argued that in the absence of strong IPRs, cooperation between private sectors and research institutes is very difficult (Ghareyazie, 1999, p100).

Compared with other developing countries Iran has a well-developed pharmaceutical industry with origins dating back eighty years. The pharmaceutical industry's activity in Iran began by licensing products and processes from transnational corporations (TNCs) and manufacturing them locally. Currently in Iran, a unique feature of this industry is the absence of any TNCs – who left Iran after 1979.

Subsequent political issues made it difficult to access technologies from other countries. The turning point was the first Five-Year Plan, which began in 1989 and emphasized a reconstruction plan following the Iran-Iraq war and is recognized as a first step towards privatisation. During privatisation, many companies were acquired by non-governmental organizations (NGOs) resulting in the current figure of 40 percent of pharmaceutical companies being owned by these NGOs. Currently there is limited competition among these companies. There are approximately 55 companies active in this sector. There have also been major programmes for developing agricultural biotechnology in Iran. Modern biotech activities, for both pharmaceutical and agricultural purposes, have been taking place in Iran since the mid-1990s. At this time universities began to establish biotechnology departments within their medical science and agriculture faculties. In 2000 the National Committee for Biotechnology was formed under the Ministry of Science, Research and Technology (United Nations, 2005).

2.3.5 The automotive sector in Iran

Car production in Iran began in 1962, when the main activity was an assembly operation for cars primarily imported from the UK. This industry evolved during Iran's transition period, and in 1990 joint venture activities were started with different countries including Germany, Korea, Japan, France and Italy. Currently Iran has the largest automobile industry in the Middle East, and this sector is one of the fastest growing industries in Iran with the capacity of producing close to a million vehicles a year. However, the sector contributes only 4 percent of the country's industrial exports. The industry's export strategy started from a low base and has gradually increased to a point when it exports to many countries, including Russia, Syria, Kuwait, Saudi Arabia, Pakistan and India (Mather et al., 2007). The automotive sector is important as a source of private sector jobs in Iran and employs half a million people (United Nations, 2005). This sector is still chiefly controlled by the Government. Privatisation activity has recently started in the automobile manufacturing sector (Mather et al., 2007, p12).

Some university-industry collaboration activities were started in Iran to investigate advanced techniques in automation (Mather et al., 2007). Reserch carried out by Kharazmi (2006) shows that the Internship centre which is recognized as an intermediary institution has performed well in terms of linking the universities and car manufacturing industry together.

2.3.6 Evaluation of Iranian university-industry collaborations

In Iran, university-industry interaction existed for many decades but it took place in an adhoc manner. In the last ten years this has become an important issue for discussion (Ghaffari, 2000). One of the major problems of Iranian industries is that they are not keen to invest on R&D and the budget allocated for research activities is not used efficiently (Auto ambitions: Economic focus, 2004). The other major barriers on U-I collaboration is that intellectual property is not recognized properly which results in low motivation for Iranian researchers (Mahdavi, 1999).

Kharazmi (2006) found the role of government as supporter in this relationship was weak. In addition, intellectual property offices had not been established in all Iranian universities resulting in a situation where academics had to take action themselves to obtain IP rights for their inventions. In the case of technology transfer, liaison offices worked ineffectively and adopted a reactive posture. Too much time was spent on adjusting apprenticeship programmes of students instead of paying attention to appropriate ways of transfer of technology and increasing links between academics and industry. Their unfamiliarity with industry’s tasks and needs is another reason for their lack of collaborative success.

Kharazmi (2006) found 52% of all technology transfers is via direct communication between professors and industry or vice versa. About 26% occurs through intermediary organizations, and 13% through liaison offices, and finally 9% takes place through university research centres. It was also discovered that spin-offs are not officially formed in Iran.

Despite these problems there are also positive signs of enhanced collaboration. One of the important actions of the 10 last years, bringing Iranian universities and industry closer together and improving the condition of technology transfer, was establishing locations such as parks and internship-centres (Ferdowsi University of Mashhad, 2009).

Kharazmi (2006) considered a bottom-up approach and focused on micro-environmental issues on UIC in Iran, which revealed that a lack of efficient mechanisms for UIC demotivates university and industry from collaboration, and also a deficiency of the IPR in Iran. This work indicated that these issues are beyond the capacity of these two organizations to address, and as a result necessitates considering the macro-environmental impact on this relationship and role of government.

2.4 CONCLUSION

The main objective of Iran is to become a principal economic power in the region by 2025. In order to reach this objective, the process of designing an NIS for Iran began in 2003. However, there are many deficiencies in this system which ultimately decreases the degree of success. The main barriers to Iranian NIS are: Monopoly of government in the market, deficiency of privatisation policies, lack of UIC activities, deficiency of financial support system, brain drain, presence of different sanctions, and uncertainty of the environment. One of the major problems of Iranian NIS is that UIC existed for many decades but it took place in an adhoc manner due to these barriers.

CHAPTER 3

MACRO ECONOMIC ENVIRONMENT AND UNIVERSITY-INDUSTRY COLLABORATION (UIC)

3.1 INTRODUCTION

Mitra and Formica (1997) postulated that universities and industry are important players in securing competitive advantages for society at both the macro and micro levels; in the way they organize and implement dependent activities. The university-industry relationship bridges the gap between university research, technology development and market application. This interaction is most effective if they consider themselves as part of a wider cluster in which they play a key role with additional supported by Government. Major studies regarding university industry collaboration focus on "*the effects of university–industry links on innovation-specific variables such as patents or firm innovativeness, the organizational dynamics of these relationships remain under-researched*" (Perkmann and Walsh, 2007, p260).

Entrepreneurs and enterprises are also primary actors in any innovation system. They interact with their environment, and are subject to a number of factors which are not under their direct control. Therefore, understanding the interaction between entrepreneurs and the environment is necessary in order to identify weaknesses, and to design possible interventions and development policies for areas that appear to cause drag in economic development processes. Social and political institutions and educational institutes may qualify as critical actors able to modify and improve the environment and influence critical environmental factors related to the innovation process (Mitra and Formica, 1997).

In order to promote an innovation and technology transfer policy, the creation of a supportive infrastructure is essential. Such infrastructure includes: agencies for technology transfer including university technology transfer offices, scientific and technology parks and incubators; and also innovation and technological development centres (Bulumac and Apostolina, in Bulumac and Bendis, 2001). These institutions also facilitate commercialization (Siegel and Phan, in Libecap, 2005). Many countries are currently attempting to create and foster a climate for entrepreneurship in order to develop an innovative environment. Such activities include: supporting spin-off formations from universities; creating hybrid and not-for-profit institutions; functioning as interfaces; and developing science and technology parks and incubators. These forms of linkage between university, industry and government generate a dynamism that creates balance between the different systems, and are generally encouraged by Governments (Leydesdorff, 2003).

Developing countries still face issues regarding technology transfer between the universities and industrial sectors. These are: large monolith (and usually Government controlled) industrial companies which stifle competition and the generation of entrepreneurship, a lack of mechanisms to facilitate technology transfer, a lack of venture capital, and also a low quality of courses in universities which are relevant to a modern industrial environment (Knight in Bulumac and Bendis, 2001).

This chapter provides an overview of the literature related to the macro-environment of UIC. Beginning with the definition of innovation and introducing different approaches to national innovation systems. National Systems of Innovation theories are discussed and the role of culture in these theories is explained. Two other important systems of innovation theories are presented including Triple Helix of university-industry-government relations and Porter's Diamond Model. The importance of cluster formation and the significant role of intermediary organizations, venture capital, and intellectual property rights in promoting UIC are discussed. Lastly the process of successful privatisation and its potential consequences on economy are evaluated.

3.2 INNOVATION

Different countries and intra-nation organizations identify innovation as one of the most important pillar for economic growth and wealth (OECD, 1997b). There are a variety of definitions for innovation and there have changed over the last 30 years. Galanakis's (2006) innovation definition is "*the creation of new products, processes, knowledge or services by using new or existing scientific or technological knowledge, which provides a degree of novelty either to the developer, the industrial sector, the nation or the world and succeeds in the marketplace*" (p1223).

Although the role of technological innovation in the economic growth of developed countries has been studied in depth; evidence shows that there has been little examination of the determinants of technological innovation and the critical factors for successful industrial innovation of developing nations, particularly with reference to Middle Eastern countries. Enterprise in developing countries remains technologically underdeveloped due to the absence of a climate of innovation. Help from transnational corporations is necessitated and the efficiency of their national technological infrastructure must be attained in order to reach advancement in technology (Baghernejad, 2006). However, as noted by Sharif (1994), the question of how to create a climate of innovation remains unknown in most developing countries. Therefore, the establishment of National Systems of Innovation may be seen as vital to create a climate to inter-connect and co-ordinate all relevant agents and manage institutional networking in the country (Baghernejad, 2006).

Competitiveness of the firm depends on the interaction of capabilities in production, investment and innovation. In the case of developed countries the sequence of events begins with innovation and progresses to investment and then to production, but in developing countries, because they transfer technology, these sequences operate in reverse, which means that they use production capability as the foundation for developing capabilities in investment and innovation (Dahlman et al., 1987). Technology transfer alone is not a good strategic basis for long-term development; therefore, technology creation must be learned. Thus, the existence of a national innovation system is necessary in order to transform the country from the position of an under-developed to a developed economy (Ozcelik and Taymaz, 2004).

3.3 APPROACHES TO INNOVATION SYSTEMS

The National Innovation System (NIS) theory was first introduced by Freeman, (1987) and Lundvall, (1992). According to Sharif (2006) other theories and approaches compete with the NIS concept, including Michael Porter's 'Cluster' or 'Diamond' model (1990), the 'Triple-Helix Model' of university–industry-government interactions developed mainly by Henry Etzkowitz and Loet Leydesdorff (1997, 1998, 2000), and the 'New Production of Knowledge' approach of Gibbons (1994).

3.3.1 National Innovation System

Until the 1990s, the most dominant approach towards innovation was the linear model of innovation policy focusing on R&D infrastructure, financial innovation support for companies and technology transfer processes. These policies emphasized the supply of innovation inputs and of support instruments. However, these linear models did not take into account the absorption capacity of firms and the specific demand for innovation support in less favoured regions (Lagendijk, in Boekema et al., 2000). The traditional concepts, which considered firms innovating in isolation, have been replaced by modern theories which consider the systematic character of innovation like the National Systems of Innovation (Todtling and Trippl, 2005).

Initially the focus of innovation system theories centred on activity at a national level (Lundvall 1992; Nelson 1993). NIS literature uncovers the differences between countries in terms of economic structure, R&D base, institutional capability and innovation performance (Edquist, 2001). It was soon recognized that the most useable definition of innovation systems might not coincide with national borders, and therefore the concept of 'technological systems' which focus on innovation in particular techno-economic areas emerged (Carlsson, 2006). More recently innovation system theorists have become interested in considering regional level activity as well. Although these theorists agree that national and technological level systems are essential, they argued however that the regional dimension is also very important (Acs, 2000; Mytelka, 2000).

"*Regional innovation systems are far from being self-sustaining units. Normally they have various links to national and international actors and innovation systems*" (Todtling and Trippl, 2005, p1206). There is a further theoretical category of the innovation systems in existence, mostly recognized as 'sectoral innovation systems' and launched in 1997 (Breschi and Malerba, in Edquist 1997). Thus far then, there are four categories of innovation systems which include, national, regional, sectoral and technological (Niosi, 2002; Carlsson, 2006).

Since the 1970s, following the emergence of the concept of globalization emerged theories around a national innovation strategy have been extended to the regions. This has resulted in a regional innovation strategy, the main aim which was the development of regional and national economies in close cooperation with central and regional governments (Chung, 2004). Since 1990, regional innovation policy has been influenced by the concept of NIS. Therefore, if the concept of NIS is applied to regional policy, a concept of regional innovation systems can be identified as a sub-system of NIS (Chung, 2002).

The existence of critical ingredients necessary in order to have successful regional innovation systems consist of: general environmental factors, industry-related elements and company-specific ingredients. The mixture of these components based on the presence of knowledge generation sources like universities and research institutes, leads to an enhancement of the competitiveness of the region. University-industry collaboration is thus vital to stimulate regional innovation capabilities (Van Looy et al., 2003).

Regional innovation systems are conceptualized as comprising "…*a collective order based on micro constitutional regulation conditioned by trust, reliability, exchange and cooperative interaction*". The role of trust is considered here as the core of successful innovation systems (Cooke, in Braczyk et al., 1998, p24).

Four elements are widely recognized in the literature as key components of a regional innovation system: development of cultural norms of openness to learning, trust and cooperation between firms; the presence of several firms and other organizations (regional agglomeration) in close proximity in specific geographical space, in a single industry, or in complementary industries; the existence and quality of a stock of proximate capital, such as human capital and an associative governance regime (Lundvall and Johnson, 1994; Morgan, 1997; Niosi and Bas, 2001).

The concept of NIS is mostly related to growth and development in developed countries, however it may be relevant for developing and emerging countries as well (Lundvall et al., 2002). The first country to adopt the concept of an NIS as a basic constituent of its science and technology policy was Finland (Sharif, 2006).

Furthermore, as noted by Rooks and Oerlemans (2005) the first developing country to adopt an NSI concept in its policy-making was South Africa.

There are various definitions in existence regarding National Systems of Innovation, however there is no consensus exists (OECD, 1997a; Niosi, 2002). This variation in the definition is related to ontological aspects which imply that the historic nature of the object precludes a single definition (Godinho et al, 2006). Table 3.1 lists the various definitions regarding NIS.

From Table 3.1, in all definitions the interaction between the actors is the most common feature. The basic characteristics of National Systems of Innovation are the institutional set-up related to innovation, and the underlying production system (Edquist 1997a). Although different countries have similar institutions to advocate innovation, they differ considerably in the way in which these institutions interact with each other in order to pursue the innovation process; this reveals the importance of the concept of the system in such a consideration (Lee and Tunzelmann, 2005).

Definition	**Reference**
"*. . . The elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge . . . and are either located within or rooted inside the borders of a nation state.*"	Lundvall (1992, p2)
"*. . . A national system of innovation is the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology*."	Niosi et al., (1993, p212)
"*That set of distinct institutions which jointly and individually contributes to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process*."	Metcalfe, in Stoneman (1995, p2)

Table 3.1: Various definitions regarding NIS

In developing countries three levels are assumed for NIS (Figure 3.1). The first level is made up of the industrial clusters within a country (all producers, buyers, and suppliers). This layer is known as a national industrial cluster and is crucial to local technological development and competitiveness. The second level consists of a set of institutions and organizations which support the learning process in industrial clusters. The exchange of knowledge and information between these institutions leads to interactive learning. These institutions include: universities, financial institutions, physical infrastructure and technological support. The final level is the set of policies that stimulate the learning processes between industrial clusters and institutions. These policies include: political and macroeconomic environment measures, trade and competition regimes, tax regimes and legislations. It is worth mentioning that NIS differs from one developing country to another. The reason underlying this is that there are differences in terms of strength of enterprises within them, efficiency of their collective learning processes and the intensity of external links. Unfortunately most NIS in developing countries has a degree of deficiency in one, some or all of these factors (Wignaraja, 2003).

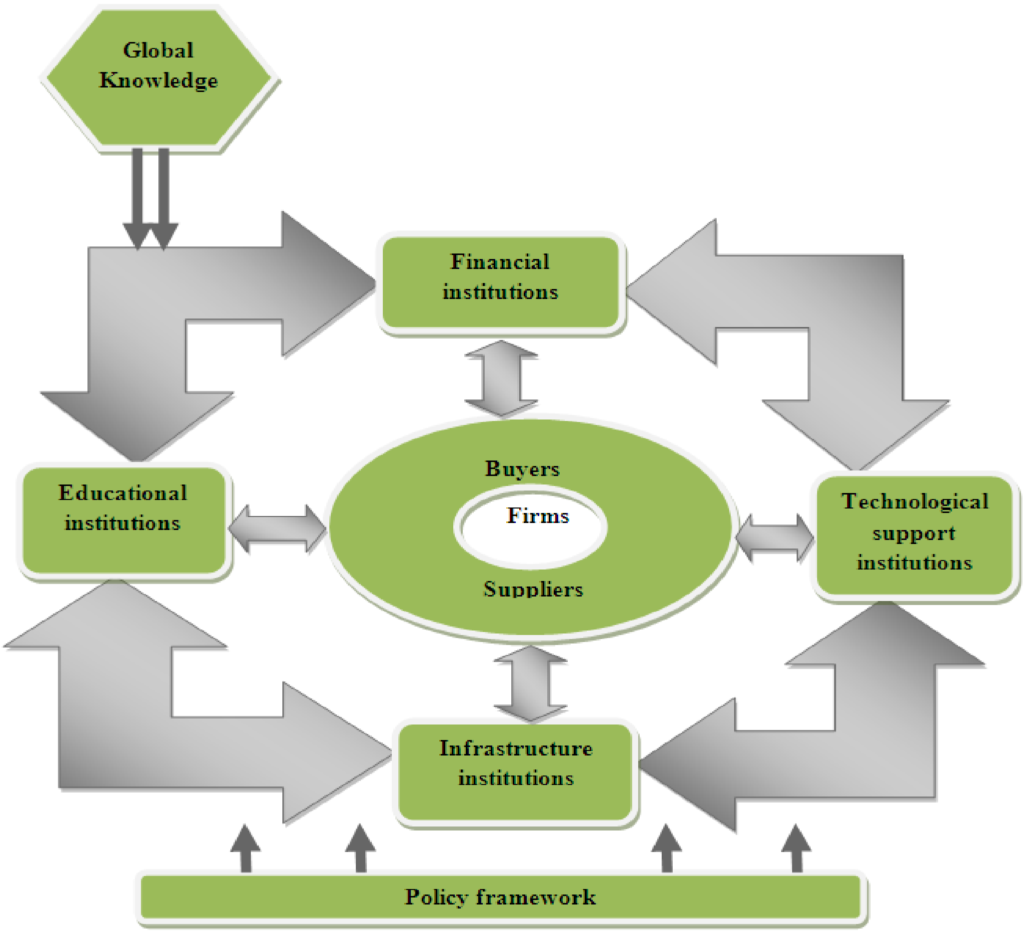


Figure 3.1: National innovation system (NIS), Adapted from Wignaraja, 2003.

In many developing countries, e.g. Thailand, the scope for innovation is limited and the network between institutions is fragmented and incomplete. This problem, which is prevalent in most developing countries, can be classified on three levels. On a macro level, the NIS is weak and fragmented and there is a lack of policy coherence and direction. On a Meso level, linkage between university, industry and government agencies is also weak and fragmented. On the Micro level, there is a low absorptive technology and innovation capability in SMEs; also there is a lack of innovation culture in SMEs, and a lack of industrial networking and social capital which is vital for creating knowledge and innovation. Trust - as an important element of social capital- is crucial for networking between companies and government, between companies and universities, and also amongst firms. Particularly for these developing countries Governments should strive to create an environment that increases trust, entrepreneurship and knowledge sharing. Network facilitators who are either government-sponsored or operate independently are needed in order to create such an environment (Yokakul and Zawdie, 2009).

According to Yim and Nath (2005) developing countries also can achieve the goal of leapfrogging their economy from production-based to knowledge-based. Malaysia is the clearest example, where the government has chosen to use the advantage of a cluster approach, and has created specific specialized agencies to achieve this goal. The Malaysian case confirms that NIS is a system that has to be continuously aligned and realigned along with national priorities. This implies other developing countries have opportunities to evolve an effective NIS. Effective strategic planning and implementation are more important than relying on natural resources in building national technological capacity.

There are four pillars and actor groups which build the NIS for each country. These groups are industry, academia, government and public research institutes (Chung, 2004). According to Niosi (2002) there are two major building blocks of NIS - institutions and linkages. These institutions are: private firms, government laboratories, public agencies and universities. The second building block is linkages and flow, which are categorized using the following determining characteristics that may help or impede the efficient operation of the NIS (Niosi, 2002):

- Financial flow between government and private organizations; start-up companies and venture capital firms are the good examples;
- Human flow between universities, government laboratories and industries;
- Regulation flow which is mostly initiated by government agencies for innovative organizations;
- Knowledge flow among these institutions

According to Rooks and Oerlemans (2005) firm is one of the important actors in NIS and requires thorough analysis. The innovative performance of firms depends partly on the support of other actors in the NIS. Regarding this issue a variety of flow into business firms can be assumed. There are four types of flow, and the effectiveness of each may lead to an increase in the innovative performance of industry:

- Effectiveness of Knowledge Flow
- Effectiveness of Financial Capital Flow
- Effectiveness of Human Capital Flow
- Effectiveness of Regulatory Flow

Government has a critical role in NIS. Designing proper policies and regulation can facilitate innovation in a country. Many developing countries suffer from government weakness in the design of effective technology policies. In the case of South Africa for example, this weakness includes the absence of a policy framework for intellectual property and fragmentation of government science and technology (Rooks and Oerlemans, 2005).

Research conducted by Godinho et al., (2006) shows that different NIS can be categorized based on eight major dimensions which are: market conditions; institutional conditions; intangible and tangible investments; basic and applied knowledge; external communication; and diffusion and innovation. Twenty nine indicators were selected to provide empirical evidence for these dimensions. Based on these indicators 69 countries were selected and the analysis indicates that nations can be classified as either "developed NIS" or "developing NIS". In the next stage of his analysis he narrows down his focus, progressing to provide greater detail of analysis. As a result he assumes three branches for "developing NIS" which may be considered. These 'branches' include: unformed NIS; emerging NIS and catching up NIS. This study placed Iran in the first branch which is developing but unformed NIS. A study carried out by Svarc

(2006) considers the impact of socio-political factors on innovation policy in transition countries like Croatia, concluding that in order to move efficiently towards a knowledge economy, it is crucial to redesign present development policies.

3.3.1.1 The importance of universities as a pillar for regional innovation systems

Historically the development and diffusion of knowledge has been considered as a push model viewed in linear terms. This definition assumes knowledge was created outside the production system, e.g. universities, and was then "pushed out" to industry to undergo further development and adoption. This view considers universities as a source of conducting trials or other experiments to prove concepts identified during research (Smith, 1990). NIS theory which emerged after traditional theories, assumed a more active role for universities in economic development, further assuming more complex interaction between all innovation actors (Freeman 1991; Lundvall 1992). NIS concepts evolved to increase attention to the role universities perform in fostering regional agglomeration through knowledge spillovers resulting from their research and educational activities (Camagni, 1991; OECD, 2001a).

Many countries have concerns regarding the diffusion of scientific and technical human capital from the home to the host country. Many nations have designed initiatives and aims for potential policy solutions. In New Zealand for example, these initiatives have been designed in two phases which include the control phase – traditional- that regulates the flow of individual human capital. This phase focuses on forcing scientists to remain in, return to, or emigrate to the home country. The second phase is a stimulation stage which creates more opportunities for research, innovation and entrepreneurship at home, stimulating the return of migrants e.g. by developing excellence in research and investment in R&D. The latter is more efficient and more systemic in nature than the former (Davenport, 2004).

3.3.1.2 Culture: An important component of National Systems of Innovation

Important cultural norms can facilitate interactive learning in a regional innovation system. These norms include openness to learning, trust and cooperation between firms (Cooke and Morgan, 1998). Referring to the importance of cultural norms that support learning and interactive innovation, Cooke points to the degree of embeddedness of a region; its institutions and its organizations, as key structural issues (Cooke, 2002). Embeddedness is defined as: "*the extent to which a social community operates in terms of shared norms of cooperation, trustful interaction, and untraded interdependencies, as distinct from competitive, individualistic, arms length exchange, and hierarchical norms*" (Cooke, 2002, p14).

Such socio-institutional and cultural factors have a significant role in shaping science, research and innovation (Ney, 1999). According to Nelson and Rosenberg (1993) National Science and Technology policy performance is considerably affected by the socio-institutional configuration in which research, innovation and technological advance take place. Although development of cultural norms is recognized as a key constituent of regional innovation systems, Ney (1999) indicated a weakness in the national innovation systems account of culture, the national differences at empirical and theoretical level are not considered in the constructs of NIS's. Ney (1999) argues that at the empirical level Nelson's (1993) work on the national political cultures has an effect on the structures and practices of NIS's, and discusses the reason for France and Britain's difference in this regard. Although true generally, at an empirical level it offers little convincing explanation that this is the case. In this view political culture is the "uncaused cause" of the structural features of the innovation system. In this approach, the analysis of which factors cause a political culture to change is not plausible, rendering it impossible to discern how changes in national innovation systems affect political culture (Ney, 1999). The theoretical approach which is based on the work of Lundvall (1988) also views this relationship in the same way and assumes that culture is a relatively constant entity impacting on national systems of innovation. Both views assess the impact of culture to be essentially in one direction. In these views, national culture has an effect on the process of innovation; however, neither is able to explain the means through which development of national innovation systems has impacted on specific national cultures (Ney, 1999).

3.3.2 Triple Helix of university-industry-government relations

For many decades developing countries obtained technological assets through pertinent technology transfer from developed countries in order to upgrade their industrialization activity. However, sometimes they were faced with difficulties in this process since these transferred technologies did not necessarily lead to economic growth. Three central reasons for this deficiency can be posited. First, in developing countries the existence of institutional and organizational fragmentation creates a barrier to the process of translating the transfer of technology into the development of innovation initiatives. This is because developing countries do not have the capacity to absorb and assimilate acquired technologies. Second, most technologies imported from developed countries focus on the development of production capabilities and not innovation capabilities. Third, most developing countries' technology transfer activities conform to a linear model of relationships between the supply and demand sectors. Such a relationship creates barriers for effective knowledge sharing across the economic spectrum; further inducing difficulties for these countries to obtain the beneficial results of the dynamic effects of technology transfer initiatives. As a result of these barriers, there is a growing awareness in some developing countries, e.g. Algeria, that a shift from traditional technology transfer practice to the development of a Triple Helix (TH) of university-industry-government relations in order to provide a sustainable basis for their innovation and technological progress (Saad and Zawdie, 2005).

The TH model suggests that the university can play a more effective role in innovation in knowledge-based societies (Etzkowitz, 2008). The TH model considers the relationship between the university, industry and government and also considers internal transformation within each of these spheres e.g. universities have been transformed from teaching organizations into ones that focus on teaching and research at the same time. This kind of transformation is still ongoing in many countries (Etzkowitz and Leydesdorff, 2000). In the TH model universities play an innovative role in the country and are active in traditional tasks as well as research; entrepreneurial training and community development. Additionally, industry engages in transfer of innovation as well as endogenous innovation. This model requires government to achieve an appropriate balance between intervention and non-intervention (Dzisah and Etzkowitz, 2008). From an analytical point of view the TH model is different from the national systems of innovation; the latter considers the firm as having the leading role in innovation and focuses on existing companies as engine of innovation, with other organizations making up a support structure. The former focuses on interaction between university, industry and government; and as a result of effective interaction, hybrid organizations can be created (incubators, start-up companies, technology transfer offices, or venture capital firms) (Etzkowitz and Leydesdorff, 2000; Etzkowitz et al., 2005; Etzkowitz, 2008). In other words the Triple Helix focuses on "*the network overlay of communications and expectations that reshape institutional arrangements among universities, industries, and governmental agencies*" (Etzkowitz and

Leydesdorff, 2000, p109). A variety of institutional arrangements of university-industry-government linkage exist as a result of the evolution of innovation systems. These institutional arrangements can be categorized as ‘Triple Helix 1’, with the government encompassing both university and industry and directing relations between them. This configuration and a particularly strong version of this, is more prevalent in eastern European countries and the former Soviet Union. Weaker versions of this configuration meanwhile exist in many Latin American countries and some European countries like Norway (Etzkowitz and Leydesdorff, 2000; Etzkowitz et al., 2005). In most Latin American countries, and also in many eastern European countries, universities were creatures of government. In this situation, part of the entrepreneurial activity aims to give a significant degree of independency from controlling bureaucratic institutions like Ministries of Education; and give the university more autonomy from the state (Etzkowitz et al., 2000). A second model or “laissez-faire” model consists of “*separate institutional spheres with strong borders dividing them and highly circumscribed relations among the spheres*” (Etzkowitz and Leydesdorff, 2000, p111). In this model indirect intervention of the state is expected whilst in statist societies direct intervention is expected (Dzisah and Etzkowitz, 2008). Finally, Triple Helix III has been interpreted as “*generating a knowledge infrastructure in terms of overlapping institutional spheres, with each taking the role of the other and with hybrid organizations emerging at the interfaces*” (Etzkowitz and Leydesdorff, 2000, p111).

The first model is considered as a failed development model. The second model is considered as “shock therapy” to reduce the role of government in first model. A small opportunity for “bottom up” initiatives is offered in model one (Triple Helix1) and as a result innovation can be seen to be discouraged rather than encouraged. On the other hand in the Triple Helix III model, arrangements between university and industry are often encouraged, but not controlled, by government. Research-based knowledge has been recognized as a major part of innovation resulting in universities playing a larger role in industrial innovation (Etzkowitz et al., 2000; Etzkowitz and Leydesdorff, 2000). The common objectives in Triple Helix III are to realize an innovative environment consisting of a strategic alliance between university, companies and government laboratories; or spin-off formation activities and also many other activities. Government can encourage these kinds of activity through many mechanisms e.g. direct or indirect financial assistance; or for example the Bayh-Dole Act in the USA. Today many countries are trying to achieve some form of Triple Helix III, "*Triple Helix as an analytical model adds to the description of the variety of institutional arrangements and policy models an explanation of their dynamics… the Triple Helix hypothesis is that systems can be expected to remain in transition. The observations provide an opportunity to update the analytical expectations*" (Etzkowitz and Leydesdorff, 2000, p112).

Etzkowitz and Leydesdorff (2000) postulated that NIS models focus too much on the complexity and dynamic process of innovation, and these complex dynamics compose different sub-dynamics including political power, social movements, technological trajectories and regimes, and institutional control. The TH model focuses on three interlocking dynamics: institutional transformation, evolutionary mechanisms, and the new position of the university.

Triple Helix has identified four processes related to major changes in the production, exchange and use of knowledge. The first is internal transformation in each helices i.e. an economic development mission by universities or strategic alliances among companies. The second is "*the influence of one institutional sphere upon another in bringing about transformation…the third is the creation of a new overlay of* *trilateral linkages, networks, and organizations among the three helices, serving to institutionalize and reproduce interface as well as stimulate organizational creativity and regional cohesiveness*" (Etzkowitz et al., 2000, p315). Examples of a third process are 'Knowledge Circle' in Amsterdam or the New York Academy of Sciences and Joint Venture Silicon Valley in the USA. The last process is "*the recursive effect of these inter-organizational networks representing academia, industry and government both on their originating spheres and the larger society*" (Etzkowitz et al., 2000, p315). An example of the last process would be the formation of firms based upon academic research. One of the major outcomes of these inter-related processes is to encourage entrepreneurial culture within universities (Etzkowitz et al., 2000).

The TH model plays a different role in developed and developing countries. In developed countries where all the necessary elements exist and their relationships are open to enhancement it is posited as an empirical model. However, in developing countries "*the triple helix is said to be a normative model that countries aspire to by putting the basic elements in place…in all developing countries, the essential triple helix elements exist. The missing component is often the lack of a coherent strategy to integrate the fundamentals ingredients necessary for socio-economic development*" (Dzisah and Etzkowitz, 2008, p105). Critics have argued that in many developing countries Governments are too bureaucratic, industries too weak and universities are academically oriented all of which creates barriers for effective implementation of the TH model. One of the basic prerequisites of development is enhancing circulation among the three helices. The critical elements of Triple Helix circulation are people, ideas and innovation. By creating a triple helix of university-industry-government interaction, and by enhancing the capacity and capabilities of universities, developing countries can grab an opportunity to leapfrog traditional phases of industrialization (Dzisah and Etzkowitz, 2008).

According to Hakansson and Snehota (1995) a relationship... "*cannot be conceived as just a relationship. A relationship is a result of an interaction process where connections have been developed between two parties that produce a mutual orientation and commitment*" (p26). Commitment and trust are two critical ingredients for the success of any kinds of complex relationships between partners including those in the Triple Helix Model. Hence, the importance of developing mechanisms in coordinating complex interactions among university, industry, and government (Hakansson and Snehota, 1995).

Hakansson and Snehota (1995) propose a model to manage and evaluate the nature of relationships or networks, involving their elements of activities (the relationship is built up of activities that connect a variety of internal activities), resources (as a relationship develops, it can connect a range of resource elements required) and actors (as a relationship develops, actors become connected). According to Saad and Zawdie (2005) based on the model which is developed by Hakansson and Snehota (1995) the three spheres of government, university and industry are linked through these elements and interrelated to each other in order to enhance the level of learning and innovation in a specific country.

These three linkages consist of: the activity link, which involves technical, administrative, commercial and other activities of an organization/sphere, and can affect the outcome and performance of the network. The availability and accessibility of resources also has a significant impact on the quality of the relationship. Such resources include: technology, material, knowledge, equipment, manpower and finance. The third level of relationship in this model involves interactions between the actors. As a result of these interactions, greater trust and synergy within the relationship will be generated (Hakansson and Snehota, 1995). The third level is usually recognized as a pre-requisite for the success of the Triple Helix university-industry-government relations (Saad and Zawdie, 2005). Saad and Zawdie (2005), based on the model developed by Hakansson and Snehota (1995), offer a model for effective links and integration between the three spheres of the Triple Helix Model can be shown. Figure 3.2 illustrates this model.

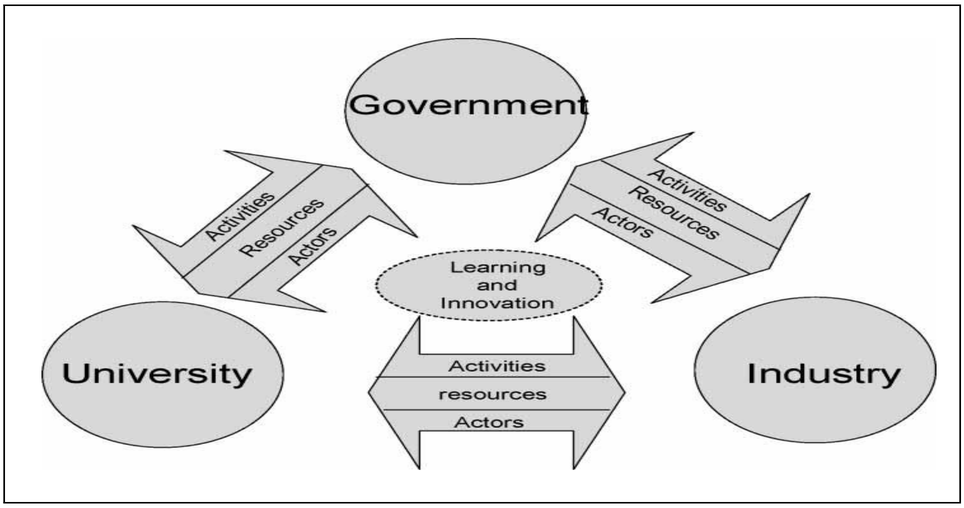


Figure 3.2: A model for effective links and integration between the three spheres of the Triple Helix Model (Saad and Zawdie, 2005).

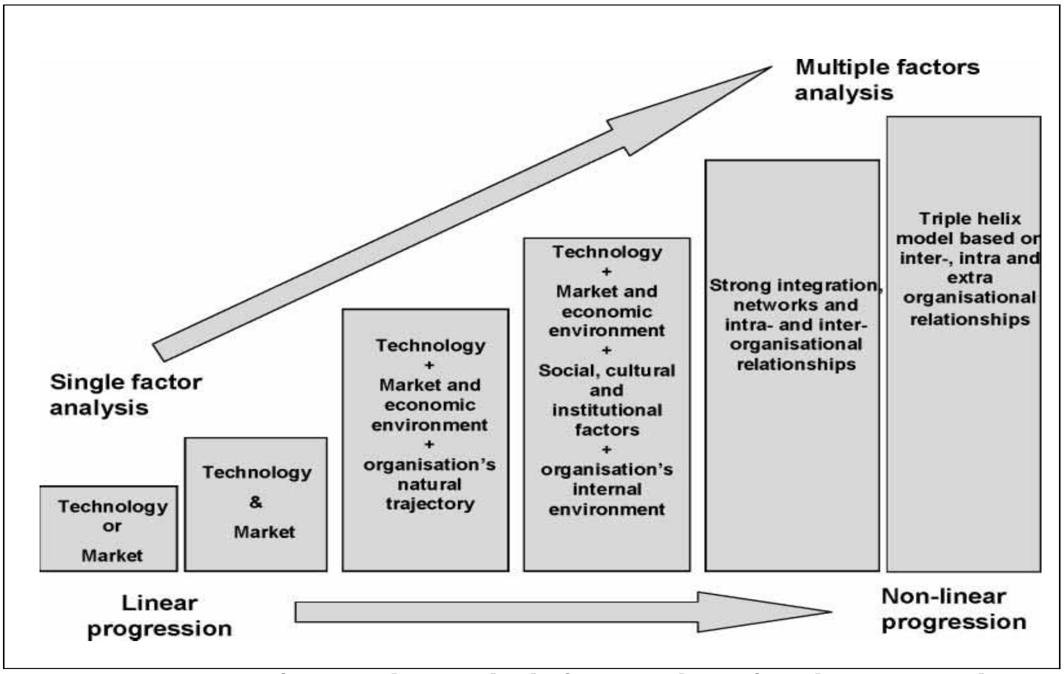


Figure 3.3: Progression from single to multiple factor analysis, from linear to non-linear process and from intra- to inter- to extra organizational relationships. Source: Based on Saad (1991, 2000, 2004 cited in Saad and Zawdie, 2005)

The "*fundamental feature of the Triple Helix model is its aim to bring together different actors, capitalizing on their interactions in order to provide a comprehensive understanding of the innovation process and its key determinants.... the Triple Helix model views innovation as a product of a complex and non-linear set of activities involving interactions within and between the principal players. Activities are not limited within the organizational boundary defined by the three principal actors. Interaction with the global technology market is also deemed significant in so far as it facilitates the transfer, acquisition and effective exploitation of knowledge*" (Saad and Zawdie, 2005, p97). The progression from linear to non-linear process, also from single to multiple factor analysis and from intra-to inter-to extra organizational relationships is depicted in Figure 3.3 (Saad and Zawdie, 2005).

3.3.3 Porter's Diamond Model - The competitive advantage of nations

This model began by asking why some nations achieve international success in a specific industry. Porter (1990) answered this question based on four major attributes of a particular country that shape the environment in which local firms compete that boost or hinder the creation of competitive advantage. These constituents of national advantage include:

- Factor conditions: this determinant focuses on the position of the nation in terms of factors of production, like skilled labour or infrastructure which are essential to compete in a given industry;
- Demand conditions: this attribute describes the structure of home demand for the industry's product or service;
- Related and supporting industries: this determinant is related to the availability of suppliers and related industries that are internationally competitive in the country;
- Firm strategy, structure, and rivalry: this determinant focuses on the issue of the conditions in the region, governing how companies are created, organized, and managed, and indicates the degree of rivalry present among domestic firms.

These determinants, individually and as a system, create the situation in which a nation's firms are born and compete (Porter, 1990).

Nations will be successful in industries or industry segments in which they create these conditions and operate these determinants as a system (Diamond). Porter suggested the term "Diamond" to refer to the determinants as a system. The diamond is a mutually reinforcing system where the effect of one determinant depends on the state of others. On one hand the weakness of each determinant has a negative impact on other system elements and the operation of systems as a whole. It may also be noted that the advantage of one determinant can create or lead to upgrades in the advantages of others. It is worth mentioning that competitive advantage based on only one or two determinants is possible in some industries, like natural-resource dependent ones. However, this situation is not sustainable. In knowledge–intensive industries advantages throughout the diamond are proven to be essential for achieving and sustaining competitive success. However such advantage in every determinant is not necessarily a requirement for competitive advantages in an industry and interaction of advantage in many determinants creates self-reinforcing benefits which are very hard to nullify or copy (Porter, 1990).

There are two additional variables, which are "chance" and "Government", which can influence the national system and are essential for completion of the system. Government at all levels can either play a facilitator role or configure barriers in terms of national advantage. Each Government policy can influence one of the determinants. Chance is an important variable for completing the theory but it includes events which have been developed outside the control of firms and sometimes government (Porter, 1990).

This 'diamond' explains how the individual determinants combine into a dynamic system. Two elements have a highly significant impact on the transformation of the diamond into the system. These elements are domestic rivalry, which can promote upgrading of national ‘diamond’, whilst the other element is geographic concentration which promotes and magnifies the interaction within the ‘diamond’. The determinants within the ‘diamond’ reinforce each other and if this reinforcement continues over time, the cause and effect of individual determinants becomes blurred (Porter, 1990).

Porter’s basic unit of analysis for understanding national advantage is industry. Although geographic concentration is a concern as regards competitiveness, the ‘nation’ is still a relevant unit of analysis, because many determinants of advantage have greater similitude within nations than across nations. Such determinants include government policy, legal rules, capital market conditions and factor costs. Porter suggests that nations are not successful for one isolated industry, but rather in clusters of industries connected through vertical and horizontal linkages (Porter, 1990). Figure 3.4 depicts how these interactions occur: there are linkages in this model however some interactions are stronger and more important than others.

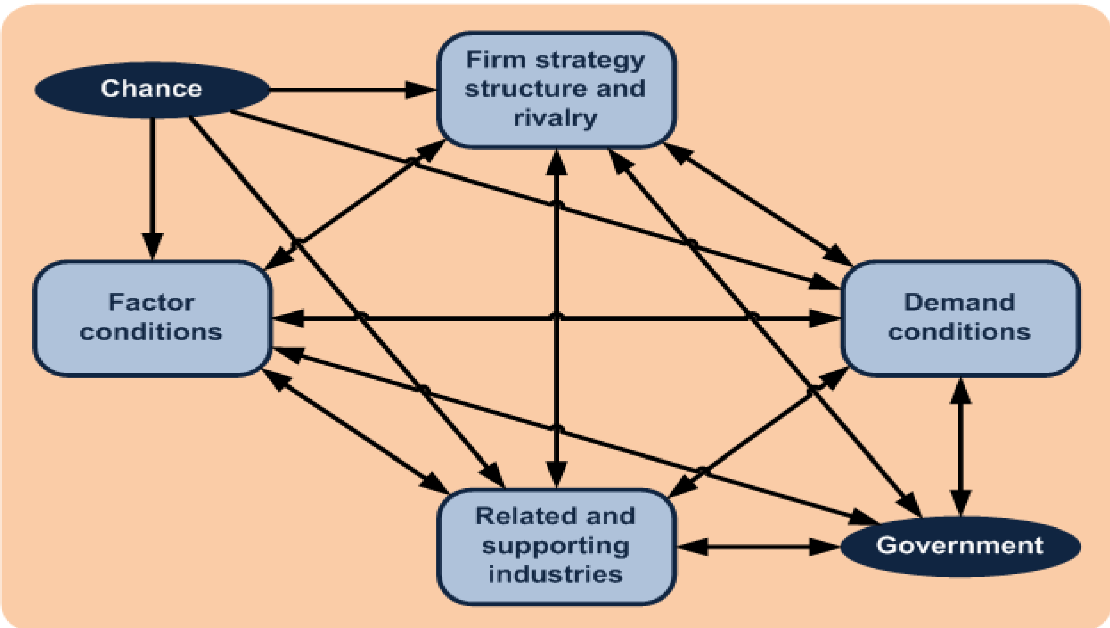


Figure 3.4: Diamond Model: The Complete System (Porter, 1990)

3.3.3.1 Critics of Porter's Diamond Model

According to Porter (1990) the role of social and political history and values in influencing competitive advantage are also influential. Social norms and values affect the nature of home demand. These elements have an impact on the institutional structure within which competition operates and also the skills that have been accumulated in a nation. Some of these aspects which are known as 'cultural' (see Chapter 5 for a fuller discussion of culture dimensions) should be considered in parallel with economic outcomes and cannot be separated from these.. "*Cultural factors are important as they shape the environment facing firms; they work through the determinants, not in isolation from them*" (Porter, 1990, p129).

The key criticism of Porter's Diamond Model related to his assumption that cultural values and social norms have no importance other than through economic factors (Van den Bosch and Van Prooijen, 1992). A distinction exists between economic and social segments. A study carried out by Van den Bosch and Van Prooijen (1992) revealed that the determinants of the 'diamond' subsist in national culture, however these findings are derived from the literature and more research is recommended in order to better understand a national culture's consequences on the competitive advantage of nations.

According to O'Shaughnessy (1996) Porter's Diamond Model does not pay sufficient attention to matters of culture and cultural dynamics which may be interpreted as a weakness. Although Porter's framework credits national culture with a certain amount of explanatory power, he does not discuss it in depth. Porter's framework is formed around and references developed countries. Many assumptions incorporated are therefore specific to developed nations. In order to make it relevant to the context of developing countries his theory may have to be radically reformulated.

According to Cooke and Morgan (1993) regional development cannot be considered separately from cultural, social and institutional activities. All of these activities should be taken into account when discussing about regional development. Few regions in the world have the same capacity of US universities and the funds required for outstanding high technology clusters. Replicating high technology clusters is very difficult, especially for those regions with different cultures, social institutions and availability of funds (Arbonies and Moso, 2002).

3.3.3.2 Porter's Diamond Model in developing countries

They are two paradigms used to study clusters in developing countries namely 'Flexible specialization' and 'Collective efficiency'. These models have been shown to be either not particularly applicable to developing countries or to miss critical elements (Neven and Droge, 2001). Also as mentioned by Albu (1997) the 'Collective efficiency' approach does not offer considerable understanding concerning the dynamic processes of knowledge acquisition in clusters.

Models used to study clusters in developing countries are incomplete. The context of industry progress is generally mid-low level technology rather that the high-technology competitive arena dominated by the OECD countries. Thus concepts like flexible specialization have to be replaced with absorptive capacity, and some elements are under developed such as external linkage formation (collective efficiency framework). Researcher and users of these models inevitably start looking for answers outside the chosen model framework indicating the need for a more encompassing framework. Porter's Diamond Model appears to offer a more complete perspective since its principles are based on research in a wide variety of countries and industries (Neven and Droge, 2001).

Porter's Diamond Model is widely used in the context of developed countries (Neven and Droge, 2001). However, as noted by Adeboye (1996) clusters in developing countries exhibit similar characteristics and similar evolutionary stages as clusters in developed countries. Although differences exist, these are not fundamental. Therefore, clusters in developing countries and developed countries can be analyzed using a similar model that is broad enough to allow a structured approach. In order to search for the best applicable paradigm for developing countries, specific attention should be paid to Porter's Diamond Model.

"*The model has not been tested to a great extent in developing countries, but those rare studies that have used it have affirmed its validity and called for more extensive applications of the model in this setting*" (Neven and Droge, 2001, p9).

A study conducted explicitly to test Porter's theory in Turkey suggests that Porter's framework can also work in the context of a developing country and even in the context of non-competitive industries, although complicating factors of FDI and multinational company influences require special attention (Oz, 2002).

In the particular case of Iran, the issues relating to the effects of globalization and FDI influence on innovative capacity and competitiveness are readily dismissed. Iran thus offers a relatively self-contained economic system to study the determinants of competitiveness, or to explain the lack of. A recent study by Rezazadeh Mehrizi and Pakneiat (2008) concerning the applicability of the Porter's Diamond Model in the telecoms industry in Iran also confirmed that the Diamond Model has its own merits for consideration in developing countries:

- It considers national conditions and their influences on the sectoral development (in developing countries generally industries are strongly influenced by national economic conditions).
- Underline the role of factor conditions which are important in many industries in developing countries.
- Shed light on the role of firms' strategies in the development of sectors.

- Focus on production (rather than innovation) – "*in the short term (mainly at early stages of catch-up process) imitation is more the norm than innovation*" (Rezazadeh Mehrizi and Pakneiat, 2008, p86).

3.4 INDUSTRIAL CLUSTER FORMATION

There are many theoretical frameworks available for examining industrial clusters (discussed in Brown, 2000). According to Feser (1998) there are a broad range of theories and ideas that constitute the logic of clusters. Thus, there is no cluster theory per se.

In the 'diamond' model the concept of the cluster is very important, implying that successful industries in particular countries are linked through vertical or horizontal relationships. In clusters there are exchanges and flows of information regarding needs, techniques and technology among all the actors of the system including buyers, supporting industries, suppliers and related industries. Mechanisms exist which can facilitate interchange within clusters and help information to flow more easily and facilitate coordination by creating trust and decreasing perceived differences in economic interest between actors. Some facilitators of information flow are: personal relationships; ties through the scientific community or other association; and trade associations encompassing clusters and community ties because of geographic proximity (Porter, 1990).

One of the most efficient ways of overcoming the size limitations of SMEs are clusters and they are widely recognized as an important instruments for improving their productivity, innovativeness and overall competitiveness (Wignaraja, 2003; Karaev et al., 2007). According to Porter (1998) the presence of formal organizations such as universities are important for the success of clusters (Porter, 1998). Advantages related to geographical proximity of actors within clusters are; strengthening communication between cluster members, and intensifying the exchange of knowledge. In this situation, besides the codified knowledge which can be easily transferred, tacit knowledge can also be transferred. However in the case of tacit knowledge, cluster members (senders and receivers) should be more involved in the communication process in order to be aware of the relevance of this kind of knowledge (Bergman and Feser, 1999).

An appropriate entrepreneurial environment is one of the necessary preconditions for cluster formation. "*An entrepreneurial environment encourages and enables an entrepreneurial spirit in ways that generate opportunities and create conditions for establishing new SMEs, and critical mass of SMEs is a crucial factor for cluster development*" (Karaev et al., 2007, p826). However, this view contradicts Porter (1998) which asserts that clusters can create an appropriate environment for new start-ups with the suggestion of clusters as an instrument for creating an entrepreneurial environment. Porter's view also contradicts other critical ideas for example those of Castillo and Fara (2002) who believes that clusters should be set up in areas where an entrepreneurial environment already exist.

Ceglie (2003) further debated whether the geographical concentrations of SMEs operating in the same sector are not sufficient for producing "external economies". Some other elements are considered crucial in building an efficient cluster. Trust building and constructive dialogue among cluster actors, exchange of information, identification of common strategic objectives, agreeing on a joint development strategy and its systematic and coherent implementation are among these critical success factors.

Formal institutions such as business associations, labour associations and specialized institutions (e.g. intermediary agents) are considered necessary for strengthening the cooperation between cluster firms (Dwivedi and Varman, 2003). Moreover, raising the level of trust between businesses that are cluster members is crucial for the successful development of clusters (Camiso´n, 2003). "*High trust levels* *decrease the transaction costs, reducing the costs for legal disputes and administrative procedures. In order to achieve this state, rules of business conduct need to be developed on several levels, together with functioning measures (both ethical and legal) that would sanction them*" (Karaev et al., 2007, p826).

Trust is recognized as a necessary precondition for collaboration between different actors in every cluster. Trust is viewed as a cumulative phenomenon and repeated interactions can enhance the level of trust among partners in clusters (Huxham and Vangen, 2005).

Knowledge concentrations or clusters are the primary constructs of many formal national development strategies based on Porter's model. They are in effect a model of a network of actors, where the knowledge cluster is a network of universities, specialists, management consultants, and other service providers including financial agencies, public bodies promoting economic development, and local companies. However, there are two aspects to this management issue - firstly it is necessary to attract agents to a region, and secondly and much more challenging a task, is to motivate the agents to participate and cooperate together (Arbonies and Moso, 2002).

According to a UNIDO report from 1999, the most important problems in developing countries is that small scale entrepreneurs are often locked in their routines and unable to introduce innovative improvements to their products and services or look beyond the boundaries of their firms to capture new market opportunities; therefore they need to overcome this problem through networking. However, the central element for the development of a network is the creation of sufficient trust among actors developed through a process of mutual learning initiative programmes. The external agent who is trained to perform this function can guide this procedure step by step through various initiatives. Although it would be possible to achieve the high level of trust among actors through these initiatives, this process should take place by first implementing lower risk initiatives and subsequently shifting to more complex ones as mutual trust increasingly builds (Ceglie and Dini, 1999).

Most cluster analysis to date has presented either static approaches which failed to discuss effectively how clusters operate and how different elements of a cluster relate to one another; or approaches with only a partial understanding of cluster elements and performance, largely ignoring varying developmental trajectories that a cluster can take over time (Brown and Smith, 2008, cited in Brown and Smith, 2009). A study carried out by Brown and Smith (2009) considering Scottish clusters argues that few researchers have explored systems thinking in relation to the cluster concept. They argue that the dynamics within cluster components are very complex and too difficult to measure and assess. They propose that as the possible solution to this, and in order to better understand cluster dynamics, a systems thinking approach can be very useful. Results of their study confirm that adaptation of this approach for studying different kinds of clusters in Scotland was largely positive (see Section 6.3.1.1).

3.4.1 The role of intermediary organizations in clusters

There is an argument among researchers around possible ways in which to promote the process of continuing innovation, learning and production in a cluster. This is related to the possible ways in which the overall dynamics of a regional knowledge system could be improved. One possible way is through establishing intermediary organizations (Smedlund, 2006). Some regionally embedded institutions such as science parks, universities, chambers of commerce and employers' unions, can enable and support networking among firms in the region. These institutions can be labelled as intermediaries that transfer knowledge inside the region, thus influencing regional success factors (Saxenian, 1994).

The role of the intermediary differs on national, regional and local levels; it is much broader than knowledge transfer in a regional context. National, regional and local intermediaries have distinct roles in terms of innovation, development and production networks of a regional cluster of small firms (Smedlund, 2006). One of the major roles of local level intermediaries is to create trust and communication; high-technology industrial parks and technology centres are good examples (Smedlund, 2006).

An industry consortium created by universities in order to help fund research is another form of intermediary organizations. This is very common in the USA which includes companies paying membership fees to join these consortia expecting benefits in return in respect of access to research (Arbonies and Moso, 2002; White and Bruton, 2007).

Research carried out by Dooley and Kirk (2007) considering the role of the research consortium in university-industry collaborations, shows that designing this kind of mechanism for collaborative research has valuable outcomes for both university and industry. From the university perspective, benefits include access to the source of research funding for university and individual researcher; faster feedback loops relating to the output of the university's discovery science; and an enhancement of status when competing for publicly funded research grants. Other benefits include, creating entrepreneurial culture in universities, and enhancement of research and teaching quality. From an industry perspective these benefits help to acquire a competitive advantage by: gaining access to better leads through faster routes in comparison with competitors; access to rich sources of highly skilled researchers; obtaining capabilities and competencies in more complex innovation processes which would have been beyond the ability of one company to achieve; and providing faster means of knowledge transfer into the R&D process of new product development (Dooley and Kirk, 2007). Other benefits of research consortia include, creating innovation culture in companies, and increasing opportunity for firms to recruit talented students (Gerwin et al., 1991). Although there are a number of mechanisms are available for UIC, some of these mechanisms, such as collaborative research e.g. availability of research consortia are more suited to integrated university-industry-government Triple Helix Model operation (Dooley and Kirk, 2007).

3.5 STAGES OF COMPETITIVE DEVELOPMENT

Nations must pass through different stages of competitive development in order to achieve a competitive position. Two most popular models of such development chronology are introduced by Porter (1990), and also the World Economic Forum's annual Global Competitiveness Report (e.g. 2008 version), which is updated every year. This section focuses on the 2008-2009 updated version of this report.

3.5.1 Porter's Stages of competitive development

"*National economies exhibit a number of stages of competitive development reflecting the characteristic source of advantage of a nation's firms in international competition and the nature and extent of internationally successful industries and clusters*" (Porter, 1990 p545). These four stages indicate the position of the country in those industries subject to international competition; they also indicate the state of competition in many purely domestic industries. Illustrated in Figure 3.5 they include: factor driven; investment driven; innovation driven; and ultimately, wealth driven (Porter, 1990).

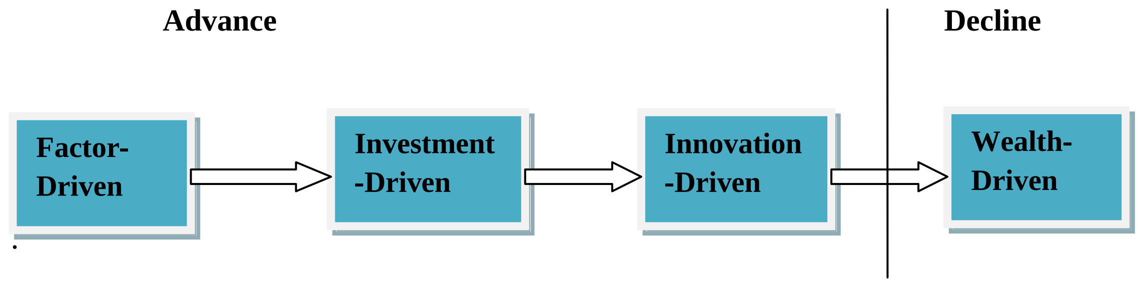


Figure 3.5: Four Stages of National Competitive Development: Adapted from Porter (1990, p546)

Building competitive advantage is not a short-cycle that might be accomplished in 3-4 years, rather it is a long term process and may take over a decade, because it requires upgrading of personnel skills, investing in product and processes, building clusters, and gaining the ability to export to other nations (Porter, 1990).

3.5.2 Stages of competitive development (Based on the World Economic Forum's annual global competitiveness reports)

The Global Competitiveness Report (2008) categorizes the level of competitiveness of a country based on 12 main pillars. Through evaluation based on these 12 pillars, countries can be classified into three stages of development. The first stage is described as a factor-driven economy. Countries at this stage mostly compete based on their natural resources, primarily unskilled labour; and their factor endowments. Competition among companies is on the basis of price and sales of basic products or commodities, with usually low productivity reflected in low wages. Well-functioning public and private institutions (pillar 1), a well-developed infrastructure (pillar 2), a stable macroeconomic framework (pillar 3), and a healthy and literate workforce (pillar 4) can maintain competitiveness at this stage of development. To be ready to move into the next stage of development government also should increase efficiency of legal framework and decrease the burden of government regulations. Countries move into the efficiency-driven stage of development as wages rise with advancing development. This is the crucial stage at which countries must begin to develop more efficient production processes, increase product quality and develop higher value products and services. The availability of effective higher education and training (pillar 5), an efficient goods market (pillar 6), a well-functioning labour markets (pillar 7), a sophisticated financial market (pillar 8), a large domestic or foreign market (pillar 10), and the ability to harness the benefits of existing technologies (pillar 9) will drive competitiveness. As countries move into the final stage which is the innovation-driven stage, they are able to sustain higher wages and the associated standard of living, but only if their businesses are able to compete with new and unique products. "*At this stage, companies must compete through innovation (pillar 12), producing new and different goods using the most sophisticated production processes (pillar 11). The concept of stages of development is integrated into the index by attributing higher relative weights to those pillars that are more relevant for a country at its particular stage of development*" (World Economic Forum, 2008, p7). The key constituents of each pillar are available in Appendix A.

Based on these categories there are five evolutionary states of an economy:

1- Factor driven economy (Stage 1)
2- Countries in transition from Stage 1 to 2
3- Efficiency-driven economies (Stage 2)
4- Countries in transition from Stage 2 to 3
5- Innovation-driven economies (Stage 3)

Statistics based on these categories, place Iran in the second category, which is that of a country in transition from factor-driven to efficiency driven (World Economic Forum, 2008).

The concept of different stages of development is integrated into the Index by assigning higher relative weights to those pillars that are relatively more relevant to a country given its particular stage of development. Although all 12 pillars are important to a certain extent for all countries, the significance of each one depends on a country's particular stage of development. *"To take this into account, the pillars are organised into three sub indexes, each critical to a particular stage of development. The basic requirements sub index groups those pillars most critical for countries in the factor-driven stage. The efficiency enhancers sub index includes those pillars critical for countries in the efficiency-driven stage. And the innovation and sophistication factors sub index includes the pillars critical to countries in the innovation-driven stage*." (World Economic Forum, 2008, p7). The three sub indexes are shown in Figure 3.6. The specific weights attributed to each sub index in every stage of development are shown in Table 3.2 (see Appendix A).

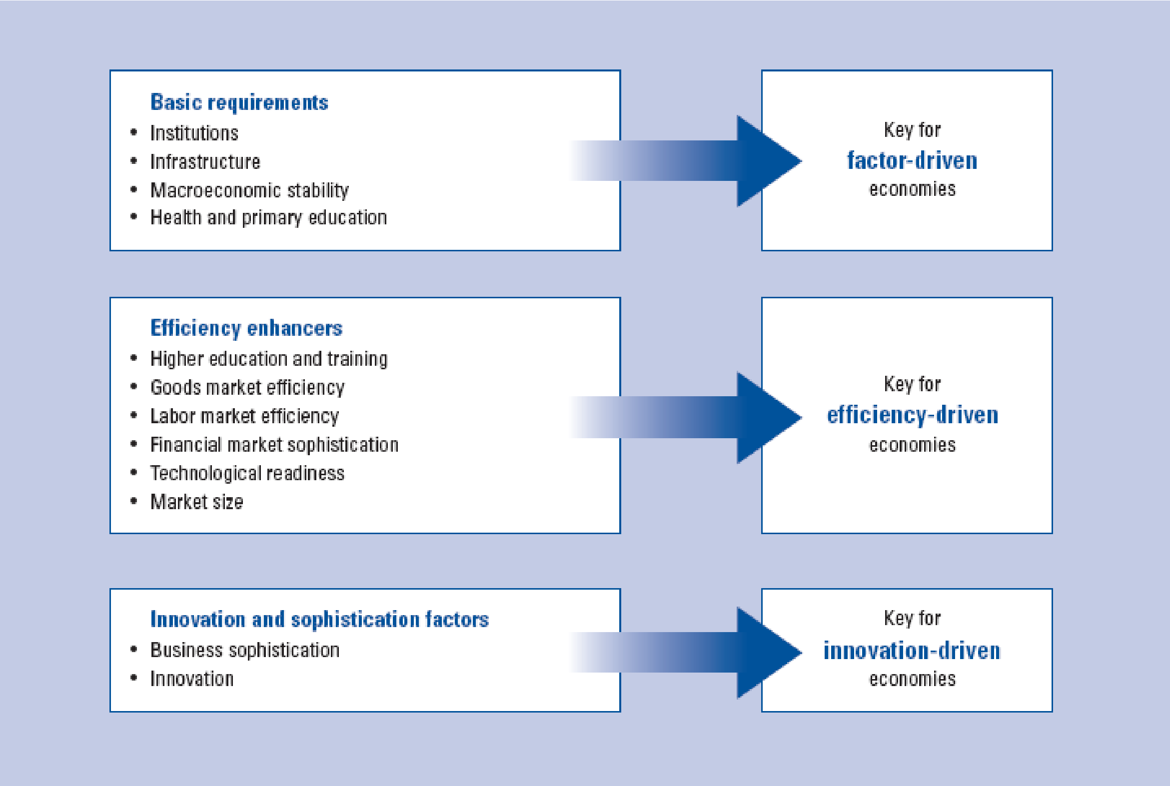


Figure 3.6: 12 Pillars of competitiveness (Source: World Economic Forum, 2008)

Pillar group	Factor-driven stage (%)	Efficiency-driven stage (%)	Innovation-driven stage (%)
Basic requirements	60	40	20
Efficiency enhancers	35	50	50
Innovation and sophistication factors	5	10	30

Table 3.2: Weights of the three main groups of pillars at each stage of development (Source: World Economic Forum, 2008)

3.6 CRITICAL INGREDIENTS FOR THE SUCCESS OF DIFFERENT NIS

By evaluating different systems of innovation and experience of successful countries which have moved from one stage of transition to another, it is evident that availability of venture capital and existence of comprehensive intellectual property systems is vital regarding UIC and consequently economic development.

3.6.1 Venture Capital

For technology-based companies, because the nature of these companies' activity is based on higher risks and involves large development investments, seeking risk capital is the usual means of funding since it does not require a security, and returns for investors depends upon the growth and profitability of the company (Marques and Neto, 2007). This kind of financing mechanism provides capital and also offers managerial and administrative support that is very different from traditional sources of borrowed finance (British Venture Capital Association, 2000).

Venture Capital (VC) is mostly characterized by high risk activity and potentially high return investment to support business creation and growth. The process happens through equity participation which provides a source of funds to finance start-up companies which have a prospect of high growth (Gompers and Lerner, 2001). Policy makers are very interested in VC markets, because it is a sensible strategy to fund high-tech companies that are rapidly growing and ultimately can have a positive effect on economic development (Wonglimpiyarat, 2006). According to Cumming et al. (2005) many factors influence VC markets for instance the country's legal and institutional structure, the position of the stock market, investor sophistication and the ability to supply VC finance to entrepreneurial firms.

A venture capital industry acts as an important infrastructure element to foster innovation and an entrepreneurial climate for the country and as a result lead to wealth creation. Government in many countries, e.g. Singapore; Japan and South Korea, support the development of a venture capital industry in order to facilitate high levels of economic growth. Venture capital industry is supported by policy instruments e.g. tax-incentives and subsidies. Successful venture capital industry exists in environments which offer high-quality investment opportunities and the general availability of experienced managers who can help companies build their businesses (Koh and Koh, 2002).

Different kinds of venture capital exist which include private, public, university, corporate and foundations venture capital. Taken together the various forms of venture capital can bring advanced technology to market. In the TH model, basically venture capital acts as an intermediary between university, industry and government (Etzkowitz, 2005).

The US experience in Silicon Valley can be considered as a benchmark for other countries. However to replicate Silicon Valley it is necessary to have a high degree of networks between actors (Wonglimpiyarat, 2006). To date no country has achieved the same level of success as Silicon Valley since there is a fundamental difference in culture. "*Unless those working in a high-technology cluster have the same beliefs, attitudes and values as those in Silicon Valley they are unlikely to replicate its achievement, regardless of the physical, legal and financial environment*" (Owen, 2007, p6). Historically the success of Silicon Valley was owed to the culture of the gold-seekers in this area, where risk taking was rewarded and failure was not punished. This culture shaped the foundation for the success of today's Silicon Valley. Therefore, the most important requirement in order to replicate this regional success is the need for an innovative-risk taking culture (Valery, 1999; Koh and Koh, 2002).

3.6.2 Intellectual Property Rights (IPR)

"*The global trend towards stronger intellectual property rights that has taken place in the past two decades has progressed in different dimensions and has extended form developed to developing countries*" (Forero-Pineda, 2006, p808). It has a further impact on many industries in developing countries where, for several decades, restrictions have existed on patenting and these countries have refused to allow patenting activities to take place e.g. pharmaceutical industry in some developing countries. Major changes in the global regime of IPR and relevant trends have an impact on the way technological and scientific research is conducted in developing countries. These changes are: establishment of specific conditions for access to the World Trade Organization; the extension of patent protection for some sectors in developing countries e.g. pharmaceutical; the patenting of research tools and databases and the Bayh-Dole Acts in the USA. Also in developing countries, besides these external pressures, local interests for enforcing intellectual property protection had emerged, in association with the development of local technology and also commercialization of imported goods. However, these procedures require a stronger stand on intellectual property which covers both legislation and enforcement perspectives (Forero-Pineda, 2006).

These issues have an impact on university and industry IPR behaviour. The Bayh-Dole Act and biotechnology revolution, for example, fostered the patenting of academic inventions which lead to higher willingness academics to apply for patents (Geuna and Nesta, 2006).

Research partnerships between universities and industry take many forms ranging from sharing of information or infrastructure to creating new research entities. This kind of partnership requires effective intellectual property protection mechanisms such as patents, copyrights, trademarks and trade secrets. These mechanisms are very important because sharing of information is key to the initial formation of the research partnership as well as to the process of completing the designed research (Hertzfeld et al., 2006). Critics suggest that the use of intellectual property protection mechanisms in research partnerships is dependent on many factors such as organizational characteristics and the culture of the owner of the knowledge as well as of the nature of the partnership, the objective of the partnership and the position of the partnership during the project. Negotiation the process of IPR depends on the type of partners, and it is more complex when universities are involved. Companies report that negotiating an IPR agreement with university technology transfer offices is very complex (Hertzfeld et al., 2006). Economic theory, strategic management and the legal literature emphasize the importance of IP and all of them describe it as a core to their argument for research partnerships (Hertzfeld et al., 2001).

In order to harmonise IP regimes with international agreement some developing countries have introduced reforms to their current national regimes. However, major actions still remain in order to define how these laws are applied to different industries, and how they are enforced on the ground. Governments have developed protection laws in selected industries, while neglecting to extend the same level of protection to other industries (Jayakar, 2003). Many developing countries legislated new IPR laws; however actual enforcement has still to take place (Jayakar, 1997). Practically all nations differ in terms of intellectual property protection in how they enforce these laws. Some nations may design a special institutional structure and financial resources to enforce IP laws and some do not. Countries could be categorized in terms of IP law, ranging from those with no laws to those with efficient and strong laws. Similarly, enforcement of laws can range from no enforcement to the availability of very strong enforcement of the law. The existence of IP laws and their enforcement are necessary prerequisites for intellectual property protection (Robert and Ostergard, 2000). According to Sherwood (1997) IP has eight different components and one of the most important ones is enforceability.

It is widely accepted that a stronger intellectual property system protect innovators from imitations and as a result economic growth is stimulated. Therefore, innovation is encouraged (Chen and Puttitanun, 2002; Furukawa, 2007).

An effective and internationally connected IPR system is recognized as one of the major prerequisite of technology development in developing countries, which can facilitate the technology transfer process (Salami and Goodarzi, 2006; Sarkissian, 2008). An IPR system is one of the main sub-systems of NIS which should interact with other sub-systems in an efficient way. Therefore, it is necessary for developing countries such as Iran to recognize the role of IPR system to strengthen the national innovation systems. This activity might include modifying national IPR laws, improving IPR enforcement mechanisms, providing proper education and training programmes and also changing the organizational structure of the industrial property office (Salami and Goodarzi, 2006).

New internationally-agreed trade regulations for IPR could be considered as a means to introduce more order and predictability, and for disputes to be settled in a more systematic way. The WTO's TRIPS Agreement is an effort to bridge the gaps in the way these rights are protected in different countries, and to bring them under common international rules. It establishes minimum levels of protection that each government has to give to the IP of fellow WTO members. The agreement consists of five issues (www.wto.org).

1. How basic principles of the trading system and other international IP agreements should be applied
2. How to give adequate protection to IPR
3. How countries should enforce those rights adequately in their own territories
4. How to settle disputes on IP between members of the WTO
5. Special transitional arrangements during the period when the new system is being introduced.

The Fourth Economic, Social and Cultural Development Plan of Iran (2004-2009) which emphasizes the role of government to design and implement a complete IP system which can stimulate commercialization of research results and facilitate the development of knowledge-based products. The TRIPS principles contrast with experience inside Iran: ..“*recent years have witnessed a heated debate about the need to overhaul the Iranian intellectual property system in both academic and policymaking circles. However, a close scrutiny of the debates reveals that a study offering a coherent account of the big pictures of the intellectual property (IP) system is still missing*” (Sarkissian, 2008, p786). Currently the match between IP registration and enforcement with the level of development of Iran is required (Sarkissian, 2008). Contradictions persist in articles related to IP issues e.g. different interpretations regarding ownership of inventions during employment contracts between owner and employee. An example of shortcomings of this system is the failure to change efficiently from a declarative system to a system based on examination. Currently two different stages are available in the Iranian IP system when an individual decides to commercialize an invention. Firstly, there is registration of the invention and the assignment of a patent to the inventor (based on declaration) and secondly, when the inventor decides to commercialize the invention an examination system takes place. If the patent is accepted then the government will give incentives for commercialization (Sarkissian, 2008).

The following section describes the process of privatisation in different countries and its potential effect on competitiveness and economic growth.

3.7 FROM STATE TO PRIVATE OWNERSHIP

As a result of effective privatisation performance will be improved (Megginson and Netter, 2001), whilst that firm's profitability is also likely to increase particularly with respect to strategic industries (Boubakri et al., 2009). Privatisation plays a crucial role in the transition process toward a free market economy (Bitzenis, 2003; Pitelis in Wignaraja, 2003). However, privatisation has a particularly strong linkage with corruption-especially in transition economies when initial property rights are poorly defined (Kaufmann and Siegelbaum, 1996).

Experience of some developing countries, e.g. Bulgaria, shows that when privatisation is slow it has a negative impact on the trustworthiness of the Government. There may be underlying factors responsible for the delay of the privatisation process e.g. political instability. Other factors also have an impact on the slowness and ineffectiveness of the privatisation process for instance the lack of transparency and the existence of corruption which discourages investors, an inadequate legal framework, the late abolishment of monopolies and the lack of an efficient stock market (Bitzenis, 2003).

The privatisation process is not only the source of corruption in a country but is implicated in the misallocation of resources by government, discriminatory behaviour of government between incumbent and other innovators could be a further sources of corruption which acts to demotivate innovators and dissuades entrepreneurs from investing. In corrupt societies investment returns are difficult to predict. Therefore, this situation demotivates entrepreneurs and investors and as a result investment is less likely to occur. Corruption can limit private investment which makes a barrier for sustainable economic development (Everhart et al., 2003). Corruption may also lower the rate of innovation in the country (Veracierto, 2008).

3.8 CONCLUSION

Three major theoretical framework including Porter's Diamond Model, NIS, and Triple Helix Model were considered in this chapter to investigate a role of UIC in a National Systems of Innovation. It can be concluded that in all of these theories the efficiency of government policies and effectiveness of four types of flow determine the success of UIC activities in NIS. These include: effectiveness of knowledge flow, effectiveness of financial flow, effectiveness of human capital flow and effectiveness of regulatory flow. Increasing effectiveness of these types of flows, in addition to efficient cluster formation policies, are usually considered as preconditions for creating entrepreneurial environment in countries. These activities can increase efficiency of any NIS.

These three theoretical frameworks considered trust and culture as two important elements which contribute to the success or failure of an NIS in general and UIC in particular. However, there is no literature related on the mechanism for including trust and cultural forces to innovation systems, thus presenting a gap in the field of NIS.

Nations must pass through different stages of competitive development in order to achieve a competitive position. These three theoretical frameworks together with World Economic Forum identified different stages and critical elements to achieve a position of developed NIS. However, still there is no efficient model to illustrate the process of interactions between these elements.

CHAPTER 4

MICRO-ECONOMIC ENVIRONMENT: UNIVERSITY-INDUSTRY COLLABORATION (UIC)

4.1 INTRODUCTION

The needs of industry to acquire technology from external sources e.g. universities, in order to respond to the global competitiveness, and also the growth and sustainability of high technology SMEs highlight the importance of the University-Industry Collaboration (UIC) (Mitra and Formica, 1997).

In addition to the physical capital and labour, knowledge is an important element of economic growth with entrepreneurship and U-I relations vehicles for knowledge flow. Mueller (2006) found that countries with a higher level of entrepreneurship experience better economic performance.

Technology transfer between universities and industry contributes to business competitiveness and economic growth (Hitt et al., 2000) and drives innovation processes (Fiedler, in Bulumac and Bendis, 2001; Perkmann and Walsh, 2007). Promoting university-industry relations has been considered a key driver for every country in order to move towards a more knowledge-based economy (European Commission, 2003).

This chapter provides an overview of the literature that related the micro-economic environment of UIC, and begins with a discussion of technology transfer (TT); introducing different partners in TT. It also highlights possible means of acquiring technologies for companies, introduces different mechanisms of TT from universities to industry, and also highlights the role of trust and commitment for successful UIC. Furthermore, it shows different motivational factors for various stakeholders in the UIC processes, the barriers to and incentives for TT, and also highlight the role of Technology Transfer Office (TTO) in UIC process. This chapter also explains in detail the role of academic spin-offs, science and technology parks, and also underlines the role of social capital in university-industry TT.

4.2 DEFINITIONS OF TECHNOLOGY TRANSFER

The general definition of technology transfer is “*the set of tools helping to make an invention to become an innovation*” (Fiedler, in Bulumac and Bendis, 2001, p120). An alternative definition is “*the transfer of new knowledge, products or processes from one organization to another for business benefit*” (Wittamore et al., 1998, p2). From the university-industry collaboration perspective this definition includes “*any process by which basic understanding, information, and innovations move from a university, an institute, or a government laboratory to individuals or firms in the private and quasi-private sectors*” (Parker and Zilberman, 1993, p88).

4.3 PARTNERS IN TECHNOLOGY TRANSFER ACTIVITIES

There are many partnership collaborations involved in TT activities including: between large and small enterprises, groups of SMEs, and between industry and university. University and industry are recognized as the classic partners when discussing TT, not only with large companies and universities but also between universities and SMEs. The latter, in most cases, is the focus of the majority of TT promotion activities (Fiedler, in Bulumac and Bendis, 2001).

4.4 MEANS OF ACQUIRING TECHNOLOGIES FOR COMPANIES

Companies can choose to acquire the technology that they require through a variety of means. The most common is to buy technology which is the fastest and safest way.

However, this method sometimes does not give a company competitive advantage, because the same procedures are likely to be available for other companies with the necessary financial resources. Another method is the internal development of technology which requires a high investment in R&D, meaning that only a small number of firms currently follow this route (Alves, 1998 cited in Jose et al., 2005). In addition, establishing joint technological development projects with universities is a method which gives greater competitive advantage compared to the buying of technology due to uniqueness of the process and a higher level of involvement of firms (OECD, 2001b). This paradigm varies between developing and developed countries and can depend upon the involvement of both university and industry in the process (Utterback and Abernathy, 1975). However, firms should consider entering into strategic alliances with universities to be successful if the benefits of such alliances are greater than the cost of developing technology internally and also greater than acquiring technology from other sources (Elmuti et al., 2005).

Industrial innovation plays a key role in economic development and providing firms with strategic alliances. In this regard, universities play a significant role as the source of creating new technologies and providers of needed qualified personnel (Lee and Win, 2004; Guan et al, 2005).

4.5 MECHANISMS OF TT: UNIVERSITIES TO INDUSTRY

The evolution of relationships between universities and industry in a specific country defines whether new partnerships are likely to provide the foundation for future economic development. This evolution develops from a traditional model (University supply-led technology transfer) to more market-oriented ones (Market-led technology transfer e.g. creation of spin-off companies) (Mitra and Formica, 1997).

There are a variety of instruments available for TT between universities and industry including: marketing, contract research and development, the transfer of research results, the transfer of personnel and spin-off company formation (Fiedler, in Bulumac and Bendis, 2001). Other vehicles for TT include publications, conferences and seminars, patents and licenses, research consortia and networks, joint ventures, consulting arrangements, research and science parks, and business incubators (Mitra and Formica, 1997; Owen et al., in Bulumac and Bendis, 2001; Lee and Win, 2004; Debackere and Veugelers, 2005). Licensing agreements, research joint ventures, and university-based start-ups are considered to be the most important commercial mechanisms for technology transfer. This kind of activity also leads to financial gain for universities (Siegel and Phan, in Libecap, 2005).

Different mechanisms of technology transfer are suitable for specific phases in the innovation cycle. Spin offs for example, are considered an important mechanism in the invention phase; while for the purpose of product differentiation, consulting is more important (Polt et al., 2001).

Many types of interaction exist between universities and industry, ranging from a simple kind of interaction e.g. ad hoc consultation; to more sophisticated forms of collaboration e.g. contract research and joint research. As these kinds of interaction evolve from simpler to more sophisticated activities the patterns of interaction between the three main actors, including university, industry and government, should also evolve from isolated to a more strategic status. In order to have more sophisticated interaction, government programmes can encourage industry to participate by reducing the risk of partnership-building with universities. Critical element of each interaction is communication among individuals; personal communication and trust are the starting points of each type and each level of collaboration (Inzelt, 2004). Five patterns of interaction in evolution during transition between government, university and industry are identified by Inzelt (2004) which consist of 'isolated form', 'vertical', 'arm's length', 'between Arm's length and horizontal triple helix' and finally 'horizontal triple helix'. In 'vertical' and 'arm's length' patterns of interaction -the second and third stages of transition- the existence of a comprehensive IPR system is necessary in order to achieve join IP between university academics and firms. In 'horizontal triple helices' forms of interaction pattern- the fifth stage of transition- more formal types of collaboration such as joint research and contract research, are being shaped. Also, mobility of staff and knowledge flow through spin-off formation is more common at this stage (Inzelt, 2004). The experience of Hungary in designing special initiatives to offer more options for networking in contrast with the previous stages of transition is a good example, showing the impact of appropriate government initiatives. For instance by encouraging industry to set up or expand existing high-tech laboratories by offering large grants for those establishing research facilities, during a specific stage of transition. This can positively encourage arm's length cooperation and create good pre-conditions for the upgrading of joint research activities, and encourage the mobility of staff from university to industry (See "Sunrise" and "Sunset" programmes in Inzelt, 2004, p984). Perkmann and Walsh (2007) consider UIC relations beginning with a high relational involvement e.g. research partnerships; and a medium relational involvement such as the mobility of people; with a low involvement such as the transfer of technology and commercialization of IP.

A study carried out by Eun et al., (2006) explains and evaluates the evolution of UREs (University-run-Enterprises) in China, categorizing different governance forms that mediate science and technology knowledge flow from university to industry which are illustrated in Figure 4.1. The vertical axis shows different university regimes and different degrees of entrepreneurship of universities, which are ‘Teaching University’; ‘Research University’; and ‘Entrepreneurial University’. “*Some of these governance forms are based more on market mechanisms, while others are based more on hierarchical or hybrid mechanisms*” (Eun et al., 2006, p1333).

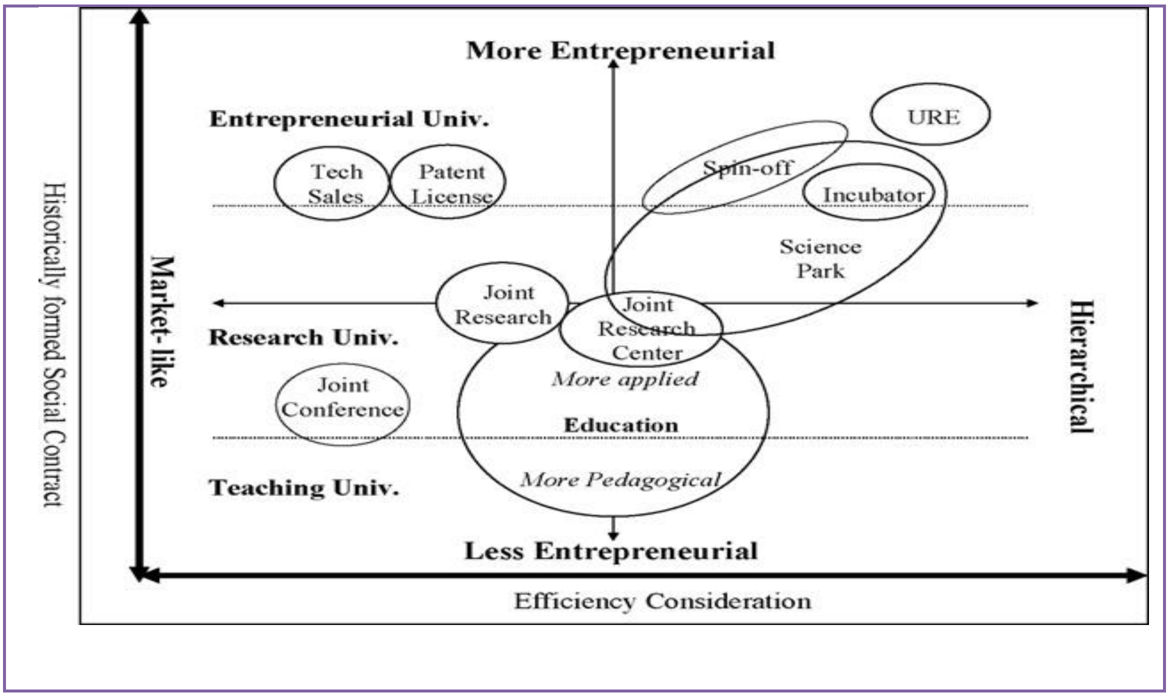


Figure 4.1: Macro-level framework: a typology of university-industry linkages (Eun et al., 2006).

4.6 TRUST AND COMMITMENT: KEY INGREDIENTS FOR UIC

According to Hewlett Packard’s model, by the name of “partnership continuum”, the development of strategic collaboration between universities and industry proceeds along a continuum. It emphasizes the main ingredient for success in these partnerships is trust (NCURA, 2006). Trust is strongly associated with greater technology transfer activities for relations between university and companies (Santoro and Gopalakrishnan, 2001). Some factors, like a breakdown in trust, a change in strategy and inability of partners to mesh their cultures, leads to under-performance and ultimately the failure of strategic alliances (Elmuti et al., 2005). Integration, trust and commitment are recognized as key drivers of successful university-industry relationships (Plewa and

Quester 2007). Thune (2007) also found that familiarity, trust, common understanding, and a long-term commitment to collaboration have positive impacts on the formation and management of university-industry relations. Plewa and Quester (2007) indicated that compatibility of organizational cultures has a positive influence on trust and commitment and trust positively influences commitment. Also the likelihood that a relationship would be renewed at the end of the current contract is positively influenced by commitment and trust. However, the former has a greater influence on a partner's intention to renew the current contract. According to Gerwin et al., (1991) other important issues for renewing a relationship would be: gain and the usage of research, satisfaction of partners from each other' regulations regarding UIC, financial return for each institution, accessibility of university technology for companies, and accessibility of funding for universities.

4.7 MOTIVATIONS FOR UIC ACTIVITIES

4.7.1 Motivational factors: Researcher collaboration with Industry

Recognition and non-financial rewards are some of the major motivators for researchers to collaborate with industrial partners; benefits include promotion, better welfare, and more opportunities for grants and research funding and a better position in society (Liu and Jiang, 2001). Some universities would be required to modify their rewards system in order to achieve effective technology transfer activities (Siegel et al., 2004). A further source of motivation is financial rewards for both universities and researchers. Financial gains from cooperation allow a faculty to purchase new equipment, hire bright students and also reduce their teaching to enhance research (Lee, 1996; Freitas et al., 2009). Other motivational factors for researchers are the possibility of maintaining collaborative industrial contacts, and also of increasing future research opportunities

(Freitas et al., 2009), recognition within the scientific community, financial gain and also a fulfilment of the desire to secure additional research funding (Siegel et al., 2004).

The management of IPR and the evaluation system are salient incentive mechanisms. The ownership of IPR can be considered an incentive mechanism that encourages universities to look for commercial applications of their research. Establishing a fair sharing arrangement for royalty payments to researchers also increases their interest and commitment to the commercialization process. A further incentive mechanism is appraisal systems for academics based not only on traditional teaching and research metrics, but also considers relevance of their research to industry (Debackere and Veugelers, 2005). Feeling a sense of accomplishment when working with industry and enhancing practical knowledge are other sources of motivation of researchers for collaboration (Gerwin et al., 1991).

4.7.2 Motivational factors: University collaboration with Industry

From the university's point of view, they can upgrade their infrastructure and also create grants for faculty members (Lee, 1996). A further benefit might be forming spin-off companies so that both researcher and university receive satisfactory financial benefits (Liu and Jiang, 2001).

A study carried out by Decter et al., (2007) which compares the UK and USA in terms of university to business technology transfer, identified a list of factors which motivate university to business transfer of technologies. The main ones they identified included: royalty payments to university, university support to business, good publicity for the university, financial support for university research, and recruitment and retention of staff (Decter et al., 2007). Other motivational factors for university have been found to include: enhancement of teaching and job offers for graduates, and also creating an entrepreneurial culture in their institutions (Rene and Heinrich, 2006).

University funding cuts or decreases in funding by a Ministry of Education could be a potential external driver for the university to seek outside funding and as a consequence collaborate with industry (Laukkanen, 2003).

4.7.3 Motivational factors: Company collaboration with Universities

Companies can also be motivated to acquire technology from universities. The main motivation for companies are: access to new ideas and technologies that allow achievements of competitive advantage, reduction in their own R&D cost, greater speed to market with new technology, building links with universities and recruitment and retention of staff, and access to the equipped university physical facilities (Decter et al., 2007; Dooley and Kirk, 2007; Freitas et al., 2009). Further motivational factors have been listed as: availability of efficient IPR policy framework in universities, lack of in-house R&D and a shortening product life cycle, access to the university's physical facilities and the expertise of its staff, access to the research and consulting services of university, an improved public image in society, improving sales and profitability, increase qualification level of employees, creating innovation culture in their institutions, gain technical knowledge, recruiting good and qualified graduates, and quality improvements (James and Casey, 2004; Lee and Win, 2004; Radas, 2005).

4.8 PROMOTING UNIVERSITY-INDUSTRY TECHNOLOG TRANSFER

Improvements in TT processes include: a greater intermediary involvement, better rewards for inventors, better government funding of near to market technologies, greater availability of financial resources, and the availability of experienced technology transfer office staff (Decter et al., 2007). Availability of training/education for faculty members and graduate students regarding the entrepreneurial process can also enhance UIC (Siegel and Phan, in Libecap, 2005).

Availability of an appropriate organizational structure, processes and context within the university is crucial in order to channel academic R&D towards exploitation (Debackere and Veugelers, 2005). In terms of organizational structure, decentralization is critical; which means that government give universities sufficient autonomy and freedom to develop their research policies and relationships with companies. This issue is also very important inside the university, particularly with respect to giving autonomy to the TTO for developing relations with industry (Debackere and Veugelers, 2005). "*There is a positively correlation between start up formation and the university's expenditure on intellectual property protection, the business development capabilities of TTOs, and the extent to which its royalty distribution formula favours faculty members*" (Siegel and Phan, in Libecap, 2005, p25).

Some countries, such as the US, design effective policies to increase the contribution of university research to the economy. By designing such a policy they also create incentives for inventor involvement in post license development and commercialization, and as a result technology transfer is speedily facilitated. For example the Bayh-Dole Act in the US led to an increase in the patenting of university faculty inventions (Mowery et al., 2004). Asian countries, e.g. Japan, recently introduced a new law for universities granting them autonomy from government. The aim of this law is to promote inter-university competition and more socially engaged institutions. Japan anticipates major reforms for 2010 in order to effectively link university and industry together (Woolgar, 2007). Additionally, some governmental policies can encourage companies to develop partnerships with universities e.g. by providing tax incentives and funding programmes that require companies to work with universities as a condition of their funding (Rynes et al., 2001). However, traditional policy instruments e.g. tax incentives, present inherent problems for SMEs and is often negatively affected by complex procedures (Andersson, 2000).

There are other successful programmes at enhancing university-industry collaborations and improving knowledge transfer activities. Several popular and successful programmes are mentioned in Table 4.1.

Programme	Explanation	Reference
Knowledge Transfer Partnerships (KTP)	UK-wide programme part-funded by government organizations led by the DTI which aim at improving the competitiveness and productivity of businesses and organizations through the use of technology, skills and knowledge available in academic base institutions. Three pillars of this programme are associate, company partner and knowledge base partner (KTP Website: www.ktponline.org.uk). KTP initiative is about "*subsidising top graduate talent to work on specialist projects for up to three years. The rationale is that it unlocks the expertise of the universities in the favour of business. It's a simple formula that can boast a number of early success*" (KTP, 2005, p29).	(KTP Website: www.ktponline.org.uk; KTP, 2005)
Interface	The knowledge connection for business (Interface) was launched in 2006 and was funded by the Scottish Funding Council and the Scottish Government. It plays a role in stimulation and brokerage. The major aim is to enable companies to gain easier access to Scotland's universities and research centres. The salient role of Interface is supporting partner university and research institutions in presenting opportunities and solutions to businesses that match their requirements.	(Jordan et al., 2009)
Vouchers for Technology and Innovation	The technology voucher, which is implemented by the Italian Government, is recognized as an innovative tool to enhance the demand of technology and scientific knowledge in SMEs. "*The voucher is a credit note given to selected SMEs to be spent in research centres, universities or Knowledge Intensive Business Services (KIBS). Thus, the purpose of voucher is to foster collaboration between SMEs and these organizations reducing bureaucracy and time of fund assignation that often prevent SMEs from applying for public funds.*"	(Sala et al., 2009, p1)

Table 4.1: Successful programmes to enhance university-industry collaborations

4.9 TECHNOLOGY TRANSFER BARRIERS: UNIVERSITY-INDUSTRY

In order to focus on the entrepreneurial dimensions of technology transfer, some crucial issues must be addressed. These are: competency and skill deficiencies in many TTOs and inconsistency of reward systems for greater entrepreneurial activity (Siegel and Phan, in Libecap, 2005). Other impediments include informational and cultural barriers between universities and firms, and insufficient rewards for faculty involvement in university technology transfer, such as credit toward tenure and promotion (Lee, 1996; Siegel et al., 2004; Siegel and Phan, in Libecap, 2005; Dooley and Kirk, 2007).

Problems with staffing in the TTO, insufficient business and marketing experience and furthermore, the lack of entrepreneurial experience in these offices are also barriers (Siegel et al., 2004; Siegel and Phan, in Libecap, 2005). Lack of understanding between university and industry via scientific norms and environments; bureaucracy and the inflexibility of university administrators and insufficient resources devoted to technology transfer by universities are also other major barriers (Siegel et al., 2004). The university's own institutional rigidity, fragmented organization, and the lack of mutual trust between firms and universities have been found to limit university-industry interaction in developing countries such as Tunisia (Bouhamed et al., 2009) and Croatia (Singer and Peterka, 2009).

A high degree of university inflexibility has two main consequences - the first one is a decrease in the number of technology transfer agreements, whilst the second is the prospect that university scientists will become reliant upon informal commercialization and knowledge transfer encouraging them to circumvent formal procedures (Siegel et al., 2004).

Cultural misunderstanding has a significant negative consequence; it creates a barrier in the negotiation of licensing agreements (Siegel et al., 2004). Differences between the objectives of partners normally produce a cultural gap between parties. An industrial culture is more based on profit maximisation and secrecy, while university culture is founded on the dissemination of knowledge and sharing of results (WIPO, 2002; Siegel and Phan, in Libecap, 2005). Companies which are operating in an entrepreneurial culture are motivated by the desire to commercialize university technologies for financial gain. Speed is very important for firms, because they want to commercialize technology as soon as possible to gain advantage over their rivals (Siegel et al., 2004; Siegel and Phan, in Libecap, 2005).

A cultural gap between partners also prevents trust building, which is a prerequisite for long term relationships benefiting all partners. Participation in regional networking organizations and also the presence of professional TTOs can facilitates the process of good understanding between partners, bridge the cultural gaps, and as a result increase interaction and enhance level of trust (European Commission, 2003).

Liu and Jiang (2001) found barriers are stronger in developing countries. Related to businesses, this includes a lack of strategic perspectives since management are chiefly interested in mature technology imported from developed countries that will result in fast short-term performance, rather than waiting for long-term, local projects. Limited R&D experience and capabilities in SMEs means technology transfer via collaboration is an absorption challenge for the enterprise. Limited financial resources in SMEs and poor levels of effective communication with universities also hinder collaboration. According to NCURA (2006) and Dooley and Kirk (2007) legal issues concerning the protection of IPRs, negotiation problems and conflict of access to intellectual property and the proportionate share of each stakeholder, also acts as a barrier to collaboration. WIPO (2002) highlights existing national IP policy frameworks, as well as the patent policy of an individual institution, have a strong influence on university-industry relations in every country.

Other major barriers are: communication problems, lack of entrepreneurs in universities and differing financial expectations (James and Casey, 2004; Decter et al., 2007). Problems such as difficulties in agreeing a technology transfer deals, slowness in negotiation of technology transfer deals, and financing technology transfer deals, are obstructive to the accessing of university technologies (Decter et al., 2007).

4.10 TECHNOLOGY TRANSFER OFFICES IN UNIVERSITIES

TTOs are mediating institutions which are designed to improve the link between science and innovations (Debackere and Veugelers, 2005). Roles TTO play varies among universities, but generally they identify technology with commercial potential, help researchers to patent their inventions, packaging the technology in a proper way so as to attract companies, develop strategies to market technology, and leading license negotiations with potential licensees. The availability of the right mixture of expertise in the office, such as scientists, lawyers and businessmen, will increase the probability of successful of technology transfer (WIPO, 2002). In some institutes, managing apprenticeship programmes is another, more traditional role for the TTO (Siegel and Phan, in Libecap, 2005).

4.11 ACADEMIC SPIN-OFF

They are two main routes for commercializing university research results; licensing the invention or collaborative research in order to commercialize the invention. Other routes include creating spin-off companies (WIPO, 2002; Macho-Stadler et al., 2008) which is an entrepreneurial route with the company birth-rate normally considered an indication of the quality of the university-industry links of a country (Macho-Stadler et al., 2008).

Mitra and Formica, (1997) classified the types of university spin-off's:

- Enterprises set up by the academic staff of a university who wish to exploit commercially the results of their research in that university;
- Enterprises set up by graduates of a specific university who wish to exploit commercially the results of research in which they have been involved at their university;
- Enterprises set up by individuals outside the university who decide to exploit commercially the results of the university's research

Macro and micro level factors have an effect on the willingness of academics to start a business to exploit their inventions. Factors which have a positive impact on the academic's entrepreneurial involvement and intention to become an entrepreneur include the availability of personal networks including academics and other people with a business background, the availability of different motivational factors, previous work with the industry, a high level of support from the academic institution, having business related skills, and undertaking more applied research. These factors have a positive impact on academic spin-off birth-rate (Prodan et al., 2006).

It is essential for TTO's to facilitate and design specific academic spin-off contracts between universities, researchers, and venture capitalists (Macho-Stadler et al., 2008). There are three different phases identified regarding proactive spin-off policies. The first, origination phase, is described as a first selection point and comprises a period of opportunity identified either by the inventing individual or by a pro-active search for technology opportunities within a research institution. The next phase is that of concept testing during which the opportunity is tested in terms of intellectual property, technical issues and also from a business point of view. The final phase is the start-up support phase, which begins when the business opportunity is exploited. Academic spin-off policies may be categorized further based on two major dimensions which are the level of support and the level of selectivity of academic institutions. By considering these two dimensions and three phases regarding proactive spin-off policies, four different archetypes emerge (Degroof and Roberts, 2004):

- Absence of proactive spin-off policies (venture creation at an early stage).
- Minimal support and selectivity (venture creation at an early stage).
- Intermediate support and selectivity (firm creation at a later stage of concept testing),
- Comprehensive support and selectivity (venture creation at later stage with comprehensive proof of concept)

Only high selectivity and high support strategies, or low selectivity and low support strategies, work along these dimensions. The former is adapted to entrepreneurially underdeveloped environments whilst the latter is adapted to entrepreneurially developed environments such as Silicon Valley (Botelho and Almeida, 2009).

4.12 SCIENCE AND TECHNOLOGICAL PARKS AND CENTRES

From the 1980’s there have been substantial increases in investment in science and technology parks worldwide. One of the main aims of establishing these parks is to promote mutual cooperation among universities and companies, meeting the demands of a market economy and facilitating the formation of new private enterprises. These resources can also facilitate technology transfer between universities and industry and in particular help the formation of spin-off companies. Furthermore, these organizations also aid SMEs in overcoming their prevalent problems: lack of start-up and investment capital, lack of information, property and ownership problems, and insufficient knowledge, experience and entrepreneurial skills (Stabulnieks, in Bulumac and Bendis, 2001; Siegel and Phan, in Libecap, 2005).

4.13 KNOWLEDGE TRANSFER

Selecting effective methods for conveying knowledge between producer (university) and receiver (industry) is a critical part of the technology transfer process. These ways include the availability of written reports showing the detailed features and procedures that industry should follow for using the technology, site visits which include regular or ad-hoc visits of a firm’s engineers to university laboratories, and plant visits by researchers to improve interaction and help in the conveying of knowledge process (Gerwin et al., 1991).

4.14 TRUST AND SOCIAL CAPITAL IN TECHNOLOGY TRANSFER

Social capital represents "*features of social organization, such as networks, norms, and trust, that facilitate coordination and cooperation for mutual benefit*" (Putnam et al., 1994, p2). Successful commercialization of new inventions requires a coordinated effort among all of the partners in the collaboration (Carayannis et al., 2000). "*When partnerships and consortia succeed, the glue that holds them together is not simply in the form of contracts that detail every aspect of these complex and dynamic relationships…the glue in the new political economy is the trust, or enlightened self-interest, among decision-makers that makes collaboration feasible*" (Fountain in Branscomb, 1998, p86). By developing trustful relationships partners can accumulate social capital - categorized into three versions of trust (Carayannis et al., 2000):

- Weak form trust
- Semi-strong trust
- Strong form trust

Trust can be built on patterns of both knowledge exchange and knowledge sharing between partners (Carayannis et al., 2000). In this regards the explicit forms of knowledge, which are easier to share, and tacit forms of knowledge, which are exchangeable through social interaction and, therefore, more difficult to share, should be taken into account (Nonaka and Takeuchi, 1995; Carayannis et al., 2000). Knowledge exchange and knowledge sharing can be considered as the basis of trust and innovation (Carayannis et al., 2000). Some forms of knowledge transfer have only one direction – producing in universities then transferring to industry. There are more explicit forms of such knowledge; conferences, publications and patents. Other forms of knowledge transfer are bi-directional requiring a greater degree and quality of interaction. This kind of knowledge transfer consists of both tacit and explicit knowledge and requires more interaction between partners such as consulting, collaborative projects and exclusive licenses; which can be considered as grounds for trust building (Hermans and Castiaux, 2007). Sharing tacit knowledge requires more cooperation among partners, and is not transferable through documents; rather it requires "*mutually reinforcing process of learning-by-doing and learning-by-learning, where the individual members of each organization participate in a shared social setting to develop and absorb knowledge in a common context*" (Carayannis et al., 2000, p480). This process leads to the growth of social capital across organizations and as a result greater sharing and exchange of knowledge will be facilitated. Government-University-Industry strategic partnerships are formed across different countries to strengthen this reinforcing system e.g. by establishing intermediary organizations like research consortia or university-industry research centres. Figure 4.2 shows the reinforcing system (Carayannis et al., 2000).

The transfer of explicit knowledge can be facilitated through intellectual property policies. However, IP policy is ineffective for tacit knowledge transfer. Social connectedness, trust, technological readiness and technological capabilities are preconditions for effective tacit knowledge transfer (Santoro and Bierly, 2006).

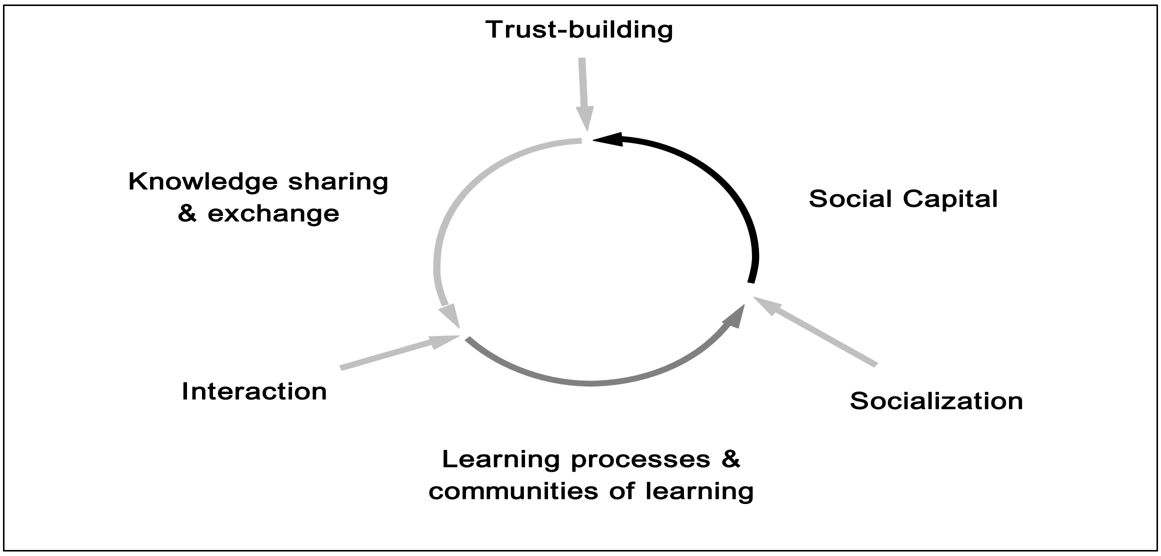


Figure 4.2: Processes linking knowledge sharing, learning and social capital (Adapted from Carayannis et al., 2000).

Worasinchai et al., (2008) developed a framework concerning the creation of knowledge through collaboration between government, universities, industries, and research networks known as (G-U-I-N) which includes the most important factors for successful collaboration between industries and universities in Thailand. He focussed on the R&D partnerships between university and industry and proposed that for the start of a relationship a catalyst is needed; in the case of Thailand this came from the government. He also proposed universities and industry start to work on gradually more complex projects; a strategy respective of cultural differences, in order to gradually build greater trust, and also to gain collaboration experience (this situation still is not strongly developed in Thailand).

4.15 CONCLUSION

Effective UIC contributes to business competitiveness and economic growth and drives innovation processes. This collaboration is a precondition to move towards a more knowledge-based economy. In order to increase the effectiveness of UIC, different motivational factors are pre-requisite for universities, researchers, and companies. Also various drivers and barriers should be identified in order to enhance the UIC activities.

The major impeders for the UIC are: cultural differences between partners, lack of trust and commitment, deficiency of IPR and enforcement laws, lack of venture capital, high degree of institutional bureaucracy, lack of university autonomy from government, lack of firms' absorptive capacity on knowledge transfer, deficiency of TTOs to connect partners, and lack of spin-off creation support in universities.

Designing effective mechanisms for collaboration e.g. intermediary agents can enhance UIC by increasing the degree of commitment and trust during collaboration. In order to achieve a success, these mechanisms should be supported by government.

CHAPTER 5

CULTURE, TRUST AND COMMUNICATION

5.1 INTRODUCTION

Guth (2005) postulated that in order to initiate and implement the innovation process in a specific country certain preconditions are required. A particular level of economic and social cohesion is prerequisite... "*Innovation builds upon successful individual and institutional learning. Institutional learning is determined by intra-organizational factors (openness, culture of communication within an organization, etc.) but also by inter-institutional activities (networks, clusters)*". Individual and institutional learning will occur only if a set of common rules, norms and visions has been developed, therefore a degree of social capital e.g. certain level of trust is essential.

In many industries, particularly research-intensive ones, there is a need to look beyond the internal capacity of their organization and adopt a collaborative research and technology development strategy. However, such research collaboration carries the risks of sensitive information leakage. Traditional legal and bureaucratic control mechanisms, e.g. intellectual property and ownership rights, are occasionally unable to deal with this problem. An extant social control system, e.g. goodwill trust is a further requirement for creating commitment between partners (Hoecht, 2004; Koeszegi, 2004). Generally, Business and Management research has been designed based on an assumed steady state of trust. Therefore, in the interest of completeness future research focus should consider the dynamic evolution of trust in inter-organizational networks (De Wever et al., 2005).

This chapter provides an overview of the literature that relates to the role of culture and trust for success in the UIC and subsequent national and regional economic development. It begins with definitions of culture and trust and introduces different ways of forming trust. Furthermore, an evaluation is presented of the impact of different processes of trust formation. Also this chapter highlights the role of culture and trust in inter-organizational relationships, and explains effective mechanisms for trust formation. Finally an explanation of the role of culture in economic development relationships and also the role of culture and trust in the Iranian context is provided.

5.2 CULTURE

According to Kroeber and Kluckhohn (1952) "*Culture consists of patterns, explicit and implicit, of and for behaviour acquired and transmitted by symbols, constituting the distinctive achievement of human groups, including their embodiment in artifact; the essential core of culture consists of traditional (i.e. historically derived and selected) ideas and especially their attached values; culture systems may, on the on the one hand, be considered as products of actions, on the other as conditioning elements of further action*" (Kroeber and Kluckhohn, 1952, p181). Johnson et al., (2008) detail cultural influences at multiple levels within society. Figure 5.1 shows different cultural frames of reference including national, organizational, functional, and individual.

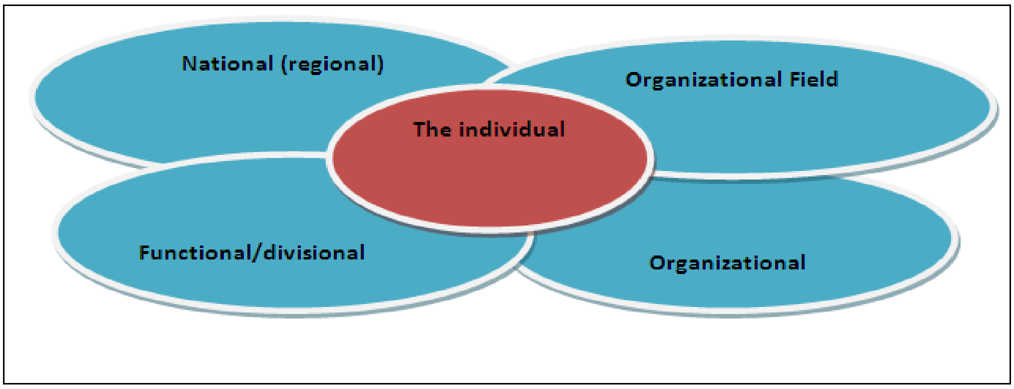


Figure 5.1: Cultural frames of reference (Johnson et al., 2008)

Many researchers have demonstrated how important factors such as attitudes to work, authority and equality differ from country to country. According to Johnson et al., (2008) "*such differences have been shaped by powerful cultural forces concerned with history, religion, and even climate over many centuries*" (Johnson et al., 2008, p190).

Culture within an organization is influenced and shaped by 'work-based' groupings, including industry, professions or organizational fields. Organizational field is a community of organizations that interact with each other more frequently in comparison with those outside the field. Therefore shared meaning systems will be developed based on these activities. Organizational culture consists of four layers (Johnson et al., 2008):

- **Values**, which are simple to identify in the organization.
- **Beliefs**, which are more specific.
- **Behaviours**, which can be seen by individuals both inside and outside the organization.
- **Culture**, is the organizational paradigm which includes the aspects of organizational life that individual may find difficult to identify or explain

5.3 TRUST

According to Sako's 1991 definition of trust, different types of trust will emerge; because different reasons exist for predictability of behaviour. "Contractual trust" refers to the situation in which each partner adheres to agreements, and keeps promises. The expectation of a trading partner performing his role competently reflects the concept of "Competence trust" and the mutual expectations of open commitment between partners reflect the concept of "Goodwill trust" (Sako, 1991). Table 5.1 explains some of the most prevalent definitions of trust.

Definitions of Trust	Reference
"*A state of mind, an expectation held by one trading partner about another, that the other will behave in a predictable and mutually acceptable manner*."	(Sako, 1991, p377)
"*Willingness to rely on another party and to take action in circumstances where such action makes one vulnerable to the other party*."	(Doney et al., 1998, p604)

Table 5.1: Definitions of Trust

De Wever et al., (2005) focused on two dimensions of trust; "resiliency" and "specificity", from which a matrix of different types of trust might be developed. Resiliency concerns the extent to which trust is "resilient" rather than "fragile" (Leana and Van Buren, 1999). Resilient trust is not calculative and its meaning is close to that of benevolence. On the other hand fragile trust is a calculative type (Bouty, 2000). Specificity is the extent to which trust may exist without much direct information and/or previous interaction, simply by association. This dimension consists of two perspectives of trust which are 'dyadic trust' and 'generalized trust' (Leana and Van Buren, 1999). Generalized trust relies more on affiliation and reputation rather than direct knowledge or previous interaction, which is prerequisites of dyadic trust (Wicks et al., 1999). Four different types of trust will be generated with combining these two dimensions (De Wever et al., 2005). These four types of trust are:

- Type 1: Dyadic resilient trust: "*this type of trust is based on frequent and direct interactions and incorporates a kind of benevolence based on these frequent contacts*" (De Wever et al., 2005, p1530).
- Type 2: Dyadic fragile trust: this type of trust is a more calculative type. Although this type of trust is based on frequent and direct interactions, these interactions do not cause the feeling of benevolence.
- Type 3: Generalized resilient trust: this type of trust relies less on previous interaction; however the feeling of benevolence is present, simply by association.
- Type 4: Generalized fragile trust: in this type of trust "*there are perceptions of immediate return and not feelings of benevolence linked to the cause of the trust: association*" (De Wever et al., 2005, p1531).

The first and forth types reflect the relationship between interaction and a feeling of benevolence; the more interaction the greater the feeling of benevolence and vice versa. However, the second and third types of trust indicate that sometimes there is no positive link between the level of interaction and dimensions of resiliency (De Wever et al., 2005). Type 1 is the most positively related to network effectiveness and type 4 is the less positively related to network effectiveness. Types 2 and 3 have an equal effect on network effectiveness and the effect is smaller than that of type 1 and larger than type 4 (De Wever et al., 2005).

Motivation is one of the conditions for the exchange of resources to occur, and that trust can facilitate this process. Without trust partners will be reluctant to share strategic resources because of the risk involved (Bouty, 2000). An understanding of how and when trust erodes complements insight regarding building, increasing and maintaining trust (Elangovan et al., 2007). Normally trust is developed based on a linear sequence of stages with the first stage constituting the lowest level of trust (Shapiro et al., 1992). Research carried out by Elangovan et al., (2007) emphasized cognition-based trust (which is grounded in knowledge of the trustee's credentials and the reliability of their past performance), and shows that trust will be eroded gradually in the majority of cases. Therefore, it is necessary to understand how to maintain trust or how to avoid diminishing it.

5.4 THE IMPACT OF DIFFERENT PROCESSES ON TRUST FORMATION

Tillmar (2006) compared preconditions for trust formation in the contrasting contexts of Tanzania and Sweden. He described trust as an analogy of a tree which has grown out of the soil. This soil consists of formal institutions whilst informal institutions are like nutrients added to the soil. "*Flourishing cooperation can be regarded as the crown of* *the tree of trust*" (Tillmar, 2006, p93). Formal institutions are laws, rules and regulations which are defined in a national level in different countries (North, 1990). Informal institutions are organic and "*evolve spontaneously and unintentionally over time out of human interactions, and they take forms such as codes of conduct, conventions or norms*" (Havnevik and Harsmar, 1999, p42). Fukuyama (1996) also confirms that trust has a strong cultural root. The interaction of formal and informal institutions in different countries can produce "virtuous" and "vicious" circles of trust in a society (Tillmar, 2006, p94). A nation's "soil of the tree" receives its nutrients from a different combination of sources and indicates why trust formation has alternative constructs in different countries (Tillmar, 2006).

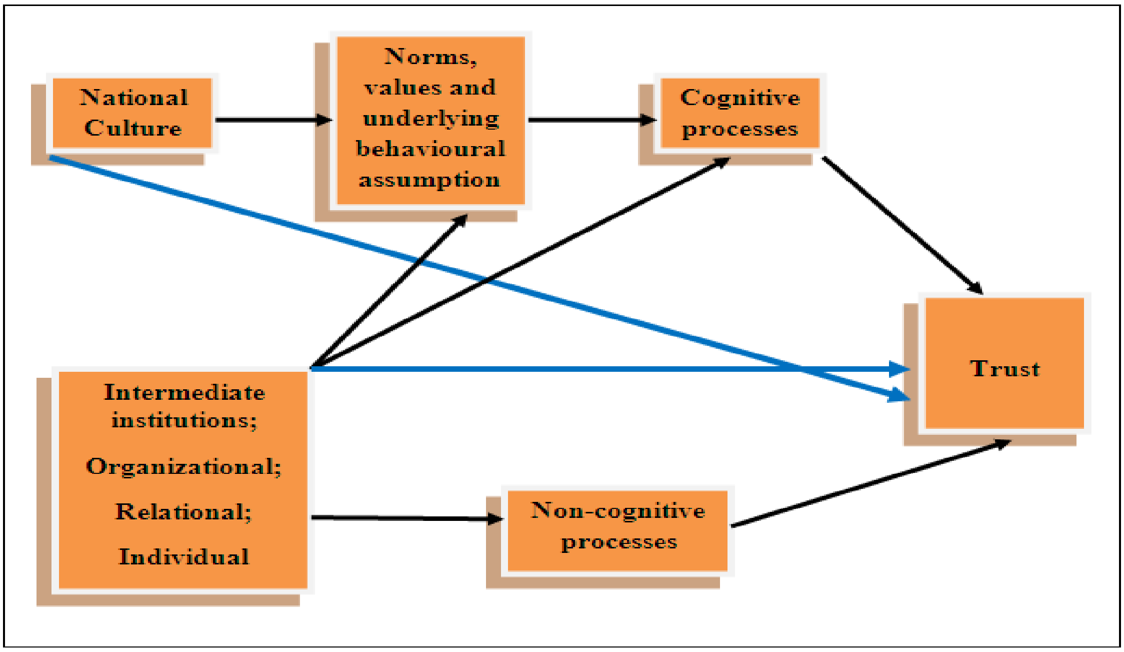


Figure 5.2: Impact of different factors on trust formation: Adapted from Doney et al., 1998.

The formation of trust is normally influenced by cognitive (essentially rational) and non-cognitive processes. Trust is affected indirectly by intermediate institutions, organizational, relational or individual factors as well as by national culture (Black Arrows). These factors have an influence on cognitive trust-building processes which ultimately lead to trust development. Some of these factors may have a direct effect on the level of trust in the society as well (Blue Arrows) (Doney et al., 1998). A summary of related trust factors is shown in Figure 5.2.

National culture is a key factor that may facilitate or inhibit trust formation. Sometimes the impact of culture is indirect and via cognitive process whilst occasionally it has a direct impact on trust formation (Doney et al., 1998). Doney's work was based on Hofstede's framework (1980), where the national culture can be specified as: individualism vs. collectivism; masculinity vs. femininity; higher power distance vs. lower power distance; and high uncertainty avoidance vs. low uncertainty avoidance.

5.5 THE ROLE OF CULTURE AND TRUST: INTER-ORGANIZATIONAL

Bstieler (2006) also found trust is an essential element for successful cooperation between partners, particularly in the product development stage, where uncertainty is increased and the level of risk is higher than it might be in other buyer-supplier relationships. Therefore it is not something that can be mandated. Normally, as a result of the actual experience of interacting with another party with the concomitant growth of knowledge and understanding of people with whom one must interact, trust will evolve (Blois, 1999). Three elements are recognized as the means for promoting trust formation: communication behaviour, perceived fairness, and shared problem-solving. This focuses on positive aspects of working closely together with a partner to facilitate communication and as a result the values and objectives of partners become mutually understood. In contrast two elements have a detrimental effect on trust development; the continued existence of conflict and partner egotism, or self-interest seeking during the project. "*Together, these five elements are expected to regulate trust formation* *between exchange partners*" (Bstieler, 2006, p58). The conclusion might be that the formation of trust can have a positive effect on partnership efficacy and project-based performance (Bstieler, 2006). As a result of timely, accurate and adequate levels of communication a shared understanding will be developed. Accordingly this improves the atmosphere of the relationship with a level of commitment fostered that enhances trust between partners (Bruce et al., 1995).

Bstieler and Hemmert (2008) focused on the impact of relational behaviours on trust formation and the role of different national cultures on trust development. They considered the direct impact of national culture and trust development and concluded that in low-trust societies, trust is more difficult to achieve "*because of the predominance of acquired social ties that confine trust to be within the boundaries of the family or the group and it requires more time and patience to establish that same level of trust with outsiders. In 'high-trust' societies, in contrast, a higher level of inter-organizational trust can be developed more quickly*" (Bstieler and Hemmert, 2008, p38). National culture also has moderating effects on trust formation. In collectivist societies the positive impact of communication quality on trust formation in new product development partnerships is weaker in comparison to more individualistic cultures. Relational factors are more important for trust formation than national culture (Bstieler and Hemmert, 2008).

The establishment of trust is more difficult in certain countries due to national cultural characteristics. However, "*the difference in the level of trust achieved between partnerships in a 'high-trust' and a 'low-trust' country is only weakly significant, indicating that trustful relationships can indeed be established anywhere by addressing more important factors, such as communication quality and fairness*" (Bstieler and Hemmert, 2008, p44).

5.6 MECHANISMS FOR TRUST FORMATION: TECHNOLOGY FOR BUSINESS GROWTH (TBG) PROGRAMME

Technology policies are designed to support collaborative projects with the aim to establish economically productive relationships between partners. However, because of the dual nature of project control in collaborative projects, management problems are likely to emerge. In university-industry collaboration particularly the mix of different organizational cultures can result in conflicting attitudes towards the management of the project. A combination of these factors creates a barrier to the establishment of trust between partners. Effective collaborative policy instruments can establish different levels of trust between partners (Davenport et al., 1999).

The university-industry cooperation "*will be more likely to survive over time, the more there are initial assets of goodwill, trust, favourable prior beliefs, mutual psychological commitment and prior relations between the parties*" (Geisler, 1995, p224). The role of intermediary institutions is significant in the process of establishing trust relationships in general and bridging the managerial gap in particular (Dodgson, in Coombs et al., 1996).

Cultural differences between partners are viewed as problematic in collaborations - stemming from a belief in the distrust of dissimilarity. When social similarities exist between partners, the probability of establishing trust will be increased. This phenomenon is known as "Character-based trust" (Zucker, 1986). Social similarity does not generally exist between university and industry partners. However, creating an environment which induces a greater degree of cultural similarity will be achieved through designing an effective intermediary scheme, e.g. TBG Programme (Technology for Business Growth); a New Zealand programme to support collaborative R&D projects between industry and research institutions. In this programme repeated collaboration with the same partner is encouraged "*by enforcing short-term goals on the researchers and by enabling the SMEs to engage in research rather than solely managing day to day operations*" (Davenport et al., 1999, p35).

Only in a risky situation will trust be needed (Davenport et al., 1999). However, "*cooperation can occur without trust, if a party is not put at risk, or if there are external control mechanisms that will punish a party for deceitful behaviour*" (Davenport et al., 1999, p36). Some intermediary schemes e.g. TBG programmes, are aimed at mitigating the need for trust from both these perspectives. Firstly, they reduce the perceived risk of collaborative projects and secondly they design contractual control procedures to take action against contractual violation. Designing such a safeguard can contribute to the establishment of contractual trust. Another benefit of these programmes is the development of competence trust. "*The increased general activity in the firms subsequent to the collaborative project suggests that an aspect of the development of competence trust, that is, a trust in the ability of research capability per se to produce useful results, has enabled the firms to develop their own confidence and competence in technical matters. In a similar vein, the increase in collaborative research indicates that the firms have increased they trust in the potential for collaborative arrangements to deliver results*" (Davenport et al., 1999, p36).

Over time, contractual and competence trust both evolve into goodwill trust. Such trust only evolves incrementally with repeat relationships between the same partners. At this stage partners come to respect their cultural differences and to gain collaborative experience (Davenport et al., 1999).

5.7 CULTURE AND ECONOMIC DEVELOPMENT

There are many ways in which cultural factors affect economic development; through their impact on organization and production, the ability to create and manage institutions and creation of social networks (Fukuyama, 2001). The relationship between culture and economic development is complex and can be viewed as causal. Some believe that economic development leads to cultural changes, others, that "*cultural values are an enduring and autonomous influence on society*" (Thompson, 2001, p1). Some researchers have proposed a global perspective for culture. They argue that it is the "international economic culture" which pushes every country toward productivity and values which lead to a globally homogenous culture. A contrasting opinion is that particular culture traits are a prerequisite for economic development (Porter et al., 2000).

Papamarcos and Watson (2006) debated whether these direct relationships between culture and economic performance are simplistic, whilst the evidence that cultural and political factors in each country continuously interact, should be taken into account. Therefore there are interactions between political and economic freedom and cultural factors which moderate culture's consequences for national economic performance.

Williams and McGuire (2008) considered the effects of national culture on economic creativity and innovation implementation, and describes innovation at a national level as a process which consists of two different phases of economic creativity and innovation implementation. Cultural values and meanings have an impact on the willingness to create and innovate. Each particular culture supports novelty, risk-taking, individual initiative, collective action and teamwork activities differently and as a result the degree of creativity and innovation implementation are different across nations (Williams and McGuire, 2008).

Entrepreneurial culture has a positive impact on regional innovativeness and economic growth (Beugelsdijk, 2007). Besides personal attributes, the economic environment, family background, social networks and national culture all have an effect on the probability of an individual acting entrepreneurially (Rauch and Frese, in Cooper and Robertson, 2000). Also, individuals may be ‘pulled’ into entrepreneurship by the provision of training and the exposure to business, which encourages the search for business opportunities (Krueger, 1993). Beugelsdijk (2007) focussed on the impact of national culture on entrepreneurial activity and showed that the differences in economic growth in some countries can be explained by corresponding differences in entrepreneurial culture (Beugelsdijk, 2007). Although cultural differences have an impact on entrepreneurs’ perception of the environment and their strategic orientation, evidence demonstrate that the impact of national difference, e.g. the level of support of government, and availability of financing and legal infrastructure, is greater (Tan, 2002).

Dod and Patra (2002) shows that culture is important in shaping the nature of an entrepreneurial network. They support the contextualist approach to entrepreneurial activities, which suggests that national differences together with other cultural variables have a great impact on the level and nature of entrepreneurship.

5.8 CULTURE AND TRUST IN AN IRANIAN CONTEXT

Javidan and Dastmalchian (2003) evaluated the Iranian cultural practices and values which included the reports of 300 middle managers in three industries in Iran and compared the median score across 61 countries. Based on their findings, Iranian culture can be recognized by “*individualism, strong in-group collectivism, high power distance, high performance orientation, and high male orientation. Furthermore, they are low on uncertainty avoidance and future orientation*” (Javidan and Dastmalchian, 2003, p138).

There are two dimensions used to measure the role of the individual in a wider context, these are delineated as in-group collectivism and institutional collectivism. The most prominent part of Iranian culture is the family and in-group orientation. The present score and desired score of in-group collectivism are the same, indicating that a strong preference exists for sustaining a significantly high level of family loyalty. Family members and close friends have strong expectations from each other. From one perspective (the individual level) this indicates a warm and satisfying culture. On the other hand it has what may be interpreted as negative consequences at the societal level (Javidan and Dastmalchian, 2003). This type of culture has a negative correlation with country competitiveness and economic prosperity (Javidan and House, in House et al., 2004). One major negative consequence of strong family orientation is that the "radius of trust" will be reduced (Fukuyama, 1996). Because members of this culture grow up learning to trust only in-group members, as a result the level of trust of outsiders is decreased. People living within this culture do not spend much time with outsiders and as a result do not build confidence in them (Javidan and Dastmalchian, 2003).

The people of Iran have experienced autocratic and corrupt regimes and because of the domination of many rulers in Iranian society, this has led to a reduced trust amongst the population for the collective system resulting in their relying more on family and friends (Javidan and Dastmalchian, 2003). The present score of the institutional dimension is low and the desired score of institutional collectivism is high, which indicates the willingness of the Iranian people to move towards a more collective well-being and "*to a situation where societal values encourage and reward collective action*". A stronger collective perspective leads to economic prosperity and competitiveness (Javidan and Dastmalchian, 2003, p132). High power distance and corruption exists in Iranian society which reflects unequal sharing of power. However, Iranian people desire a situation where there is a smaller difference between those in power and those with none (Javidan and Dastmalchian, 2003).

Uncertainty avoidance is another scale which shows the extent to which a society has effective rules and regulations that organize and structure people's lives. This scale is low in Iranian society because policies and regulations in Iran have been formulated by different interest groups, these are open to interpretation (usually unclear rules), and as a result the level of instability and uncertainty in society is increased. The desire score for this scale is significantly high, which indicates the willingness of the people for stricter disciplines (Javidan and Dastmalchian, 2003). A country with a higher degree of uncertainty avoidance has a greater chance of economic prosperity and competitiveness (Javidan and House, in House et al., 2004).

5.9 CONCLUSION

Culture and trust are two elements which determine the degree of success of specific country in the innovation process. Degree of trust formation between partners, and between entrepreneurs and government which have a strong influence on UIC performance, could be influenced by many factors and it is considered as one of the most important elements which have a strong impact on the NIS. Trust can be influenced by national culture of the country as well as institutional culture. Government rules and regulations also have a strong impact on trust formation process. Availability of effective mechanisms for UIC can decrease cultural differences between partners and in the long term it can enhance trust between university and industry.

Although literature highlights the important factors which have an impact on the process of trust formation, they do not adequately explain the mechanisms involved.

CHAPTER 6

SYSTEMS THINKING

6.1 INTRODUCTION

Systems thinking is a framework developed more than fifty years ago to give a full clearer picture. Systems thinking is a tool for understanding how things work. It is a framework to look beyond events and scrutinise for patterns of behaviour (Senge, 1990).

This chapter provides an overview of the literature that is related to systematic analysis. It begins with explaining the system's concept. Furthermore systems thinking approach is explained and the activities related to this approach are highlighted. This chapter also examines different systems analysis methodologies.

6.2 SYSTEM CONCEPT

The word "system" has a number of different meanings. One definition is "*a group of things or parts working together or connected in some way as to form a whole*" (Collins English Dictionary, 2004). Another definition of the system which is mentioned by Bertalanffy (1976) is: "*A system is an entity which maintains its existence through the mutual interaction of its parts*". The key here is mutual interaction, in that something is happening between the parts, over time (Bertalanffy, 1976, p2).

To reach a point of insight in the analysis of an entity, constructed of parts or sub-systems, it is necessary to understand how a system differs from a simple collection of parts without a common identity, and how a process of interaction is achieved and controlled. This process maybe understood only by studying concepts of emergence, hierarchy, communication and control (Patching, 1990). Associated with the concept of systems is a principle known as emergence. The mutual interaction of the elements of a system leads to the construction of characteristics which are unique and never occur as characteristics of any sole individual element of the system (Bellinger, www.systems-thinking.org; Patching, 1990).

Another important concept in systems theory is that of hierarchy, "*no system is an island unto itself*" (Patching, 1990, p11), and each system itself will be part of a hierarchy of systems (Figure 6.1), with integral sub-systems in turn displaying emergent properties (Patching, 1990, p11).

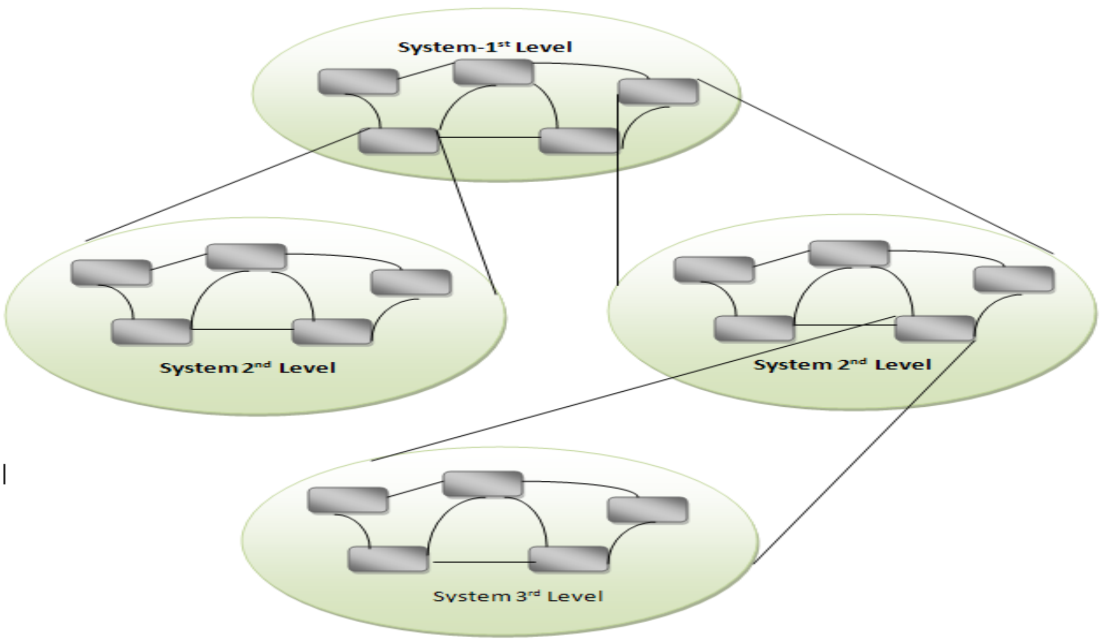


Figure 6.1: Hierarchy of Systems: Adapted from Patching, 1990.

All system components should interact to function as a whole. Each sub-system receiving an input, which leads to further activity in the process of production output, which is directed either to other sub-systems or to the environment (Patching, 1990).

6.3 SYSTEMS THINKING

Developed in WWII, Systems Analysis (Checkland, 1999) dealt with complex problems of policy making or military planning (Patching, 1990). One of the branches of systems analysis is the systems thinking approach composed of three stages (Flett, 2001):

- Discovering the interrelationships between the components of the system;
- Drawing an 'influence diagram' in order to illustrate and analyze these relationships and verify their behaviour;
- Using system dynamics in order to model and simulate the 'system' in a different situation.

Systems thinking is a strong approach to deal with complex issues. Originally used in the biological sciences, the methodology is now widespread in other disciplines including management (Patching, 1990). Senge (1990) considers systems thinking as a framework to give a full clearer picture of a problem situation, and as a tool for understanding how things work. It is a framework to look beyond events and scrutinise for patterns of behaviour.

6.3.1 Activities in systems thinking

Balle's (1994) work, *Managing with Systems Thinking,* gives a general overview of the systems thinking process and the ways in which it can be applied in a real situation. He introduced three activities for systems thinking:

a. Focus on the relationships rather than parts,
b. Detect patterns not just events,
c. The use of circular causality (archetypes)

6.3.1.1 Focus on the relationships rather than parts

Systems thinking seeks to answer the question of how structures influence behaviour, critically encouraging a consideration of interrelationships (Senge, 1990). In the regional development and innovation management fields, systems methods are evident in the Triple Helix system of innovation and the Porter's Diamond Model (1990). According to Porter (1990) if the constructs from the Diamond model are correctly applied in a specific country it can promote interrelationships between different elements in and around the environment.

Researchers on government policy for innovative cluster development recently have called for a new approach to policy making using systems thinking to be able to cope with ambiguity of this phenomenon (Mulgan, 2001). Systems which do not behave in linear way have limited predictability of the outcomes from policy intervention. Therefore, systematic understanding allows policy makers to better comprehend structural weaknesses and also provides opportunity for developing innovative networks and relationships, which is impossible to achieve when using the traditional model (Chapman, 2004).

Brown and Smith (2009) developed a basic framework using systems thinking to understand the dynamics within clusters: "*this basic model attempts to explain how a successful cluster might develop and the changes in cluster behaviour and company interaction that might be seen at each stage*" (Brown and Smith 2009, p3). Figure 6.2 depicts the main components of this model consisting of several loops, used to build different stages of the cluster's development and impact on the performance of both individual firms and all firms in the cluster. "*For the purposes of describing the model the loops should be viewed as a sequential process from 1 to 5, though it is likely that, especially for the later stages (3, 4, and 5) they potentially develop in non-sequential ways*" (Brown and Smith 2009, p3). Figure 6.2 also shows the inter-related nature of the loops and illustrates that each part of the system is connected to other parts within the overall environment.

Application of systematic analysis and considering interrelationships is also crucial in terms of Triple Helix interactions. As noted by Hakansson and Snehota (1995) (see Section 3.3.2) one of the important subjects in guaranteeing the success of the triple helix system of innovation is the task of developing mechanisms to coordinate the complex interactions among university, industry, and government.

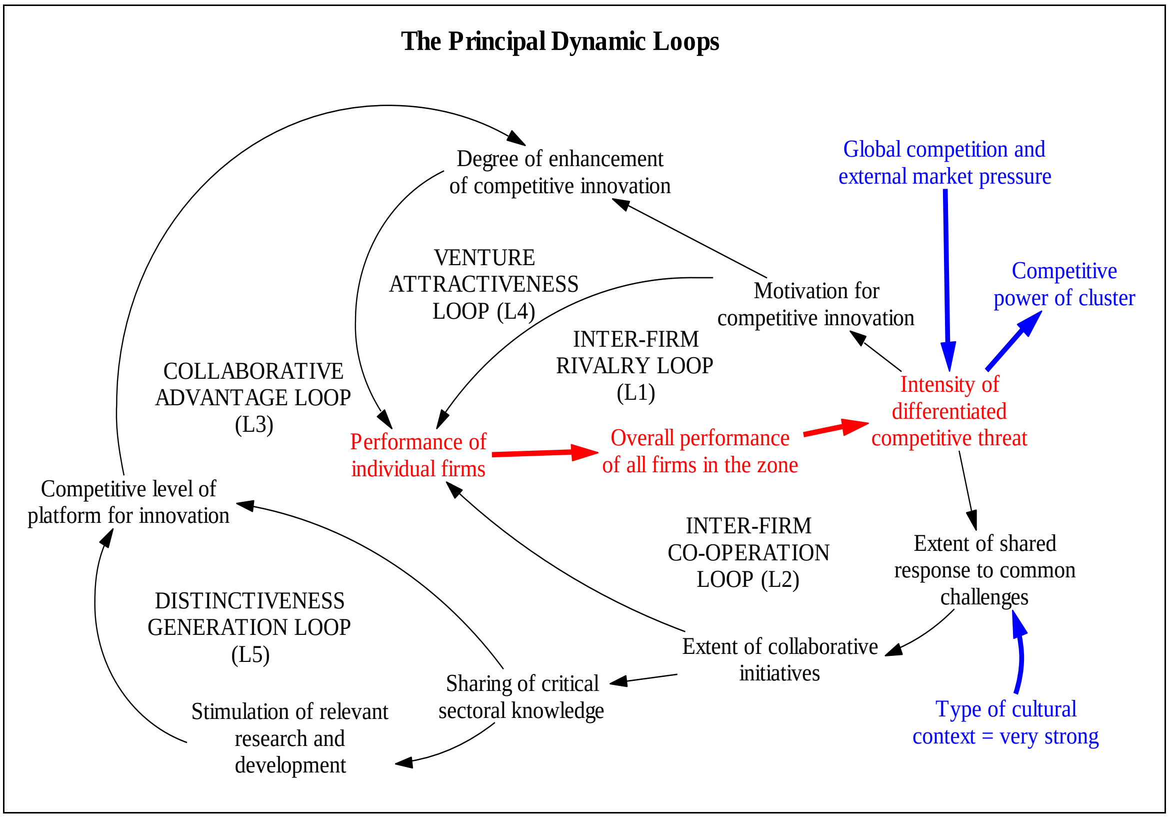


Figure 6.2: The Cluster Dynamic Model: Adapted from Brown and Smith, 2009.

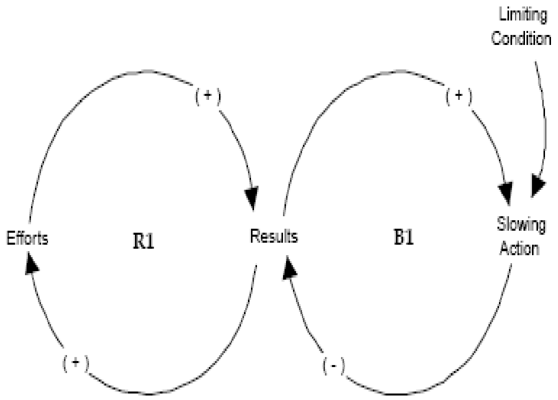
6.3.1.2 Detect patterns not just events

"*Structures of which we are unaware hold us prisoner. Conversely, learning to see the structures within which we operate begins a process of freeing ourselves from previously unseen forces and ultimately mastering the ability to work with them and change them*" (Senge, 1990, p90). In the macroeconomic environment, systems thinking can help stakeholders and policy makers to observe underlying trends and patterns in order to understand the forces underlying these events. Both the pattern and the event should be seen by systems thinkers, as he puts it, the generic and the specific – keeping one eye on the woods and one eye on the trees (Richmond, 1994).

6.3.1.3 System archetypes

An important aspect of systems thinking is that certain patterns of structure are repeated. These "system archetypes" are very important in prompting us to learn to see structures in our lives. "*The systems archetypes suggest that not all management problems are unique, something that experienced managers know intuitively*" (Senge, 1990, p90). When the archetypes arise in one specific subject you can feel them rather than see them, due to their subtlety. Although experienced managers know many of these plot lines intuitively, it is very difficult to explain them. Therefore, the systems archetype can provide that language and make it explicit. Understanding systems archetypes gives an opportunity to the organization putting systems perspective into practice (Senge, 1990).

Senge's archetypes are illustrated by causal loop diagrams depicting types of behaviour and their related components. He defines two different loops, which combine to produce a complete archetype. The first of these is a reinforcing loop which is depicted by a snowball going down a hill, and the other is a balancing loop depicted by a balance beam (Senge et al., 1997). Several archetype have been identified, including, but are not limited to; Limits to Growth; Shifting the Burden; Eroding Goals; Escalation; Success to the Successful; Tragedy of the Commons; Fixes that Fail; and Growth and Underinvestment (Senge, 1990). Two of Senge's archetypes (1990), 'limits to growth' and 'shifting the burden are illustrated in Figures 6.3 and 6.4. These two occur more frequently, and are also the preliminary stages in the progression of understanding other archetypes and more complex situations. All of the archetypes have common features in their structure. All of them are made up of systems building blocks, reinforcing loops, balancing loops and delays.



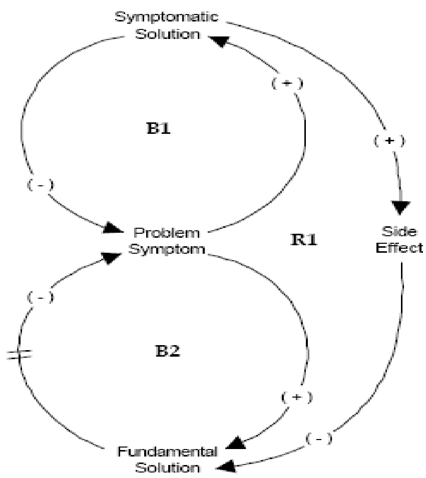


Figure 6.3: Limits to Growth
Source: Senge, 1990

Figure 6.4: Shifting the Burden

Table 6.1 and Table 6.2 summarize Senge's Archetype characteristics.

Type of Archetype	Definition	Management Principle
Limits to Growth	"*A reinforcing (amplifying) process is set in motion to produce a desired result. It creates a spiral of success but also creates inadvertent secondary effects (manifested in a balancing process) which eventually slow down the success.*" (Senge, 1990, p95).	"*Don't push growth; remove the factors limiting growth*" (Senge, 1990, p 95)
Shifting the Burden	The underlying problem occurs and generates symptoms that need attention. But people are searching for other solutions to the problem rather than focusing on fundamental one. This seems efficient temporarily, but leads to fundamental problem being left unaltered and then leads to worsening of the underlying problem, because the symptoms have apparently been removed, and the system have no abilities to solve the underlying problem.	People should be aware of the symptomatic solution. Solutions which focus on symptoms of a problem and do not consider fundamental causes have a short term benefit, as sometimes the main problem may occur again and there will be a greater tendency for a symptomatic response. This situation leads to a decreasing the capability for fundamental solution.

Table 6.1: Definition and management principle related to Limits to Growth and Shifting the Burden Archetypes

Type of Archetype	Pattern of Behaviour	How to Achieve Leverage
Limits to Growth	In this structure, there is a limit which gradually increases and leads to slowing down the growth rate after its boom. After sometimes the growth may slow so much that the reinforcing loop may turn around and activated in reverse (Senge, 1990).	The limiting factors should be identified and changed as soon as possible.
Shifting the Burden	"*Shifting the burden structures tend to produce periodic crises, when the problem symptoms surface. The crises are usually resolved with more of the symptomatic solution, causing the symptoms to temporarily improve. What is less evident is a slow, long- term drift to produce a side effect,...The problem symptom grows worse and worse.....The longer the deterioration goes unnoticed,...the more difficult it can be reverse the situation. While the fundamental response lose power, the symptomatic response grows stronger and stronger*" (Senge, 1990, p110).	The fundamental response should be strengthened and the symptomatic response should be weakened at the same time

Table 6.2: Pattern of behaviour and ways of achieving leverage related to Limits to Growth and Shifting the Burden Archetypes

The list of archetypes are "*tools for inquiry not advocacy"* (Senge et al., 1997, p139) which means that we should not consider the archetypes as a solution but they should help in discerning our way to find a solution (Senge et al, 1997). Archetypes may also interact with each other to construct other archetypes (Goodman and Kliener, 1994).

6.4 SYSTEMS ANALYSIS METHODOLOGIES

The application of systems thinking to real world problems is typically via a specific methodology on how the system is constructed, illustrated and used. Industry specific problems have their own variants – especially the Information Systems field, but in management research the main methods are:

- Process Mapping (predominantly industry related)
- Systems Dynamics (generic)
- SSM (generic)
- Causal Mapping (generic)

6.4.1 Soft Systems Methodology (SSM)

Soft Systems Methodology (SSM) is an organized way of tackling messy and complex situations in the real world. It is based on system thinking, which enables it to be highly defined and described (Checkland and Scholes, 1999). Checkland (1999) viewed problem situations in terms of the big picture rather than divided into parts. Checkland and Scholes (1999) highlighted that SSM was developed in the 1970s after the failure of the Systems Engineering (SE) approach to solve complex problem situations.

Hicks (1991) described this approach to system thinking as a method for generating an image of a system, or a conceptual system with properties and attributes from the real world. In contrast to the real world system, this conceptual model is not as limited by the boundaries of the real world environment, and value is placed on the inter-relationships.

Figure 6.5 provides the stages of Soft System Methodology to illustrate the concept of real world and system thinking (Checkland and Scholes, 1999). A system does not exist in the real world. This is a model that we create by our own perception of reality, which gives us the ability to understand the actions and behaviour of a particular environment (Checkland, 1987, cited in Flett, 2001).

Figure 6.5 consists of a series of guidelines, with each stage taking a specific name. In practice, an analyst will interview, observe or analyze relevant literature material and then decide on acceptable ways of making changes, and how these might be implemented. The line that exists between this real world activity and the system world divides these two, at the point where the analyst withdraws from examining the real situation, and objectively considers the relevant system models. Providing a summary of the actual situation as a 'rich picture' during the stage of collecting the information is necessary. The meaning of such a division is that these two types of activity require to be considered separately. The system models that are developed and taking account of a number of relevant viewpoints, are clearly defined as part of the modelling processes, and are then used to explore the real world to see if the system is reflected there. In other words, the real situation should be examined to find out if those activities necessary to give the defined system functionality are actually going on in practice. When a small difference between the model and practice is found, some improvement might be assumed, but occasionally no improving action to manage this difference can be taken, in which case there must be a return to the system thinking stage and a fresh attempt at the modelling exercise (Checkland and Scholes, 1999).

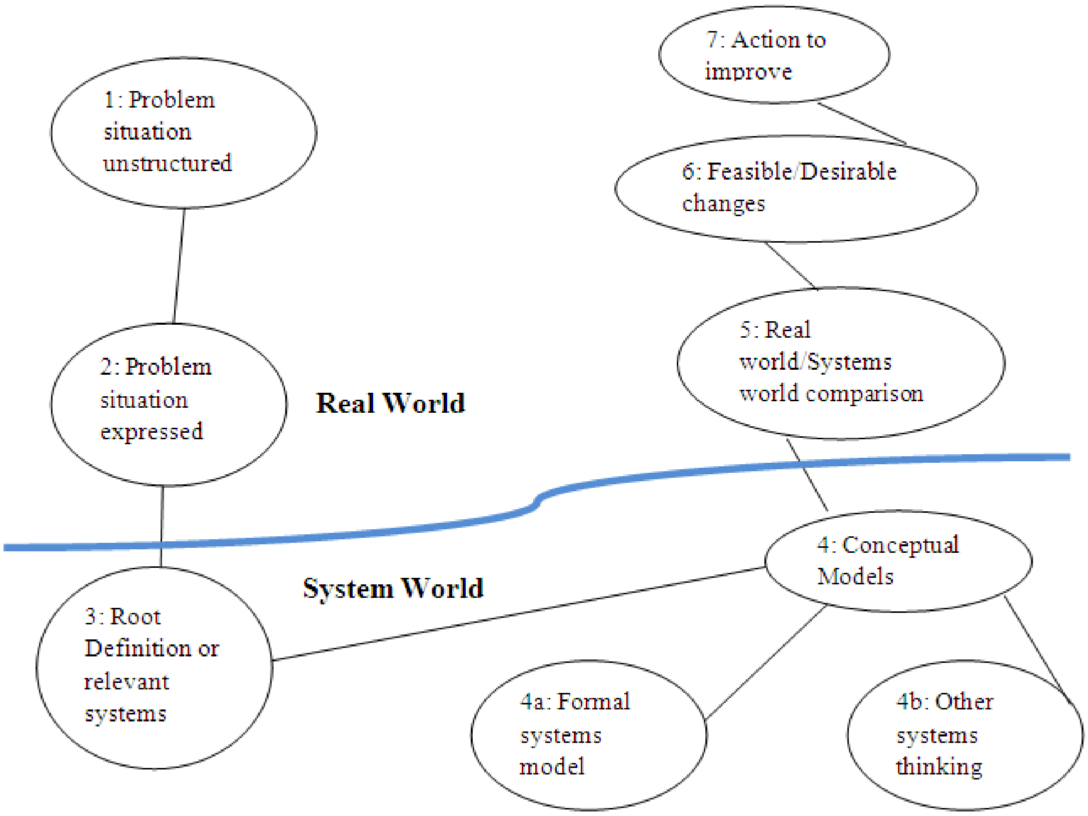


Figure 6.5: The Soft System Methodology Model: Adapted from Checkland and Scholes, 1999.

Using pictures in SSM is common, e.g. root definitions can be presented by pictures. But the best use of illustration in SSM is the policy of indicating the problem situation in the form of a so-called 'rich picture' (Stages 1 & 2 of Figure 6.5) (Checkland and Scholes, 1999). Finegan (1994) developed a soft systems model which represents the relations between public sector, research organizations and industry.

6.4.2 Causal Mapping and Systems Dynamics

Influence diagrams, causal-loop diagrams and process maps are ways of visualizing the relationships within a system. Analysis in system thinking is an indivisible stage of system dynamics. There are three stages to complete the process of analyses (Section 6.3), firstly is the analysis of the situation, followed by drawing an 'influence diagram, and finally, to use system dynamics (Flett, 2001).

6.4.2.1 Influence diagrams

Various techniques are available to create a model to discern the cause and effects of a situation or problem. One of the most popular techniques is the influence diagram. Users of this tool try to depict all causal relationships in a way that is 'non-ambiguous' and 'probabilistic' (Tan and Platts, 2003). This tool, which is also known as the causal loop diagram, is a graphical method of representing the dynamic structure of a system. An influence diagram illustrates the 'dynamic evolution of the system', where elements in an influence diagram can have a reinforcing (positive) effect, a balancing (negative effect), or a delayed effect (Flett, 2001).

a. Applicability of influence diagrams in the modelling of NIS

The NIS represents *". . . a system of innovations constituted by elements and relationships . . . the national system of innovation is a social system. . . It is also a dynamic system, characterized both by positive feedback and by reproduction. ... Cumulative causation, and virtuous and vicious circles, are characteristics of systems and sub-systems of innovation*" (Lundvall, 1992, p2).

Very complex processes are involved in the NIS. Rather than following a linear path, this system is characterized by complicated feedback mechanisms and interactive relations involving the major components of the system. These relations between components are often characterized by reciprocity, interactivity, and feedback mechanisms in several loops (OECD, 1997b). Figure 6.6 shows the applicability of the influence diagram in the NIS. This example illustrates the use of influence diagrams to model the interdependence and interaction between product innovation and process innovation in the system. Figure 6.6 consists of four positive loops. This causal loop diagram shows the interaction of five different components of subsystems in Taiwan's

NIS. These subsystems are: human resources, science and technology, innovation commercialization, product market and finally financial (Lee and Tunzelmann, 2005).

Loop number 4 (Figure 6.6) is related to University-Industry Collaboration (UIC). This diagram consists of the interaction of four subsystems which are science and technology, innovation commercialization, product market and finally financial. This loop indicates that if the R&D budget increases in the company it will lead to greater investment in increasing R&D capacity and also increasing science and technology transfer out of universities or from overseas (in the form of spin-off, joint ventures or licensing), simultaneously promoting the innovation rate for process and product (Lee and Tunzelmann, 2005).

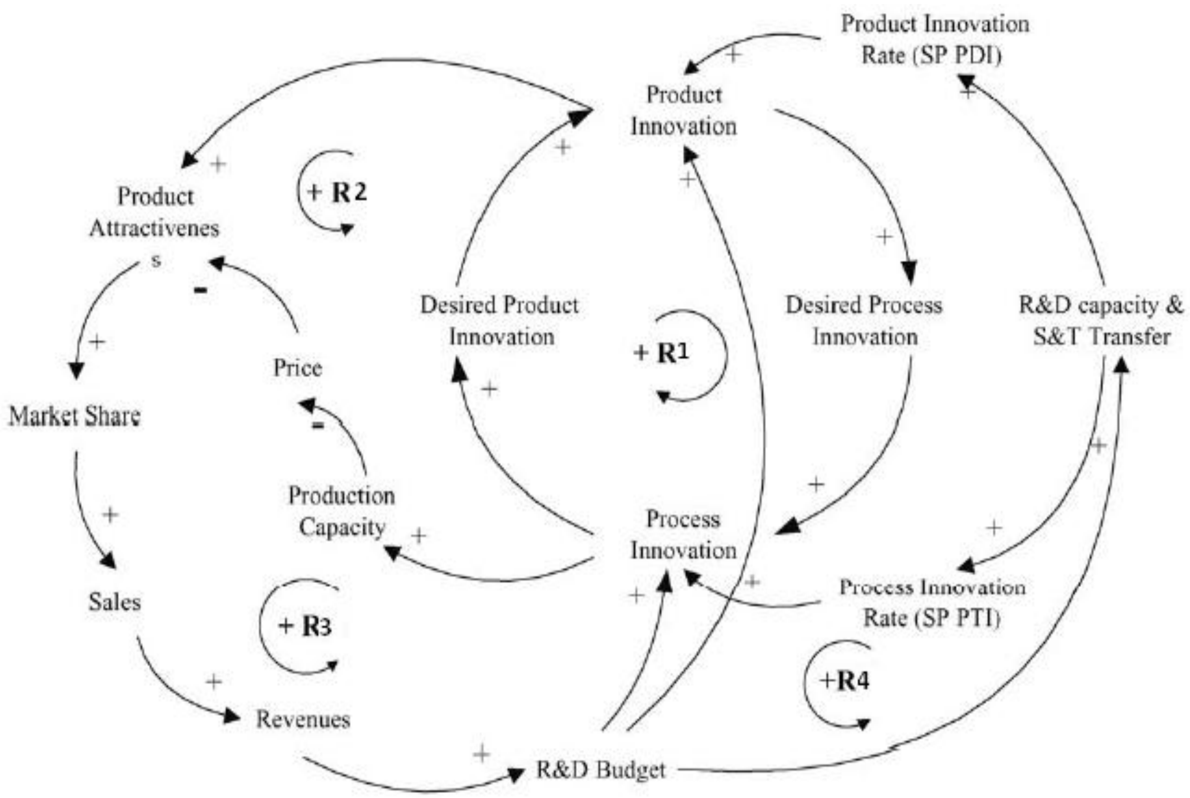


Figure 6.6: Product and process causal loop diagram (Lee and Tunzelmann, 2005).

6.4.2.2 Systems dynamics

Systems dynamics is recognized as ‘language’ to describe how effective changes are achievable in organization. This approach is an extension of the ‘systems’ analysis which includes the development of a clearer picture to help understand a situation or problem more deeply (Senge et al., 1997). Systems dynamics is well known through the influential work of J.W. Forrester of MIT, originating in the late 1950s. This concept asserts that the behaviour of an organization is principally orientated by the organization’s structure (Robert, 1978). Systems dynamics deals with the study of behaviour of the complex systems. It aims to demonstrate how information feedback governs its behaviour and shows how policies, decisions, structure, and delays are interconnected through simulation and optimization (Lee and Tunzelmann, 2005; Galanakis, 2006).

Systems dynamics has own merits in fulfilling certain modelling requirements, which include: a holistic view of specific phenomena; development of causal relationships between variables; availability of feedback mechanism; and finally the attempt to explain a specific pattern of behaviour. Systems dynamics has a major focus – that of examining the impact of one factor on another- and it can be considered as a modelling tool to identify variables that need to be improved in order that optimum results be achieved in a specific subject, with the minimization or elimination of possible barriers (Rodrigues and Bowers, 1996).

Mohaparta et al., (1994) indicated that systems dynamics models are appropriate to study systems that show feedback mechanisms; therefore, causal relations could be developed as a series of influence and causal loop diagrams. The four major elements of systems dynamics are: the closed boundary; feedback Loops; stocks or flows and observed conditions within the system **(**Forrester, 1976).

a. Applicability of systems dynamics in NIS

Systems Dynamics is generally used in business and public policy analysis (Pidd, 1998). Lee and Tunzelmann, (2005) and Galanakis (2006) established that this approach is applicable to National Innovation Systems.

Theories from different perspectives, such as economics and management, are used to describe how innovation occurs in a firm and what factors have an effect on the outcome of this process (Galanakis, 2006). The example shown in Figure 6.7 is to illustrate the applicability of systems dynamics in NIS. Galanakis (2006) considered this issue in his paper entitled "Innovation process: Make sense using systems thinking". The main objective of his research was "*to communicate innovation theory to the different actors in the system under a common perspective and to reveal the complexity of innovation systems. .....The model's main focus is the Knowledge Creation from public or industrial research; the New Product Design and Development process, and the Product Success in the market. This process is affected by other internal factors of the firm as well as by the National Innovation Environment. This innovation system has been codified, under a system dynamics approach, to create a model..... That includes all the aspects that academia, a firm or the policy making bodies need to consider around innovation activity*" (Galanakis, 2006, p1222).

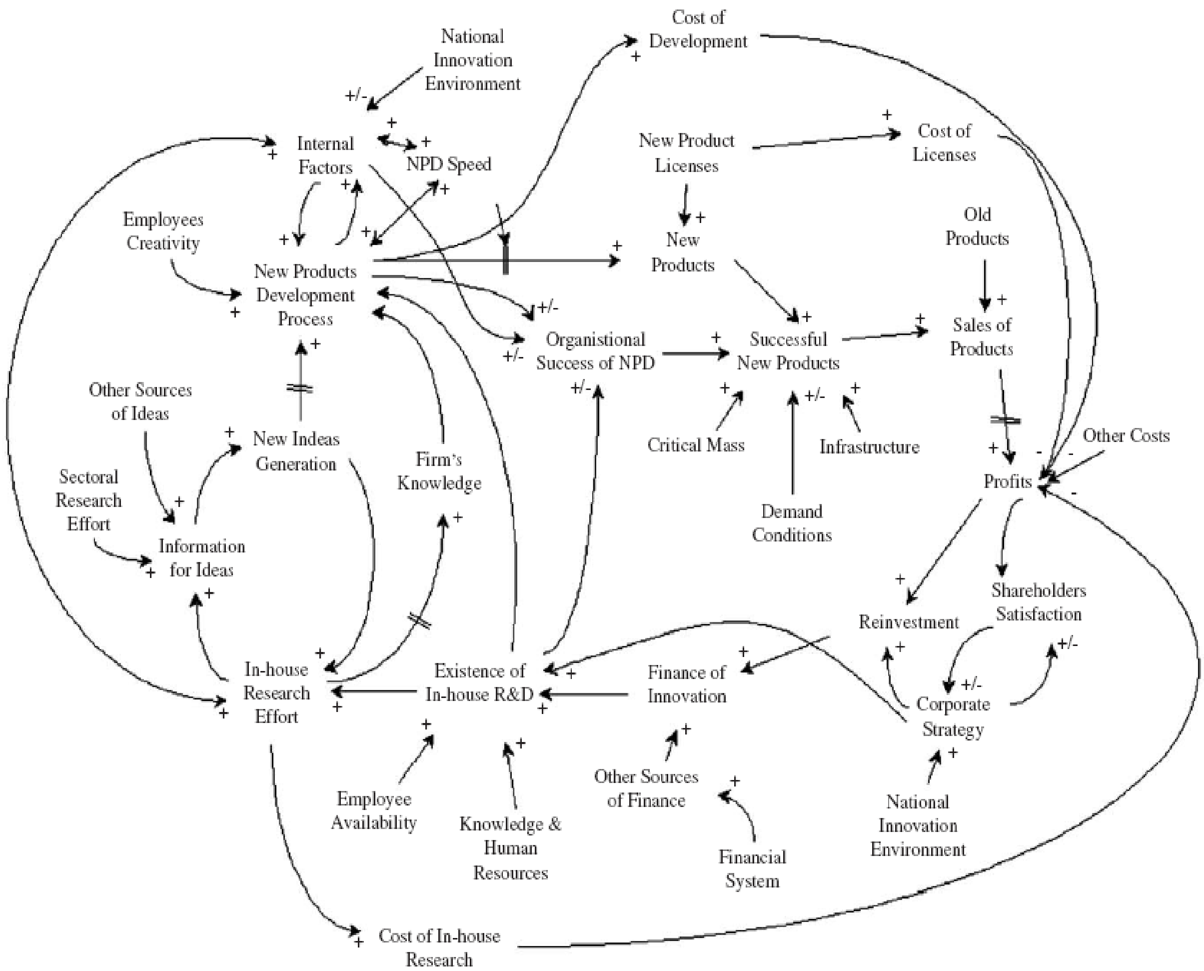


Figure 6.7: Influence diagram showing innovation process effects upon a firm's profits (Galanakis, 2006)

6.5 CONCLUSION

System thinking is a strong approach to deal with complex issues. Senge (1990) considers system thinking as a framework to give a full clearer picture of a problem situation, and as a tool for understanding how things work. It is a framework to look beyond events and scrutinise the patterns of behaviour.

System thinking is recognised by many literature as a sound methodological approach to tackle the complexity of NIS and to better understand the relationship between different elements in NIS. However, there is a gap in the literature in the area of systematic behaviour models of UIC.

CHAPTER 7

SCENARIO METHODS

7.1 INTRODUCTION

A popular approach to forecasting employed by governments and businesses is 'forecasting based on probabilities'. However, notably increasing the degree of uncertainty in some situations makes this planning tool useless. This method asks questions of what has already occurred that will create the future rather than what is most likely to happen (Drucker, 1995). Applying a specific approach, e.g. scenario building, to 'project potential futures' is used in order to increase the quality of our present decisions (Ratcliffe, 2000).

This chapter provides an overview of the literature related to scenario development. Various uses of scenario development are explained and different kinds of scenario methods are examined. Furthermore, applicability of scenario development for UIC development is discussed. Finally, a unified systematic conceptual model based on the combination of different systems of innovation theories (in macro and micro level), culture and trust related theories, and some Iranian-related factors is developed.

7.2 ORIGINS OF SCENARIO PLANNING

The scenario concept initially emerged following the Second World War and was identified as an approach for military planning purposes (Schwartz, 1998).

The Second World War pulled together a large number of academics into government and subsequently caused development of the field of corporate planning. After the war the RAND Corporation started to research new forms of weapon technology. RAND's Kahn initiated the technique of "future-now" thinking, which focuses on producing a report based on analysis and imagination as it might be written by people living in the future. During the 1960s a number of scientists from defence contractors were asked "*what will the world want and need in the next twenty years?*" (Ringland, 2006, P3).

7.3 DEFINITION OF SCENARIO

Scenarios might be described as a tool to project a potential future. They are a combination of an estimation of what might happen, with assumptions about what could happen; however, scenarios do not forecast what actually will happen (Fahey and Randall, 1998). Scenarios should be plausible, which means that they need to be possible, credible and relevant. Plausible evidence should illustrate that the projected narrative could happen in the future (be possible), show how it could happen (be credible), and finally indicate its meaning for the organization (be relevant) (Fahey and Randall, 1998).

Definition (Scenario)	Author	Year
"*Quantitative or qualitative picture of a given organization or group, developed within the framework of a set of specified assumptions*"	Kahn, p3	1962
"*An internally consistent view of what the future might turn out to be-not a forecast, but one possible future outcome*"	Porter, p112	1985
"*Descriptive narratives of plausible alternative projections of a specific part of the future*"	Fahey and Randall, p6	1998

Table 7.1: Definition of Scenarios

The main components of scenario are listed as (Fahey and Randall, 1998):

- Driving forces: Scenario plots are constructed by driving forces. These forces shapes the story described in a specific plot;
- Logics: Scenario logic represents the rationale behind a scenario's story or plot. It describes why specific forces behave as they do;
- Plots: End states which depict the specific event in future time are the results of one or more specific plots or stories. Each plot contains a story that connects the present to the future;

- End States: Describe what will happen in a particular future or world at some specific point in time. One possible way to generate an end state is to ask 'what if?' type of questions.

7.4 SCENARIO PLANNING APPROACH

Scenario planning has been widely employed since the 1970s to help organizations to decrease the huge number of future possibilities down to a handful of consistent views (Fink et al., 2005). Scenario planning has been accepted by scientists as an investigation tool that offers a more logical approach than traditional forecasting techniques (Bell et al., 2004).

A scenario plan regenerates many stories; each telling how various components might interact under specific conditions. This approach does not represent a single possible plan and does not indicate how changes in one variable can affect a process as a whole. It attempts to represent a range of possibilities by telling stories which are easier to understand and use than great volumes of data (Bell, 1999). Various definitions of scenario planning are provided in Table 7.2.

Definition (Scenario Planning)	Reference	Year
"An efficient approach to strategic business planning, focusing on business ideas in an uncertain world."	Van der Heijden, p2	1996
"*Builds plausible views of different possible futures for an organization based on groups of key environmental influences and drivers of change about which there is a high level of uncertainty.*"	Johnson and Scholes, p273	1999
"*That part of strategic planning that relates to the tools and technologies for managing the uncertainties of the future.*"	Ringland, p4	2006

Table 7.2: Definition of Scenario Planning

The outcome of scenario planning is focusing on better thinking and constant strategic conversation about the future, rather than providing a very exact picture of the future (Van der Heijden, 1996; Johnson and Scholes, 1999; Bell et al., 2004; Ringland, 2006).

7.5 THE PURPOSE OF SCENARIO DEVELOPMENT

The purpose of the scenario is to "*effectively organize a variety of seemingly unrelated economic, technological, competitive, political and societal information and translate it into a framework for judgment- in a way that no model can do*" (Wack, 1985, p146). Scenarios also serve to provide managers with a good picture of an alternative future by which offers a deeper insight into the consequences of their hypothetical decision, and ultimately to improve a decision making (Ratcliffe, 2000; Wright, 2005).

Scenarios also help managers to understand what the possible future might look like. They explain how these possible futures might come about and why these futures might happen. Scenarios may produce new decisions; in others word scenarios may lead to new considerations appearing that were not part of previous organizational plan. Also, scenarios may change the existing decision of an organization and also help managers to formulate important "contingent" decisions (Fahey and Randall, 1998).

7.6 BUILDING SCENARIOS

Scenarios can be built using two methods. The first, is the "Exploratory" scenario, and focuses on identifying the current state of important driving forces and then analyzes the combination of possible future trends over a period of time. The second is "anticipatory" and starts with the future state and the search is directed backwards as a method for uncovering the series of events which leads to this occurrence (Ratcliffe, 2000; Fuller-Love et al., 2006). In other words, futures are selected and this attempts to find which path leads to them; the method is also recognized as "future backward" (Fahey and Randall, 1998; Ratcliffe, 2000).

The scenario process starts with a set of thinking about the future. Normally researchers focus on three types of future, which are probable, possible and preferable. The probable future focuses on the direction which is likely to be. The possible future emphasizes the emergence of a new idea or activities which will lead to the new generation of something. Finally the preferable future focuses on developing the most desirable image of the future (Bell, 1999). Schwartz (1998) mentions that most of the time (not always) scenarios can be categorized in three groups: “more of the same but better”; “worse” (which consider the depression situation); and “different but better”.

7.7 DIFFERENT TYPES OF SCENARIOS

Scenarios can also be classified by the scope or scale of the investigation. These include:

- Regional and country scenarios

  These scenarios identify two critical questions that have the ability to alter the fortunes of some developing countries in the next twenty years, e.g. Saudi Arabia. These two question include: “will leaders be able to implement the necessary economic and political reforms and enforce the rule of law, both in public and in private governance?”. And “will the country be able to maintain internal order and stability, in particular vis-à-vis a complex and uncertain regional situation?” (World Economic Forum, 2007).

- Industry scenarios

  This gives the ability to the manager to identify the plausible future states of industry and to identify how they differ from each other, so as to analyze how these different industry states might develop. It also directs the manager in order to find out what they have to do to cope with each situation so that they might be successful in this regard (Fahey and Randall, 1998).

- Technology scenarios

  This type can help management make better technology decisions by giving them deeper insight into different choices in order to prepare them for a highly uncertain future market (Fahey and Randall, 1998).

7.8 OPERATION OF SCENARIOS

Effective scenarios are usually simple both in content and in the process which generate them. More than twenty years ago the Shell Company started to build a number of scenarios, but in time discovered that managers are only able to concentrate on a handful of scenarios. Managers can only cope effectively with three scenarios (Mercer, 1995).

Ratcliffe (2000) proposed a number of recommendations for the operation of scenarios. He categorized the results of his study as:

- Participants: he concluded that the scenario building process is by nature a team exercise and it is therefore critical that the proper people from a representative cross-section of the organization are selected.
- Expectations: should be realistic. An appropriate time frame should be assigned for the horizon of the scenarios. Many organizations do not consider the future far enough and as a result they are unable to assign enough recourses to conduct the process.

Schwartz and Ogilvy (in Fahey and Randall, 1998) agree that it is crucial to assign a fitting time frame for the scenario relevant to the field of study, because this will have a direct impact on the range of issues the scenario addresses.

7.9 RELATED TECHNIQUES FOR BUILDING SCENARIOS

Of the many approaches in the literature for building scenarios, the most popular are systems analysis, the Delphi technique, projections, correlation methods, brainstorming, and decision trees. The Delphi technique and systems thinking are widely accepted as a methodological base for building scenarios (Garret in Slaughter, 1966; Mercer, 1995).

The Delphi technique, developed in the 1950s as a 'subjective' approach, incorporates the collection of necessary information to decide about the future. It was developed by Kapalan during the Second World War in order to improve the use of expert ideas in policy-making at the RAND Corporation (Woudenberg, 1991; Ratcliffe, 2000). The process includes gathering information from a number of experts in specific fields and attaining a consensus view about what might happen in the future (Ratcliffe, 2000; Loo, 2002).

The systems thinking approach (see Chapter 6) is also used to develop scenarios. Systems thinking concepts emphasize the point that the world can be seen from three different perspectives: events, pattern of behaviour and structure. Ratcliffe found that when systems thinking and scenario planning are used together, the learning rate improves (Ratcliffe, 2000). Systems thinking is also recognized as a tool for expanding scenarios. Studying the way the parts of a system interact can be a powerful tool for examining the logic of a scenario. Usually the researcher focuses on individual events, but sometimes they need to explore a deeper understanding about the appropriate plot for a scenario by examining the underlying patterns of events (Schwartz and Ogilvy, in Fahey and Randall, 1998).

7.10 APPROACHES TO CONSTRUCTING SCENARIOS

Important approaches for scenario development are: mental maps of the future and dynamic scenarios (where systems thinking meets scenario planning). According to

Fahey and Randall (1998) these two approaches are usually used when researchers are required to cope with complex sets of forces and uncertainties. The former is useful to understand all related forces in the context of the study and the latter is used to add dynamic features to the scenarios. Other approaches are also useful for developing simpler situations (e.g. developing scenario matrix based on two dimensions of uncertainty).

7.10.1 Mental maps of the future

The most important aim of scenario planning is to challenge, test and sometimes change the decision maker's view about the present and future. This process leads to a recreation of the decision maker's "mental maps" of the world (Wilson, in Fahey and Randall, 1998).

The scenario development discernible in such an approach consists of six major stages. The terminology varies and the number of stages varies in alternative models, but the focus of this thesis is on the common basic elements and processes among these models. These stages are: identify and analyze the organizational issues that will provide the decision focus, specify the key decision factors, identify and analyze the key environmental forces, establish the scenario logics, select and elaborate the scenarios, and finally interpret the scenarios (Schoemaker, 1993; Schoemaker 1995; Schwartz, 1998, pp241-248; Wilson in Fahey and Randall, 1998; Ratcliffe, 2000). The explanation for these six stages is provided below:

Stage 1: Identify and analyze the organizational issues that will provide the decision focus:

> This step explains which strategic decisions should provide the focus for the scenarios. This step should include management consensus regarding the selection of strategic decisions. It is worth mentioning that if the scope of the

decision or strategy is considered narrower, it will make the process of scenario construction easier (Wilson, in Fahey and Randall, 1998).

Stage 2: Specify the key decision factors:

At this stage the following question should be answered: what are the important issues we would like to know about the future in order to make our decision? (Wilson, in Fahey and Randall, 1998).

Stage 3: Identify and analyze the key environmental forces:

This section can be divided into two subsections. The first stage is to identify the forces that will determine the future course and value of the key decision factors. These driving forces are cultural; demographic; economic; environmental; governmental and also technological (Wilson, in Fahey and Randall, 1998; Ratcliffe, 2000). The next stage starts the sorting of these forces, by considering that all of them are not equally crucial and the level of uncertainty (probability of happening) related to each of them are different. To be systematic in this sorting process of forces, an impact/uncertainty matrix can be utilized to place each force within a high-medium-low sorting system (Figure 7.1) (Wilson, in Fahey and Randall, 1998). Each of these forces should be rated based on:

- The level of its impact on the key decision factors;
- The degree of uncertainty about the direction and pace of its future.

When using this ranking process, only those forces with a higher degree of uncertainty and also higher degree of impact should be selected. Therefore, the crucial scenario driving forces can be realized (Wilson, in Fahey and Randall, 1998). Forces that are low uncertainty/ high impact are features which already exist, are positive and embedded in the reality of the system being studied.

Forces which are high uncertainty/low impact are largely unimportant to the system outcomes.

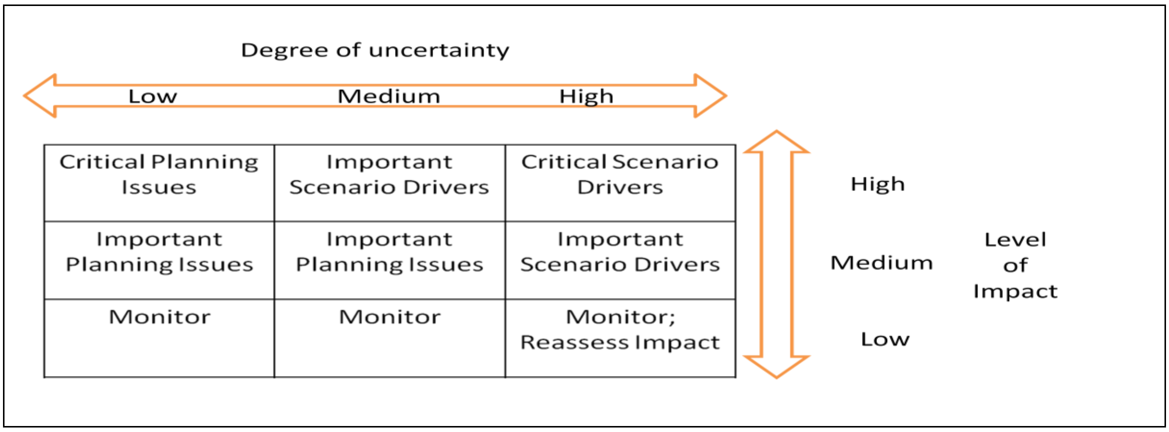


Figure 7.1: Illustrative Impact/Uncertainty Matrix adapted from Wilson, in Fahey and Randall, 1998.

Stage 4: Establish the scenario logics:

It is possible to develop scenarios using the forces which are placed in the three upper-right quadrants of the impact/uncertainty matrix. However, in some situations where many important forces exist this would result in a large number of scenarios which would be very difficult to use in any planning system. Developing the structure that leads to the production of a manageable number of scenarios is the main objective of this step (Wilson, in Fahey and Randall, 1998). Scenario logic helps researchers to achieve their objectives. Scenario logics are "*organizing principles around which the scenarios are structured. They focus on the critical external uncertainties for the business, and present alternative theories of the way the world might work. Each addresses an important area of uncertainty*" (Wilson, in Fahey and Randall, 1998, p90). All of the alternative future states should be logical, meaning that for each of the outcomes a persuasive and rational case can be made (Wilson, in Fahey and Randall, 1998).

Stage 5: Select and elaborate the scenarios:

According to Wilson, in Fahey and Randall's (1998) specific rules for developing a manageable number of scenarios should be followed. Even after reducing the number of scenarios in the previous stage, sometimes researchers end up with a situation incorporating a number of scenarios. At this stage some specific selection procedures among these forces are needed, otherwise the decision maker who wants to use them will be overwhelmed. Five basic criteria exist in order to reduce the number of scenarios and to prevent the problem of facing a large number of choices:

1. Plausibility: Scenarios should fall within the realms of possibility.
2. Differentiation: The structure of each scenario should be different. In other words they should not be close to other alternatives.
3. Consistency: Scenarios should be built in such a way that they maintain internal consistency.
4. Decision-Making Utility: Each of scenarios and the set of all scenarios should contribute specific insight into the future that will be relevant to the decision focus that was selected.
5. Challenge: The scenarios should challenge accepted customs and properties about the future.

Stage 6: Interpret the scenarios:

"*This step poses the fundamental question of how the task, issue or decision identified at step one looks in the light of the scenarios constructed. What are the strategic implications? How does the decision fit into each scenario? What options are suggested? Are any particular vulnerability exposed? Is the decision or strategy robust enough? Does it seem to work in only one scenario and thus qualify as high-risk? How can the strategy or decision be adapted to make it more robust?*". In this way, step six gives decision makers the ability to turn scenarios into strategy (Ratcliffe, 2000, p137).

7.10.2 Dynamic scenarios

Ward and Schrierfer (in Fahey and Randall, 1998) developed a unique approach for dynamic scenario building, involving systems thinking meeting scenario planning. The main purpose of the scenario is to depict a possible image of the future in order to enable effective strategic decisions (policy instruments) to lower critical force uncertainties in order to provide structural reliability for economic planning. The real world can be viewed as dynamic - an ever-evolving system and not static – offering greater insight regarding the complexity and dynamism of political and social environments. Complexity here means considering a large number of variables and the different relationships that can exist among them. Dynamism refers to the types and rates of changes that can occur. Ward and Schrierfer (in Fahey and Randall, 1998) observed that scenario learning increases if the analytical approach considers the environments in which organizations operate as systems of dynamic complexity.

The concept of dynamic scenarios is based upon a large body of system methodologies, e.g. Peter Senge (1990). An important principle common in all systems methodologies is that complexity and dynamism can be understood only in the context of a system. The main feature of any system is that the behaviour of each element affects the behaviour of the whole system in some way. Another principle of systems thinking is the view of the world in three levels at the same time; events, patterns of behaviour and structure (Ward and Schrierfer, in Fahey and Randall, 1998).

This dynamic scenarios approach developed largely for company strategy proposes by Ward and Schrierfer (in Fahey and Randall, 1998) consists of seven major steps:

1- Generate scenario event ideas

This step involves many activities including: intelligence gathering, in which information is collected on related environments. This information can be shown in time series charts for crucial variables. The interview process should be facilitated to ascertain their ideas in depth. After obtaining the relevant information about actual and potential issues, the next stage is arranging focus sessions. This stage includes recruiting the most knowledgeable individuals from different system elements (organizations, agencies, institutes) in order to participate in a series of focus sessions. The role of the focus group is to participate in the creation of a number of plausible and comprehensive scenarios that describe potential futures.

2- Discover scenario dimensions

After the focus groups express their ideas about the future, the ideas and events are arranged into specific groups which are related to each other. This clustering of events forms the 'scenario dimensions'.

3- Develop divergent scenario themes

This process involves selecting important events from the previous step (scenario dimensions) and reorganizing them into varying scenario themes. "*The scenario theme clusters are new grouping of events that could logically fit together".* The objective is to *"look for events within the scenario dimensions, that, when woven together, would create the elements of a proactive, but logically consistent story*" (Ward and Schrierfer, in Fahey and Randall, 1998, p146). A result of this process is a proposal of a large number of scenario themes. In order to reduce the number of scenario themes, only those that suggested significantly different futures are selected.

4- Discern patterns of behaviour

Scenario themes, from step 3 are investigated in order to identify a number of events that seem to be more significant in shaping the story of the themes and to categorize key variables related to these events. The next step (5) describes how these variables change over time.

5- Diagram scenario structure

This step is to identify the group of key variables related to each scenario theme; furthermore the relationships between variables, in the form of influence diagrams, should be constructed. Usually scenario themes share many of the same variables. In this step many causal loops will be created and often share some of the scenario variables. Each causal loop will explain only the part of the story underlying the scenarios and when they combine together they create a diagram of the whole system. This diagram, which depicts the complex system, is known as the Dynamic Scenario Generator or DSG.

6- Write the scenario scripts

The Dynamic Scenario Generator (DSG) is a tool to model the dynamics within a complex system. This tool is used to consider and write scripts for plausible scenarios by testing major changes to one of the important variables, or by considering critical uncertainties in the system. It is possible to generate several scenarios with any DSG. Only those scenarios which are significantly different from one another are required to provide strategic perceptivity.

7- Assess strategic choices

The final step is to use a number of strategic management tools for developing alternative choices; groups of compatible options will be organized and recognized as classifiable strategies. The final step is to test the quality of each of these strategies by considering to what extent they will work in each of the scenarios.

7.11 SCENARIOS IN NATIONAL SYSTEMS OF INNOVATION (NIS)

"*The term 'scenario' is used for a variety of different approaches-from single alternative projections to results of complex simulation-models*" (Fink et al., 2005, p360). In this research the term 'scenario' is used to determine future images and are developed based on systems thinking approaches.

The application of scenario analyses has been recently expanded in many fields of research. The work by Harper and Georghiou (2005), for example, used scenario planning by organizing 24-hour 'Success Scenario Workshop' for the next five years of the future of business-university linkages in the city region of Manchester. These scenarios create a picture of the future and focus on the point that the success scenario will be achievable if sufficient drive and resources can be mobilised by stakeholders. Fuller-Love et al., (2006) also suggested that scenario analysis can be successfully used to enhance entrepreneurial activities.

7.12 SUMMARY TABLE (KEY FORCES)

This section is designed to address the key forces identified in the literature which contribute a vital role in an NIS. Table 7.3 lists these key forces which form the basis of the conceptual model for this study. The groupings are explained in Section 8.7.2.2.

Key Forces		References
Barriers to UIC	Companies low investment in R&D	(Inzelt, 2004; World Economic Forum, 2008; Yokakul and Zawdie, 2009)
	Status of brain drain	(Davenport, 2004; Mani, 2004; World Economic Forum, 2008)
	Instability of government regulations	World Economic Forum, 2008
	Monopoly of government	(Porter, 1990; Bitzenis, 2003; Wignaraja, 2003; World Economic Forum, 2008)
	Inefficiency of privatisation	(Bitzenis, 2003; Pitelis in Wignaraja, 2003; Wignaraja, 2003)
	Political environment	(Torbat, 2005; Marossi, 2006)
	Cultural differences between partners	(Davenport et al., 1999; WIPO, 2002; Siegel et al., 2004; Bstieler, 2006)
	Lack of understanding of partners from each others' norms	(Davenport et al., 1999; Bstieler, 2006)
	Financing the technology transfer deal; speed of negotiation of technology transfer; difficulties in agreeing a technology transfer deal;	(Liu and Jiang, 2001; Siegel et al., 2004; Siegel and Phan in Libercap, 2005)
	Bureaucracy and inflexibility of university administrators	(Dzisah and Etzkowitz, 2008; Bouhamed et al., 2009; Singer and Peterka, 2009)
Collaboration Continuity	Accessibility of industry funding; university satisfaction from company's regulations regarding UIC; satisfaction of companies from universities' regulations; Gain and the usage of research; accessibility of university technology; impact on companies 'sales	(Gerwin et al., 1991)
	Commitment	(Roth and Magee, 2002; Plewa and Quester, 2007)
	Trust	(Fountain, in Branscomb and Keller 1998; Davenport et al., 1999; Bstieler, 2006; Hermans and Castiaux, 2007; Plewa and Quester, 2007)
Motivation for Researchers	Feeling a sense of accomplishment when working with industry; to enhance researcher's practical knowledge; funding for future research; taking new knowledge to practical application; modify reward system based on amount of technology transfer activities	(Gerwin et al., 1991; Liu and Jiang, 2001; Siegel et al., 2004)
	Clear institutional policy on royalty sharing	(Inzelt, 2004; Decackere and Veugelers, 2005; World Economic Forum, 2008)
Motivation for Companies	Access to the equipped university physical facilities; Higher access to government funding when collaborating with universities; availability of tax credit if cooperating with universities; to access and recruit highly qualified personnel from universities; to accelerate or improve existing research product; access to new technologies; improve sales and profitability	(Lee and Win, 2004; Radas, 2005; Decter et al., 2007; Dooley and Kirk, 2007; Freitas et al., 2009)
Motivation for Universities	Creating entrepreneurial culture in universities; integration into the labour market for graduated students; access to applies knowledge with positive impact on academic research and teaching ; higher access to government funding; access to industrial information; recruitment of qualified staff; access to network of knowledge creation; increasing budget limitation for the academia	(Lee, 1996; Rene and Heinrich, 2006; Decter et al., 2007)

Table 7.3: Key forces which form the basis of the conceptual model

Key Forces		References
Drivers of UIC	Efficient national policy on IPR and enforcement laws	(Jayakar, 1997; Robert and Ostergard, 2000; Forero-Pineda, 2006; Geuna and Nesta, 2006; Hertzfeld et al., 2006; Furukawa, 2007; Sarkissian; 2008)
	Efficient Institutional policy on IPR	(Inzelt, 2004; Mowery et al., 2004; World Economic Forum, 2008)
	Support of venture capital (VC)	(Porter, 1990; Knight in Bulumac and Bendis, 2001; Etzkowitz, 2005; Marques and Neto, 2007; World Economic Forum, 2008; Singer and Peterka, 2009)
	Activities of TTOS to support UIC	(Etzkowitz and Leydesdorff, 2000; Etzkowitz et al., 2000; Degroof and Roberts, 2004; Debackere and Veugelers, 2005; Macho-Stadler et al., 2008; Reeves et al., 2009)
	Efficient programme which includes mobility of people in UIC	(Inzelt, 2004; Dzisah and Etzkowitz, 2008)
	Existence of efficient methods for conveying knowledge between partners	(Gerwin et al, 1991; Bergman and Feser, 1999; Santoro and Bierly, 2006; Hermans and Castiaux, 2007; Dzisah and Etzkowitz, 2008)
	Evaluation of faculty members according to the extent of their contributions to the UIC process	(Gerwin et al., 1991)
	Efficient government programme to enhance awareness/training for entrepreneurial activities	(Krueger, 1993; Siegel and Phan, in Libercap, 2005)
	Availability of active research consortia	(Ceglie and Dini, 1999; Carayannis et al., 2000; Etzkowitz and Leydesdorff, 2000; Arbonies and Moso, 2002; Dwivedi and Varman, 2003; Inzelt, 2004; Etzkowitz et al., 2005; Rohrbeck and Arnold, 2006; Dooley and Kirk, 2007)
	High degree of intermediary involvement	(Porter, 1990; Ceglie and Dini, 1999; Davenport et al., 1999; Etzkowitz and Leydesdorff, 2000; Dwivedi and Varman, 2003; Etzkowitz et al., 2005; Smedlund, 2006; Kodama, 2008)
	Status of entrepreneurial environment	(Porter, 1990; Porter, 1998; World Economic Forum, 2008)
	Status of cluster formation	(Porter, 1990; Porter, 1998; World Economic Forum, 2008)
	Competition	(Porter, 1990)
	Formal institutions (laws, rules and regulations)	(Tillmar, 2006)
	Informal institutions (national culture)	(Tillmar, 2006)

Table 7.3 (Continued): Key forces which form the basis of the conceptual model

7.13 CONCEPTUAL MODEL

This section represents the unified conceptual systems model which is developed based on the combination of different systems of innovation theories (in macro and micro level) (see Chapters 3 and 4), culture and trust related theories (see Chapter 5), application of systems modelling approach (see Chapter 6), and also consist of some of the Iranian-related factors (see Chapter 2). This conceptual model is depicted in Figure 7.2. One of the important features of this model is the impact of culture and trust on the whole system which can be considered as a weakness of other innovation systems theories. This model also shows the way that different actors in the system (companies, universities, individual within universities) are motivated to collaborate. Factors which have an impact on collaboration performance and collaboration continuity are depicted in this conceptual model. It also shows the important role of government for creating favourable entrepreneurial environment.

Loops emerged as a result of interactions of factors in this model (Figure 7.2). For example, efficient cluster formation is recognized as a driver for UIC in which as a result of intense competition, companies are more interested to adopt technologies from external sources e.g. universities. Therefore, UIC performance is enhanced. Also as a result of efficient UIC, the efficiency of cluster activities is increased (Loop R1). Furthermore, favourable entrepreneurial environment can enhance the efficiency of cluster formation, and by enhancing the efficiency of a cluster; competition will be increased resulting in greater encouragement of an entrepreneurial environment (Loop R2, R3). By creating a favourable entrepreneurial environment, the willingness of the people to leave the country in order to find opportunities elsewhere is decreased; therefore, it will have a positive impact on UIC performance. By increasing UIC performance, efficiency of the cluster is increased which have a positive impact on favourability of entrepreneurial environment (Loop R4).

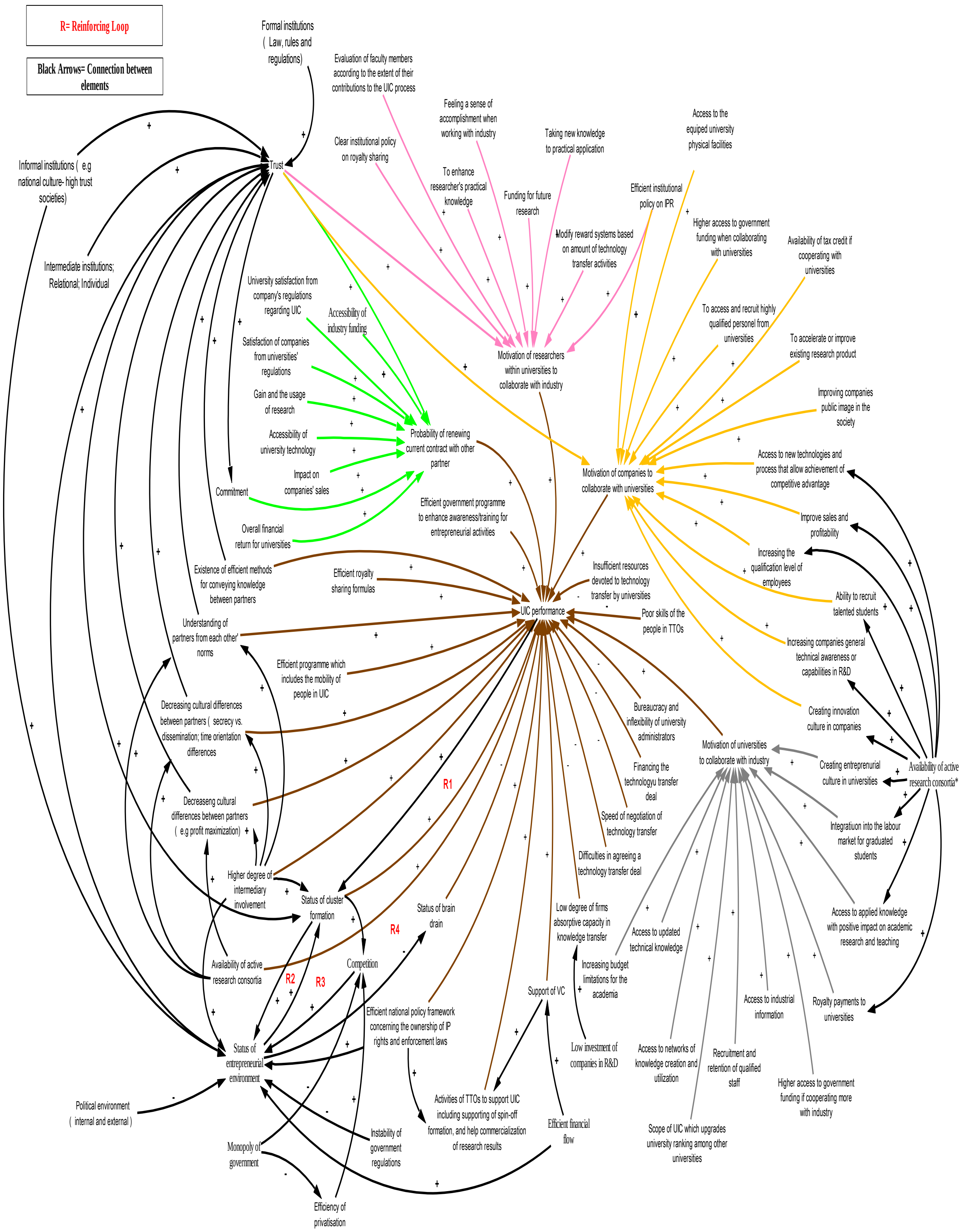


Figure 7.2: Conceptual Model

7.14 CONCLUSION

Scenarios can be described as a tool to project a potential future (Fahey and Randall, 1998). Many literature acknowledged that utilising this method is very useful when there is a degree of uncertainty about the future. This methodology is applicable to the level of the country as well as organisation in order to understand what the possible future might be like. This ultimately enhances a quality of decision makers.

Many approaches are recommended for developing scenarios. Among these, system thinking is considered as an effective methodological base for building scenarios. According to Ratcliffe (2000) when system thinking and scenario planning are used together, the learning rate improves.

A scenario approach is used for the future of university-industry linkages e.g. scenario matrix which only considers two dimensions of uncertainty. But this approach seems to be insufficient to tackle more complex situation in developing countries. Despite the fact that developing a scenario based on system thinking is more desirable, no research exists related to UIC in order to put this in practice.

CHAPTER 8

RESEARCH METHODOLOGY

8.1 INTRODUCTION

In this chapter theories of research methodologies and the practicalities of data collection are explored, and the methodology used for the current research is detailed. The choice of the most appropriate methodology to examine the role of university-industry collaboration (UIC) in the Iranian national system of innovation is discussed. The core of this research focuses on developing different future transition scenarios for Iran based on policy instrument changes with a systems modelling approach, and also tests the validity of the results from these scenarios.

This research methodology consists of four stages. The first is a systems model conceptualization in order to understand the problem. Secondly, the use of a survey instrument to test and validate the conceptualization of the model. Thirdly, an adjusted Delphi-based Technique is used to utilize semi-structured interviews of key actors to validate and develop a dynamic to the systems model, and also to establish future outcomes of system changes in the Iranian case. The last stage is the follow-up Delphi session, which involved testing the series of transition scenarios in front of panels of experts. Each stage is tested. In other words, the conceptualization stage is tested by a questionnaire, the output from the model developed from the questionnaire analysis outcomes is then tested by interviews, and the output of interviews which constructs the scenarios is tested by the forum meeting. Thus, each stage enhances the evolution of the model to the point where all the components are captured in the UIC model and scenarios for Iran.

The methodology used in this chapter is mix-method research (sequential) which combines quantitative and qualitative techniques and procedures. The sampling process and the research instruments developed are highlighted.

8.2 PHASES OF THE RESEARCH PROCESS

Business research is similar to other forms of scientific inquiry and consists of a sequence of highly interrelated activities. The stages in the research process overlap continuously, and it is not appropriate to say that all research projects will necessarily follow the same ordered sequence of activities. Nevertheless, business research frequently follows a general pattern. The stages consist of: defining the problem; planning a research design; planning a sample; collecting data; analyzing the data and finally formulating the conclusions and writing the research report (Zicmund, 2003).

8.3 RESEARCH QUESTIONS

The main research question in this investigation is; what policy instruments enhance university-industry collaboration to transit Iran toward a knowledge-based economy?

As this question was addressed during the research it became necessary to deconstruct it further into four sets of sub-questions:

1. Understand the problem by establishing the factors from the literature, models and evidence from other countries relating to University Industry collaboration. Can this information be conceptualized into a useable model? What methods can be used to examine policy changes on UIC performance?
2. The second set of questions are to examine the relevant drivers and barriers to collaboration between University research groups and Industry in Iran:
    a. What factors motivates the individual within universities to collaborate with industry?
    b. What factors motivates universities to collaborate with industry?
    c. What factors motivates industry to collaborate with universities?

d. What factors are barriers to any UIC?
e. What changes are likely to promote more effective UIC?
f. What are the uncertainties due to these factors?
g. What are the roles of culture and trust in these relationships?

This stage concludes with the refinement of the conceptual model from stage one into a detailed systems model using the Iranian UIC case.

3. How can these factors be combined into a coherent dynamic model to understand change impact and plan policies?

    a. How do policy changes affect university- industry collaboration?
    b. How would these policy instruments change the behaviour of actors in a UIC system?
    c. How are these change forces incorporated into the systems model?
    d. How are policy changes for university-industry collaboration enhancement reflected in transition scenarios for the case of Iran's shift toward a knowledge-based economy?

4. How can these policy instruments be tested and validated?

8.4 RESEARCH PHILOSOPHY

Research philosophy is a crucial part of every research project because it contains important assumptions about the way in which the researcher views the world. These assumptions can be considered to be the foundation of any research strategy and the methods chosen as part of this strategy. There are three major ways of thinking about this philosophy; the first is Epistemology, which concerns what constitutes acceptable in a field of study and asks whether the approach to the study of different subjects are the same. The answer to that question points the way to the acceptability of knowledge developed from the research process (Saunders et al., 2007). It is divided into three branches of Positivism, Realism and Interpretivism (Bryman and Bell, 2007; Saunders et al., 2007). The positivist paradigm belief is that the world is external and objective; whereas the interpretivism belief is that the world is socially constructed and subjective. In the former paradigm researchers should focus on facts, look for causality, and hypotheses and then test them while in the latter researcher should focus on the meanings, try to understand what is happenings, and develop ideas through induction from data (Easterby-Smith et al., 1996).

The second is Ontology, which concerns the nature of reality and raises questions relating to the assumptions researchers have about the way the world operates. It incorporates two aspects of objectivism and subjectivism (Saunders et al., 2007). Questions of method are secondary to questions of epistemology or ontology, some would still be excused for thinking that selecting between one position and the others is somewhat unrealistic in practice. If this situation occurs, then the researcher could be said to be adopting the position of pragmatism (Guba and Lincoln, in Denzin and Lincoln, 1994). Pragmatism argues that: "*the most important determinant of the research philosophy adopted is the research question- one approach may be 'better' than the other for answering particular questions. Moreover, if the research question does not suggest unambiguously that either the positivist or interpretive philosophy is adopted; this confirms the pragmatist's view that is perfectly possible to work with both philosophies*" (Saunders et al., 2007, p110).

- **Research philosophy of the current research**

Considering all of research paradigms to study social-political phenomenon, the researcher finds that limiting oneself to one particular paradigm offers a partial view of the world. It is certainly the case that the research described in this thesis does not precisely fit into either of these paradigms. In this case it was decided a pragmatic approach was most appropriate to combine the strengths of each of these positions in determining the philosophy to be followed for the research. The focus of this study is on university-industry collaborations in order to find out how such collaboration can be developed in Iran as part of the country's move toward a knowledge-based economy. This requires indentifying critical forces that affect UIC process including motivational factors as well as institutional and government policies (focus on facts); such forces can then be used as a foundation for developing transition scenarios. Furthermore, it also requires a deep understanding regarding the relationships among these forces for modelling purpose and completion of scenario development process (try to understand what is happening). The nature of the questions to be answered suggested that a quantitative study would provide the best data for subsequent analysis and the possible formulation of hypotheses, whereas qualitative data was required in order to reach a deeper understanding of the quantitatively derived information and to find out what is happening. Therefore the philosophy adopted was a mixture of the positivist and interpretivist.

8.5 RESEARCH APPROACHES (DEDUCTIVE VS. INDUCTIVE)

A researcher should observe and record what is seen impartially. Some of these statements of observation are established as true and they could be considered as a foundation for theories and laws. Induction and deduction are ways of establishing what is true or false and to how reach conclusions. Induction is based chiefly on empirical evidence, whilst deduction is based on logic (Ghauri and Gronhaug, 2005). According to Collis and Hussey (2003) a deductive approach is based on the development of the theory that is subjected to an accurate test. Therefore, it is the main research approach in the natural sciences, where laws present the basis of explanation, allow the anticipation of phenomena, predict their occurrence and therefore permit them to be controlled.

Using a deductive approach, a theory and hypothesis is developed and a research strategy is designed to test the hypothesis. The other research approach is inductive in which theory is developed based on the data that has been collected and analyzed, and therefore the questions and reasons for things happening are answered (Cooper and Schindler, 2003; Zikmund, 2003; Ghauri and Gronhaug, 2005; and Saunders et al., 2007). The inductive type of research is often related to qualitative research and the process starts from an assumption and continues until a conclusion is achieved. On the other hand, the deductive type of research is often related to a quantitative type of research (Ghauri and Gronhaug, 2005). There is no rigid division between deduction and induction approaches and it is possible for the researcher to combine these two approaches in the same research and it may also be an advantage to do so (Saunders et al., 2007).

- **Research approaches of the current research**

The approach adopted in this research is a combination of the inductive and deductive approaches because questions are actually produced, and these are based on a set of theories, and these theories are combined into a unified model of the problem situation. So, in this thesis a model (theories) to structure the problems is used and then questions are used to get specific information on the nature of the problem; i.e. one of them is deductive (the former) and one is inductive (the latter).

8.6 RESEARCH DESIGN

Research design is divided into two stages: research strategy and research choices.

a. Research strategies

There are choices of research strategy which can be employed to enable researchers to answer their particular research questions and meet objectives (Saunders et al., 2007). Each strategy can be used for explanatory, descriptive and exploratory research. No one research strategy is superior to another. However, the appropriateness of research strategy will depend to what extent it enables the researcher to answer the research questions. Use of alternative research strategies simultaneously is possible and may not lead to strategies contradicting each other (Yin, 2003). Research strategies can be classified as experiment; survey; case study; action research; grounded theory; ethnography; and archival research (Zicmund, 2003; Saunders et al., 2007).

- **Research strategies of the current research**

There are two different research strategies used in this research. Firstly, Iran can be considered as a case study; in other words from a national systems perspective the case study component becomes Iran. Furthermore, this study looks at section of industry as well as universities and relevant ministries. Therefore, by looking at two major sectors of the Iranian NIS (Biotechnology and Automotive); cross-sectional industries were considered as the main focus. Thus, at the organizational level a survey based upon a cross section was utilized as a research strategy. Also the conceptual level of this thesis is the case study of Iran. Meanwhile on an analytical level, industry, universities, and ministries are used within the Iranian case study; high technology industries as well as universities and related ministries are further utilized to allow the researcher to analyze the relationship between universities and industry through the format of the survey. Therefore this research can be considered as a combination of case study and survey.

b. Research choices (qualitative Vs. quantitative methods)

In the literature related to research methods, the appropriateness of data methods is discussed. The main difference between qualitative and quantitative technique is not the notion of quality but of procedure. In qualitative research findings are not obtained by statistical methods or other quantification procedures. The basic distinction between these two kinds of research is that quantitative researchers use measurement, whereas qualitative researchers do not (Bryman and Bell, 2003). There is a further difference between qualitative and quantitative approaches which is a reflection of different perspectives on knowledge and research objectives. It should be mentioned that these two approaches are not contradictory with each other and not mutually exclusive (Ghauri and Gronhaug, 2005).

Qualitative research methods are designed to help researchers understand people and what they say and do. These methods also enable researchers to gain a deeper insight into the social and cultural context within which people live and may provide answers to questions regarding what is happening here; why is it happening; why did it happen in this way; and when did it happen? (Myers, 2009).

The major disadvantage to quantitative research is that so much information that is required (for instance around the social and cultural aspects of an organization) remains unclear and is furthermore not considered in a comprehensive way. On the other hand qualitative research is considered as the best choice if a researcher wishes to study a particular subject in depth. However there are some disadvantages related to qualitative research, for instance it is often difficult to generalize the outcome to a larger population (Myers, 2009).

Research methods are chosen either as single data collection technique and related analysis procedures, or use more than one data collection technique and analysis procedures (multiple methods) in order to answer research questions. Multiple methods are then divided into multi-methods and mixed–methods. The mixed-method is used when both quantitative and qualitative data collection techniques and procedures are used in the research design. Mixed-methods also have two branches, mixed-method research and mixed-model research. The mixed-method research refers to the situation when quantitative and qualitative data collection techniques and analysis procedures are used in parallel or one after the other, which is known as sequential. Some advantages can be recognized in the use of mixed-methods in research, the most important being that it enables triangulation to take place (Saunders et al., 2007). Triangulation allows better visualise what is happening and also corroborates findings by looking at the same topic from different angles (Myers, 2009). In some situations quantitative research facilitates qualitative research and vice versa (Bryman and Bell, 2007, p650). It should be noted that qualitative research sometimes facilitates the interpretation of the relationship between variables (Bryman and Bell, 2007).

- **Research choices of the current research**

Firstly, an exploratory survey investigation was undertaken to identify the critical forces in University-Industry collaborations in Iran. This was the first stage of developing and corroborating the conceptual unified model created from the literature. Secondly, after an extensive qualitative interview based stage, a deeper understanding regarding the relationships among these forces was obtained, allowing further refinement of the model, and projections of future states based on scenario questioning. Therefore, in this thesis mixed-method research was adopted and both quantitative and qualitative data collection and analysis techniques and procedures were used sequentially.

8.7 RESEARCH METHODOLOGY

The approach of this study is structured as a four-stage methodology (see Figure 8.1) based on the deconstructed research question (Section 8.3), for developing scenarios based on systems thinking, to test and evaluate policy instruments for the competitiveness and UIC success and the development of Iran's economic make-up.

The research purpose is classified in the research methods' literature as exploratory, descriptive and explanatory. However, in the same way that research questions can be both descriptive and explanatory, it follows that the research project may have more than one purpose (Saunders et al., 2007). An exploratory study will help to understand what is happening -searching for new insights, whilst asking questions and attempting to evaluate phenomena in a new light. It is also very useful to clarify the understanding of a problem (Robson, 2002). There are three ways of doing exploratory research: a search of the literature; by conducting an interview with the experts in a specific subject; and finally to conduct focus group interviews (Saunders et al., 2007). The aim of descriptive studies is to describe a precise profile of persons, events or situations (Robson, 2002). Explanatory studies establish causal relationships between variables and focus on studying a situation or a problem in order to clarify the relationships between such variables (Saunders et al., 2007).

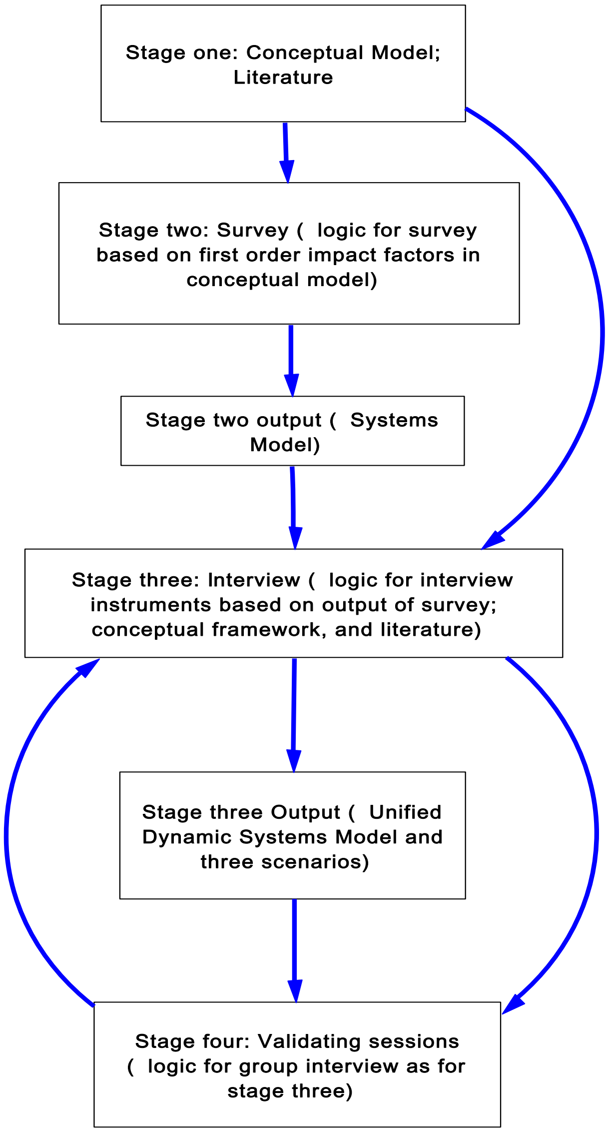


Figure 8.1: Schematic of the research methodology

8.7.1 Stage One: Literature development and conceptual modelling

In all stages an explanatory approach is implicit in identifying the causal relationships between factors related to UIC and also the clarification of the relationships between such factors. In pursuing these objectives exploratory pre-analysis is employed to clarify the understanding of the problem situation.

After investigating the context of the study (Iran) and relevant issues regarding the Iranian National System of Innovation and UIC activities in the country, a conceptual model was developed of the relevant macro and micro environment using the theoretical constructs based on systems of innovation theories. These included, National Systems of Innovation developed by Freeman, (1987) and Lundvall, (1992); Michael Porter's 'Cluster' or 'Diamond' model (1990); and the 'Triple-Helix Model' of university–industry-government interactions developed mainly by Henry Etzkowitz and Loet Leydesdorff (1997, 1998, 2000). Also at the micro-level an analysis of the role of the UIC on economic development was investigated; different motivational factors for researchers within universities to collaborate with industry were identified and also different motivational factors for universities and industry to collaborate with each other were explored. Furthermore, the role of culture and trust in various innovation theories was examined, and the role these elements play in UIC activities was particularly highlighted. However, there is no literature related on the mechanism for including trust and cultural forces to innovation systems, thus presenting a challenge for the current research. Specific issues of trust and culture, and the relationship between the two based on theories of trust formation were fitted to the most relevant components of the UIC conceptual.

The model developed was extensive, including all the critical trends and forces from the literature (see Section 7.13). This model maps the key cause-and-effect relationships among these forces. Further development of this conceptual model required searching literature related to systems thinking to uncover methods to investigate and model the dynamic behaviour of UIC; i.e. the people relationships. Although some researchers tried to introduce the dynamic behaviour of NIS and related theories in general (e.g. Galanakis, 2006); no research exists which focuses on systematic behaviour models of UIC. Furthermore in order to understand the role of planning uncertainty regarding UIC activities (especially in the case of Iran) literature related to the concept of scenario development was considered to be most useable. Although scenario development has been employed before in developing UIC concepts (in simple forms such as scenario matrix e.g. Harper and Georghion, 2005); no research exists related to UIC in order to develop scenarios based on systems thinking approach. Such linkages between systems thinking and scenario methods have been limited to a few company based problems (see Section 7.10.2).

Scenarios for this research are built on a combination of two major approaches for scenario development; mental mapping of the future, and a dynamic scenarios approach. These approaches are utilized because of the complexity evident in UIC systems and the high degree of factor uncertainty. The dynamic scenario approach is useful to add dynamic features to the scenarios (see Section 7.10.1 and 7.10.2). The early stages of building scenarios (particularly those phases which are related to identification of scenario driving forces) are based on “mental maps of the future” approach due its detailed investigation of finding scenario driving forces. Another approach which is “dynamic scenario” is chiefly used in order to construct scenarios based on systems thinking approach. The first two stages of “mental maps of the future” approach (Section 7.10.1) are already covered in understanding the problem using the developed conceptual model. Section 8.7.2.3 of this research focuses on the third stage of “mental maps of the future” approach which is identification of key scenario forces. Section 8.7.2.4 of this research focuses on the fourth stage of “mental maps of the future” approach (establish the scenario logics) and also second stage of “dynamic scenario” approach which is discovering scenario dimensions. Section 8.7.2.5, 8.7.2.6, and 8.7.3.2 are developed based on stage 3, 4, 5, and 6 of the “dynamic scenario” approach accordingly (see Section 7.10.2). These stages focused on developing scenario themes; discerning patterns of behaviour, diagram scenario structure, and finally writing the scenario scripts.

Ultimately these dynamic system models are intended to be used as predictive platforms to simulate the outcomes from introducing policy instruments. However, unlike the traditional use of scenario methods to predict the outcome of policy changes, the current research uses a desired future state as a goal set (Iran’s transition to a developed economy) in a “future backward” or anticipatory approach to test various policy paths.

8.7.2 Stage Two: Investigating UIC (Iran case)

Using the outputs from stage one, a survey investigation of the relevant drivers and barriers for university-industry collaboration was selected. Although this research is based on the case study of Iran, the scale of the challenge required a survey approach (Section 8.6a) to collect the necessary scale of data to address the connections in the conceptual model. The normal practice of interview based data collection for case-study methods would have proven unfeasible on this scale.

8.7.2.1 Scope of the study

Two industrial sectors (Automotive and Biotechnology) were selected to focus the study on areas of the economy that are considered of national importance for the transition of the country towards a higher technology base. Both are Government priority growth industries, both are economically significant with a large national demand market (Ghazinoory, 2003; United Nations, 2005), and are also strongly represented in a wide range of industrial organizations (Ministry of Industry and Mines Portal, http://www.mim.gov.ir/) and university research departments (Ministry of Science, Research and Technology, www.msrt.ir, 2001) – basic conditions for knowledge cluster formation. These two sectors have been selected because they are emerging sectors in which academia has been one of the main actors.

The biotechnology sector is very useful for consideration of university-industry collaboration because it includes representation of all the main knowledge transfer and innovation processes of the sector, ranging from basic research to commercialization of the product (Mets, 2006).

Two regions of the country including Tehran (Capital city) and Mashhad (second largest city) were chosen for this study due to their identified high potential for cluster formation in both Biotechnology and Automotive-related areas (Ministry of Industry and Mines Portal, http://www.mim.gov.ir/). Four universities were selected because they are active in both Biotechnology and Automotive related research and are recognized as main pillars of the Biotechnology and Automotive clusters in these two regions (Ministry of Science, Research and Technology, www.msrt.ir, 2001). Of the four universities considered in this research two (Tehran university and Sharif University) are located in Tehran (both are public universities); the other two (Ferdowsi university and Azad university) are located in Mashhad (the former is public and the latter is a private university).

Facing a highly uncertain environment regarding the Iranian system of innovation (Mani, 2004; United Nations, 2005; Paya and Baradaran Shoraka, 2009), the

Biotechnology and Automotive sectors in Iran may attain an inflection point in the next 10-15 years. These are the possible options: these sectors might continue to grow, stagnate, decline or experience periodic variation. For this reason, the research draws on analysis that is both quantitative and qualitative and considers the concepts of scenario analysis based on systems thinking in order to simulate potential UIC enhancing policy impacts through a series of evolved models.

Many countries have decided to invest in biotechnology and automotive industrial clusters. Mostly the success of these clusters depends on availability of university as an important prerequisite for success. The examples are described in the following sections.

- **Biotechnology sector**

The science underlying the field of biotechnology had its origins in the early 1970s when discoveries were made in university laboratories and after that were exploited by science-based start-up firms. The following two decades witnessed an increasing number of biotechnology firms (Powell, 1998). Recently many countries have tried to establish national systems of innovation in biotechnology. Biotechnology is recognized as an emerging economic wave after the Internet wave. The main objective for developing systems of innovation in this sector is to optimize scientific and economic resources and to generate products based on a national biotechnology. Many developing countries such as Brazil, face obstacles in order to become significant world players in this sector (Marques and Neto, 2007).

In developed countries like the UK, much of the rise in commercialization of biotechnology is at the hands of small start-up and spin-out companies that originated as UK science-based (Cooke, 2001). "*Biotechnology is unusual in being heavily dependent everywhere upon major public funding of basic scientific research, in turn* *giving rise to spin-out activity in geographical proximity to universities, research hospitals and public research laboratories*" (Cooke, 2001, p44). Biotechnology cluster success depends heavily on the degree of support and collaboration from universities. The biotechnology cluster in the Cambridge area is a good example and is mainly supported by the university, hospital research facilities, and science parks. It benefits from the access afforded by close proximity to large customers and funding partner firms (Cooke, 2001).

- **Automotive sector**

The automotive industry currently exists in many countries and some of them are in the process of forming clusters. For instance in China currently attention is being paid to its prosperous automobile industry with some degree of success (Lee and Anderson, 2006). Emphasizing on forming an automotive cluster is the main focus of some countries. Automotive clusters in Germany, Japan and the West Midlands of the UK are good examples of Cluster formation. The role of government in designing national and regional initiatives plays a very important role in supporting this industry. In the UK for example at a national level the main policy support is via the regulatory environment. One specific initiative which has been established in the UK is the Foresight Vehicle Programme, which has been running since 1997. This programme is a collaboration between industry, university and government in order to identify technologies for sustainable road transport (EMCC, 2004).

Since the current research investigated two different industries, for the modelling purpose, it is necessary to examine whether there are differences between these two sectors' with respect to their UIC activities (in Iran or elsewhere) (see Section 8.7.2.3).

8.7.2.2 The survey instrument

The development of a questionnaire survey was based on the direct forces on the key themes identified from the conceptual model (Section 7.13), literature based on university-industry-collaboration (UIC) in general, and Wilson's Impact/Uncertainty model of scenario formation (see Section 7.10.1). From the literature and the conceptual model five primary categories of enquiry to understand UIC drivers and barriers emerged. These categories were identified and used as the logical framework in developing the survey questions:

- University collaboration with industry
- Industry collaboration with universities
- Individual academics collaboration with industry
- Collaboration performance
- Collaboration continuity

The rationale for each question in the instrument is developed in the logical map of categories to questions in Figure 9.1 (Section 9.2).

Two variants of the survey questionnaire were designed using the conceptual model and piloted to ensure issues were relevant to both university and industry respondents. Questions were administered through the online questionnaire tool Survey Monkey, extending to seven pages for the industry sector and nine pages for the university sector.

Questionnaires can be used for descriptive or explanatory research. There are two types of questionnaire: self-administered, that are normally completed by the respondents, and interviewer-administered, which are recorded by the interviewer. Selecting the appropriate type of questionnaire is a critical step in data collection. Unlike in-depth and semi-structured interviews, the questions the researchers ask in a questionnaire should be completely defined prior to the commencement of data collection (Bryman and Bell, 2007; Saunders et al., 2007).

The design of questions, structure of the questionnaire and pilot testing of the questionnaire are very important stages in designing the questionnaire, since the internal validity and reliability of the data collected will depend on these activities (Saunders et al., 2007).

- **Assessing validity in the questionnaire**

Internal validity refers to the ability of the questionnaire to measure what the researchers intend it to measure. In other words, it should be designed in such a way that what the researcher finds with the questionnaire represents the reality of what they are measuring (Saunders et al., 2007). Validity can be categorized as: content-validity; criterion-related validity and construct validity (Blumberg et al., 2005). Content validity refers to the extent to which the measurement questions in the questionnaire provide enough coverage of investigative questions. There are many ways to find out what constitutes enough coverage; one is the careful definition of the research through the literature reviewed. Criterion validity refers to the ability of the questions (measures) to make correct anticipation. In assessing this type of validity sometimes the use of statistical analysis, like correlation, will be needed. Construct validity refers to the extent to which the measurement questions actually measure the presence of those constructs that the researchers intended them to measure (Saunders et al., 2007).

- **Testing for reliability**

Reliability refers to consistency which is a prerequisite in order for a questionnaire to be valid; however this is not sufficient on its own. It is worth mentioning that reliability alone is not sufficient as internal validity is also required, otherwise respondents may interpret a question in one way, despite the researchers meaning something else. Therefore reliability is concerned with the robustness of the questionnaire and whether or not it will produce consistent findings at different times and under different conditions (Saunders et al., 2007).

Three approaches for assessing reliability are common: test re-test, internal consistency and alternative form. Test re-test refers to the situation when questionnaires are administered twice to the respondents in order to estimate reliability by correlating data collected with those from the same questionnaire. However, in practice it is difficult to persuade respondents to answer the same questionnaire twice. Internal consistency concerns the correlation of responses to each question in the questionnaire with those of other questions in the questionnaire. There are many methods for calculating internal consistency; the most popular of these is Cronbach's alpha. The final approach is alternative form, which compares responses to alternative forms of the same questions or groups of questions (Mitchel, 1996), however this falls into the same practical difficulty as test re-test. Most research designs include only internal consistency measures due to this practical difficulty.

a. Questions coding and scaling

In view of the scale of the data being collected, SPSS was used to analyze the data, and so some form of coding of the responses was required in the questionnaire design. Where opinions were sought, a Likert-types scale was used. The Likert scale used consisted of seven categories (no impact to very high impact) with the middle category labelled "middle impact" and (certain to uncertain) with the middle category was labelled "unsure". Questions were Likert-scale and pre-coded answers were provided in the form of tick boxes. The only un-coded question was in the final section where the respondents were asked if they had any additional comments.

b. Survey questionnaire format and measures

This section describes a format and measures used for university and industry survey questionnaire.

- **University survey instrument**

The first section of the university survey instrument (see Appendix C) requested descriptive details of the person and institution and their experience regarding UIC activities. The second section of the university survey instrument made use of a Likert-scale, for 58 items. Respondents were asked to rate the impact of each item by choosing one of seven responses (ranging from no impact to very high impact). Of the 58 items, 9 were used to construct scales regarding motivation of individuals in universities to collaborate with industry, 11 were used to construct scales with respect to motivation of universities to collaborate with industry, 9 were used to construct scales to identify the elements that enhance university-industry-government collaboration, 14 were used to construct scales to identify elements that impede university-industry-government collaboration, 9 were used to construct scales to identify potential technology transfer office activities that promote university-industry collaboration, 6 were used to construct scales to show the degree of a partner's intention to renew any previous contracts. The third section of the university survey instrument featured a Likert-scale for 28 items. Respondents were asked to indicate the degree of uncertainty they felt about the pace, validity or direction of forces and to range them from certain to uncertain. Scales were subjected to reliability testing using Cronbach's alpha (see Section 9.4.3).

- **Industry survey instrument**

The first section of the industry survey instrument (see Appendix C) sought descriptive details regarding the person and institution and their experience regarding UIC. The second section of the industry survey instrument had a Likert-scale for 45 items.

Respondents were asked to rate the impact of each item by choosing one of seven responses (ranging from no impact to very high impact). Of the 45 items, 16 were used to construct scales regarding the motivation of industry to collaborate with universities, 9 were used to construct scales to identify the elements that enhance the university-industry-government collaboration, 14 were used to construct scales to identify elements that impede the university-industry-government collaboration, 6 were used to construct scales to show the degree of a partner's intention to renew any previous contracts. The third section of the industry survey instrument had a Likert-scale composed for 29 items. Respondents were asked to indicate the degree of uncertainty they felt about the pace, validity or direction of forces and to range them from certain to uncertain. Scales were subjected to reliability testing using Cronbach's alpha (see Section 9.5.4).

c. Translating questions into other languages

Translating questions into another language potentially complicates the process further, because literal translation is rarely possible and the respondents may not answer the questions in the way the researchers intended (Saunders et al., 2007). In a translation situation questionnaires are categorized as source questionnaire and target-questionnaire. The source questionnaire refers to a questionnaire that is to be translated, whilst the target-questionnaire is the translated questionnaire. There are number of techniques for translating the source questionnaire. These techniques include: direct translation; back translation; parallel translation and mixed techniques. Direct translation is easy to implement and relatively inexpensive (Usunier, 1998).

- **Translation process in the current research**

The direct translation technique was implemented in this thesis for online-questionnaires by a bilinguist working across both the university and industry sectors.

The questionnaires were first prepared in English, and then translated into Persian. The translation was closely verified by a second independent translator to ensure translation accuracy and reliability.

d. Piloting and Pre-Testing Questions

A crucial stage before sending out the questionnaire is pilot testing in order to refine the questionnaire to ensure that respondents will encounter no difficulties or ambiguity issues in answering the questions, and that there would be no problems in recording the data. This also enables the researcher to make some assessment concerning the validity of the questions and the likely reliability of the data that will be collected (Saunders et al., 2007). Pilot testing not only increases the likelihood that survey questions operate well, but also has a role in ensuring that the research instrument as a whole functions well. It is particularly important in self-administered questionnaires because in such circumstances no interviewer is present to clarify any confusion (Bryman and Bell, 2007).

- **Pilot testing process in the current research**

Before the mass survey a pilot test was conducted with a number of individuals from university and industry backgrounds. At this stage a draft of two questionnaires (university and industry) was given to two people from the university pool and two from the industry pool as well as to one who works in both sectors. Their observations were helpful to refine the questionnaire, especially for the Iranian context. The questionnaire was then revised based on their feedback to improve its clarity and the format of questions.

A second draft was submitted to the researcher's supervisor at the University of Stirling and further changes were made to improve presentations. The third and final version was the one that was subsequently used (Appendix C).

e. Questionnaire administration: the sample pool

The questions for the current study were constructed to gain views about UIC over the next 5 years (study was undertaken in 2008). An effective sample of 161 university academics, administrator and members of technology transfer offices in four major universities and 156 industry management staff working in Biotechnology and Automotive sectors (these includes all companies with related activities) located in Tehran and Mashhad resulted for the first mail-out, together with a comprehensive covering letter on University of Stirling headed paper (Appendix C) which described the aim of the research and also guaranteed anonymity for the respondents. Internet-mediated questionnaire was applied (Survey-Monkey). Both university and industry translated-version questionnaires (in Persian/Farsi) were entered into the Survey Monkey and respondents were asked to complete the questionnaire.

The industry sample was constructed from various sources; primarily the biotechnology and automotive industry databases from the Ministry of Industry and Mines. The university sample was developed from institutional websites identifying relevant research groups and professors in related fields, and also from a Ministry of Science, Research and Technology database.

8.7.2.3 Stage Two outcomes: Analysis of questionnaires

The analysis of the survey data focused on gauging the forces identified in recognition that they are not all equally important to driving UIC behaviour, or equally likely to happen. To be systematic in this sorting process, an Impact/Uncertainty matrix with a simple high-medium-low scoring system was used (Wilson, in Fahey and Randall, 1998). The criteria employed to select the forces are based upon scores related to mean, and median and calculating the cumulative percentage of forces (see Chapter 9). The output from this stage was anticipated to form a clearer picture (to that of the conceptual model) of what are the most important factors for UIC development in Iran: i.e. which factors have a higher degree of impact and also have a higher degree of uncertainty of occurrence; these are inputs useful in shaping scenario development.

The survey created an opportunity to test a set of hypotheses relating to factor differences between the university and industry samples, and also between two industry sectors investigated in this research. As all responses are in the form of Likert scale scores, the non-parametric Mann-Whitney U test was employed (Levin, 1999; Curwin and Slater, 1996; Keller and Warrak, 2000). The Mann-Whitney U test is used to compare z statistics in order to decide whether or not to acknowledge the null hypothesis. In all cases for comparing university and industry, the null hypothesis is that the university and industry samples come from the same population. Furthermore, for comparing two industry sectors, the null hypothesis is that these two sectors come from the same population (i.e., there are no differences in the answers of the respondents from each organization or sector). In other words, rejecting the null hypothesis (related to university-industry comparison) would confirm that there is a statistically significant difference between university and industry results, while accepting the hypothesis would verify that the results are the same, or similar. Likewise rejecting the null hypothesis (related to two industry sectors comparison) would confirm that there is a statistically significant difference between these two sectors, while accepting the hypothesis would verify that the results are the same, or similar (see Section 9.11 and 9.12).

8.7.2.4 *Stage Two outcomes: Establishing the scenario logics*

The sorting process after data analysis identified the critical forces from the total set investigated. However, even with this reduced number to consider (24 independent), all the possible combinations of outcomes of these force combinations would produce almost 12,000 scenarios using simplistic 3 position settings, a situation beyond the ability of any policy maker to utilize. Therefore the most important aim at this step was to develop a structure that would produce a manageable number of scenarios in a logical way.

In order to achieve this objective, factors obtained from the survey results were grouped under common headings. It was assumed that for the university-industry collaboration in Iran, the truly critical scenario forces are clustered around five factor groupings of the Iranian system (see Section 9.7). These five factor groupings are represented as sub-systems in the UIC system model (see Section 10.3.3).

- Organizational Structures to Coordinate and Support Partnerships (OS)
- Asset Management (AST)
- Leadership and Culture (LC)
- Organizational Capabilities (OC)
- Creation of an Enabling Environment by Government (GOV)

8.7.2.5 Stage Two outcomes: Developing scenario themes

At this stage several perspectives or scenario themes based on the findings need to be developed. Events from the scenario logic developed in the previous step were selected and reorganized into several scenario themes. A large number of scenario themes could be developed at this stage. These themes range from a significantly backward future to an evolutionary future of the country (see Section 9.9).

Some of the scenarios for Iran suggest gradual change, but some of them are big step changes and even beyond the control of government. From a planning perspective point of view, the focus should be to put in place policies which government can control rather than conditions which are uncontrollable. Therefore, because the main objective of this research is to influence policy thinking, the focus is on developing those scenarios which manage the process - these are potentially sequential ones over an extended period of time (>15 years). As a result the whole system evolves directed by these sequential processes rather than considering radical step changes for which there is no plan. Evidence shows that most countries that have achieved a developed status have followed a planned evolutionary change period rather than revolutionary change (World Economic Forum, 2008). Therefore, this research focuses on the policy planning framework necessary to optimize the UIC contribution for Iran to develop, i.e. to consider the conditions to create an aspirational but pragmatic scenario rather than optimistic, sub-optimal or worse-case ones.

Based on consideration of these criteria and in order to be more logical in the process of selecting scenario themes (Ward and Schriefer in Fahey and Randall, 1998), the procedures of special metrics were followed (e.g. World Economic Forum - global competitiveness index, 2008; Triple Helix I, II, II; National Systems of Innovation including Passive NLS, Active NLS and NIS) which cover all the related criteria for economic development. The logic behind using these metrics was to limit scenario themes to those considered pertinent to the evolutionary stages of development. As a result of using these metrics, three preliminary scenario themes emerged (see Section 9.9).

Names were assigned to each scenario theme that symbolised its core conditions.

Scenario theme A: Stagnation
Scenario theme B: Efficiency driven
Scenario theme C: Innovation driven

8.7.2.6 *Stage Two outcomes: Discerning patterns of behaviour*

This step involves using these scenario themes in order to identify crucial events and factors which underpin the story of the selected theme. The five factor groupings are required to be set in accordance with the suggested transition patterns from the global competitiveness index report (2008), Triple Helix (I, II, III), National systems of innovation (including passive NLS, active NLS and NIS) which describes in detail the necessity of the existence of every factor within these groupings in different stage of evolution. Many of these factors are common amongst different themes and only the strength of these factors differ through stage transitions (Wignaraja, 2003; Lee and Tunzelmann, 2005; Dzisah and Etzkowitz, 2008; World Economic Forum, 2008). Using these concepts and the outcomes of the analysis on the current state of Iran (see Chapter 2), all of the critical factors necessary for economic development were found in Iran albeit in a primitive and incoherent state.

8.7.3 Stage Three: Dynamic modelling and scenario development

Although the systems model output from stage two has confirmed and clarified the conceptual model (stage one), this model lacks the connective complexity of the real-world problem as illustrated in the conceptual model. The Systems Model output from stage two is a simple map of the direct forces on the primary factor groups. This model requires further development to incorporate the known second and third order connections (conceptual model), system archetypes including feedback loops, and indirect (but important) features. These developments can be considered as adding dynamic features to the model.

According to Lee and Tunzelmann (2005) the dynamism of a system depends on the availability of feedback (interaction), without which, the system is static. In systems which develop feedback mechanisms, the behaviour of an entity which includes elements, attributes and relationships changes over time. The intention in developing a dynamic model is to understand possible feedback loops in the system. Such a dynamic model is a more accurate reflection of the real-world problem situation, and the dynamic UIC system is intended to provide a more accurate predictive capability of any policy or other changes to the system elements. These policy change sets are considered as scenarios for Iran in the current research design.

The process of building such a dynamic model requires significant data collection from the real-world problem – i.e. the Iranian case. Only by investigating the connective paths of every force and their associated behaviour with respect to policy, structure, entity or other changes, can a useable dynamic model be produced. This quality of data and requisite knowledge of deep system mechanisms assumes access to experts – both credible and capable in their respective organizational capacities. In this study an adapted Delphi method was used (see Chapter 10) in order to gain insight to the views of the main actors who will ultimately set the future directions for the university-industry-government collaboration in Iran.

The Delphi method structures and facilitates group communication that focuses on a complex problem so that, over a series of iterations, a group consensus can be achieved about some future direction. As a group approach to forecasting and decision making, the Delphi method requires a panel of subject-matter experts (Linstone and Turoff, 1979; Loo, 2002). While Delphi was known as a forecasting procedure it is also usable in some other areas including: putting together the structure of the model, developing causal relationships in complex economic or social phenomena (Linstone and Turoff 1979).

In the current research, gathering such a pool of experts into a group for discourse was considered both unfeasible from a scheduling and time perspective (32 actors from across University, Industry and Government sectors). However, arranging face-to-face interviews to gather their views allows much deeper insight from each individual with extended discussion of what-if policy change questions. The main weakness of this approach is the loss of the dynamic of group discussion and insight, although this is recovered in stage four of the research design.

8.7.3.1 Interviewing key actors

The use of semi-structured and in-depth interviews raises some data quality issues such as: reliability, forms of bias and validity and generalisability. The lack of standardisation in this type of interviews may sometimes result in a negative effect on reliability. Regarding qualitative research, reliability can be determined dependent upon whether other researchers would uncover similar information. The issue of bias also increases a concern with reliability in these types of interviews (Easterby-Smith et al., 2002). Triangulation of the outcomes is the best method to address these weaknesses (see Section 8.7.4 on validation).

There are means available to overcome these quality issues. They can be resolved through preparation, which means that five Ps "prior planning prevents poor performance" are followed. Therefore it is critical that researchers demonstrate their capability and the means whereby they will attain the confidence of interviewees. Furthermore the researcher should have adequate knowledge concerning the organizational or situational context in which the interview is to take place. Also, providing information related to the theme of the interview to the respondent before the meeting takes place is a method available to promote credibility. This also promotes validity and reliability, because respondents are given time to consider the requested information and they can provide and assemble organizational documentation from their files. The approach to questioning and phrasing questions clearly is significant in this context (Saunders et al., 2007). These issues are dealt by pilot testing the instruments and preparation for interview through advanced provision of question materials to respondents as detailed later in this section.

There are various methods available for analyzing and interpreting qualitative data. Some of the most popular ones used in management research include: coding; memos; analytic induction; series of events; critical incidents; hermeneutics; semiotics; content analysis; conversation analysis; discourse analysis; narrative analysis and metaphorical analysis. It is worth mentioning that combining some of these approaches can be very productive (Myers, 2009, pp166-175). Thematic analysis is the other popular methods in analyzing qualitative data. This is a process for encoding qualitative information (Boyatzis, 1998). It is not logical to say that one approach is better than the others. There are general guidelines for selecting the appropriate methods for analyzing qualitative data (Myers, 2009).

a. Interview instrument format

The semi-structured interview instrument contained two distinct components. Part 1 uses the systems model outcomes from stage two and the conceptual model from stage one; a logical map of the necessary inquiries was used to produce a semi-structured interview instrument to develop a dynamic perspective of the UIC system (see Section 10.3.2). Part 2 is a set of what-if scenario questions to obtain future insight to policy changes.

Part 1: Dynamic Systems Model (DSM)

Three versions of the survey questions were developed for respectively university, industry and government respondents (Appendix D). Questions were organized based on the set of 5 factor groupings (see Section 8.7.2.4). Some questions were also added based on the literature (conceptual model) to find out the relationships between the forces within the same category or between categories. Respondents were also free to add other linkages to the system based on their knowledge of the Iranian case. Therefore, there was a possibility of interaction between categories (sub-systems) as well. The DSM was considered as a platform for developing different future transition scenarios for Iran. In order to design this policy-neutral platform, all the questions designed for developing DSM had a neutral direction (see Appendix D).

Some factors were found to be of common concern among the three respondent groups from University, Industry and Government (from the stage 2 Systems model and the stage 1 conceptual model) e.g. Intellectual property issues in institutions, and performance of intermediary agents. Other factors common among pairings of respondent groups (Industry- Government, University-Government, and Industry-University). While other factors were relevant to only one grouping e.g. Industry's concerns with a firm's capabilities in R&D, or a University's concerns with status of reward system for faculty members (see Appendix D).

Part 2: What-if Questions

A related objective here is the construction of a series (three) of policy scenarios based on systems thinking to verify the behaviour of all relevant stakeholders at different stages of the process of UIC, and also to understand the dynamic behaviour of the system at each stages of scenario evolution, and ultimately the elimination of barriers in order to assist the country moving toward the knowledge-based economy.

The first scenario was developed using the respondent's knowledge of the current situation of UIC in the country based on every single element in the Dynamic Systems Model (DSM), and also by asking what is likely to happen if the policy pathways of Iran remain unchanged in the future (for 15 years).

To generate second and third scenarios, what-if questions steered the discussion to the required key policy change issues. It should be noted that for the second and third scenarios; a political/societal manifesto was developed in order to change the direction of several levers (forces) of the DSM simultaneously in each scenario to understand the system response. These changes in direction were based on literature on the experience of countries in different stages of transition. The majority of "What-if?" questions were aligned with the policy experience of countries in two specific stages of development i.e. efficiency-driven economy and innovation-driven economy. Seventeen questions were designed for the second scenario and twenty questions for the third scenario (see Appendix D).

In this stage; scripts for different scenarios can be written by changing a direction of principal forces in the model (DSM). Because the change in the direction of one important force cause change in many other forces direction, a set of consistent responses start to happen. The set of stories which are created due to these changes are the final scenarios. It should be noted that questions for the 'second' and 'third' scenarios were designed based on the critical elements obtained from the survey analysis (Section 8.7.2.4). Their direction and suitability for a specific scenario were determined by theories of innovation systems; especially those which consider the role of university, industry and government in transition e.g. Competitiveness Index Report (World Economic Forum, 2008) and other supporting literature e.g. Triple Helix, NIS and Porter's diamond that focus on the necessity of existence of specific elements for each stage of evolution. The direction and suitability of some "what if" questions for second and third scenario related to Iranian context (e.g. questions regarding political situation and embargoes or joining WTO) were defined based on views from pilot testing the interview instrument regarding the suitability and direction of these questions for a specific scenario.

In developing the second and third scenarios, respondents were asked to assume that in scenario 2, apart from the new direction of forces, the systems model will have all features of the first scenario (i.e. the shift from current policy).

Furthermore they were asked to assume that in scenario 3, apart from its new direction of forces, this scenario includes all other changes in direction of forces proposed for scenario 2 – a transition.

The outcomes of this approach were anticipated to highlight the likely contributing factors for successful university-industry-government collaborations and to obtain the view of interviewees regarding their projection for 10-15 year future scenarios in Iran. These interviews were also designed to uncover the conditions to create an increase in the probability of UIC, and also to estimate the degree to which Government policy may moderate existing barriers to collaboration.

b. Translating interview questions

The direct translation technique also was implemented in this thesis for interview questions because of the availability of bilinguist person who works on both university and industry. The Interview questions were first prepared in English, translated into Persian, and the translation closely verified by a second independent translator to ensure translation accuracy and reliability.

c. Piloting and pre-testing questions

Before interviews, pilot test were conducted in number of individuals from university, industry, and government background. In this stage a draft of three interview questionnaires (university, industry, and government) was given to two people from the university pool, two from the industry pool, two people who works in government ministries (one person from Ministry of Industry and Mines and one person from Ministry of Science) and finally one who works on both university and industry sectors. Their observations were helpful to refine the interview questions especially for the Iranian context. The interview questions were then revised based on their feedback to improve its clarity and the format of questions. Also two people who works in government ministries separated those questions which needs to be answered by Ministry of Science-related departments and those who needs to be answered by Ministry of Industry and Mines-related department. These comments were very useful to enhance the quality of responses.

A second draft was submitted to the researcher's supervisor at the University of Stirling and further changes were made to improve presentations. The third and final version was the one that was subsequently used and is attached as Appendix D.

d. Key Actor Pool

It should be noted that the methods in selecting the respondents were focused to find those individual at universities, industry and Governmental Ministries who through their experience would be aware of the UIC activities. In order to reach this goal the information centre in each university, Ministry of Industry and Mines, and Ministry of Science Research and Technology statistical centre helped considerably. It should be noted that because the respondents represent a large percentage of those leading in technology transfer in Iranian universities, industry and other involved organizations so the results of this study should be generalizable. Gathering perspectives from these three groups of stakeholders ensured that a broad range of views were captured.

The stakeholders interviewed, who are all based in Iran (Mashhad and Tehran), comprise: eleven academic faculty staff, from a range of university faculties which are located at four major universities in Mashhad and Tehran. These faculties include metallurgy engineering, mechanical engineering and biotechnology; nine business interviews including small and large technology companies in the Automotive and Biotechnology sectors; and twelve with Government related organization including five Ministries and related subsidiaries (study was undertaken end of 2008- early 2009).

e. Interview questions administration

A package of materials including a statement of the purpose of the interview, the interview questions together with a comprehensive covering letter on University of Stirling headed paper (Appendix D) that described the aim of the research also guaranteed anonymity of the respondents were sent to the interviewees. Respondents were asked to review the questions and identify the possible relationships between these forces prior to the day of interviews. At the day of interviews the two parts of the instrument were separated with a break. Both stages took an average one hour to complete. All the interviews were recorded to enable a more accurate interpretation and checking of the responses, and consequent understanding and justification of the findings.

In order to give the respondents an opportunity to recall their model during the scenario development exercise, an A2 size paper was used to draw the model as the interview sessions proceeded. This also allowed the researcher to analyze the results of scenarios more easily. This method was adopted after pilot of interview questions in which useful feedback was obtained from the respondents.

After pilot testing, a preliminary survey format was used for the first two interviews for each group and this was then refined in order to improve the quality and flow of the questions.

In this thesis 'systems thinking' is the causal loop diagramming technique which is utilized to show the form of linkages between major variables of university-industry collaboration (UIC) and further can be used as a means for developing scenarios. This technique includes the direction and also the type of causality between factors. There are many standards exist in the literature to define the direction and also the type of causality, but in this thesis it is defined as follows: if variable X makes a change in variable Y, then the direction is from X to Y. The type of causality is positive if both variables change in the same direction (increase-increase or decrease-decrease), otherwise it is negative.

8.7.3.2 Stage Three outcomes: Dynamic Systems Models, neutral and scenario

A thematic analysis approach was mainly adopted. Coding and metaphorical analysis was also used for the analysis of interviews. “Vensim Software” was utilized in order to construct various influence diagrams based on analysis of the results.

Several dynamic system models are generated to illustrate the findings from the expert community. These are policy-loaded DSM’s which represent a set of three transition scenarios (see Figure 8.2):

- Scenario 1: Stagnation (current policy framework + 15 years)
- Scenario 2: Efficiency driven (current to new policy framework + 15years)
- Scenario 3: Innovation driven (Scenario 2 + enhanced policy framework + 15years)

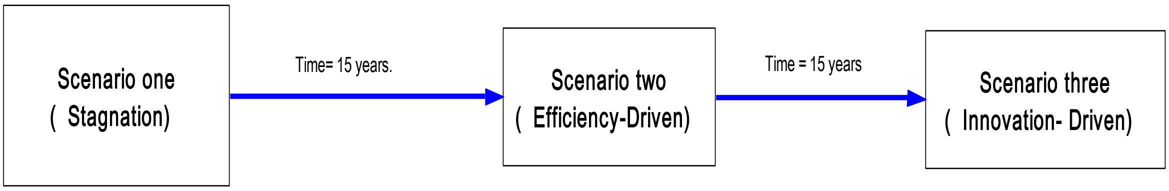


Figure 8.2: Transition of scenarios

8.7.4 Stage Four: Delphi Group Sessions (testing the validity of scenarios)

The main objective of this stage was to validate the results that were obtained from the three scenario scripts, and thereby complete the adapted Delphi method started in stage 3. In order to achieve this objective, two different Delphi Group sessions were arranged (2009 and 2010) using independent participants i.e. not from the interview pool (see Chapter 12).

These discussion sessions were chaired by the researcher and considered essential to test the behaviour of the models and also to validate the outcomes from Stage Three. Since the main focus of this research was to evaluate the expected impact of planned policy changes; at this stage the validity of the policy manifestations as scenario models to achieve such changes were tested. Respondents also were asked to consider the role of culture and trust in both institutional and national level in both sessions.

It should be stated that, at the beginning of both sessions the objective of the research was presented for the respondents; then the instrument which included questions for generating the DSM's were distributed among the respondents and they were asked to review these questions (see Appendix D) for 15 minutes. After that, in both sessions, the main topics for discussion (scenario questions- see Appendix D) were raised by the researcher and discussed by a panel members. Any consensus common agreement or disagreement among respondents was considered as an input for analysis. Both sessions were voice and video recorded, taking around two hours each. The main objective of the researcher was to encourage the participation of actors within the three helices including university, industry and government in order to have a more vivid picture about the future of the country regarding UIC activities and to validate the scenario models, and thereby the methods used in stage 3. The following sections describe the details of each session.

8.7.4.1 First validation session (2009)

This session was highly interactive and challenging, it involved 25 people from the industrial sector (30%), researchers from universities (50%) and politicians (20%). The location was a government-based organization under the MSRT in Ferdowsi University of Mashhad by the name of Jahad-e-Daneshgahi meaning "University Revoloution".

8.7.4.2 Second validation session (2010)

This session involved 18 people from the industry sector (40%), researchers from universities (20%) and politicians (40%) and it took place in the Khorasan Science and Technology Park in the city of Mashhad. This organization was principally established as an intermediary organization in order to promote UIC in the region and to support cluster activities in Mashhad. The participation of the manager of this organization and also the person who was in charge of cluster development in Khorasan-E-Razavi province enhanced the quality of the session.

CHAPTER 9

SURVEY RESULTS AND FINDINGS

9.1 INTRODUCTION

University-industry collaboration (UIC) activities can be investigated from either the university or the industry perspective. This research considers both sides simultaneously. This chapter introduces the logical map of conceptual model categories to questions and then categorizes the results obtained from two different questionnaires (university and industry) in seven parts. These parts were designed in order to get views from two important actors of the Iranian National Systems of Innovation regarding the early stages of policy development relating to UIC in Iran. The first part focuses on realising the crucial policy levers from the university's point of view. The second part centres on understanding the crucial policy levers from the industry point of view. The third part is basically designed in order to describe the scenario logics. The fourth part considers using these policy levers in various scenario themes. The fifth part describes patterns of behaviour by searching through scenario themes/policy instruments in order to identify the most important events and factors which underlie the story of the selected theme. The sixth part of this chapter compares two industry sectors investigated in this research. Finally, in the last part of this chapter, university and industry are compared together through the utilization of statistical tests e.g. the Mann-Whitney test.

9.2 LOGICAL MAP OF CONCEPTUAL MODEL ELEMENTS TO QUESTIONS

The development of a questionnaire survey was based on the direct forces (first order impact) on the key themes identified from the conceptual model (Section 7.13), literature based on university-industry-collaboration (UIC) in general, and Wilson's Impact/Uncertainty model of scenario formation (see Section 7.10.1). From the literature and the conceptual model five primary categories of enquiry to understand UIC drivers and barriers emerged. These categories were identified and used as the logical framework in developing the survey questions:

- University collaboration with industry
- Industry collaboration with universities
- Individual academics collaboration with industry
- Collaboration performance
- Collaboration continuity

The rationale for each question in the instrument is developed in the logical map of categories to questions which is shown in Figure 9.1.

It should be noted that, both survey instruments were subjected to pilot testing (see Section 8.7.2.2d). From the tests, some important issues which may have a direct impact on the Iranian UIC activities emerged. These include: Instability of government regulations regarding UIC which impede collaboration between universities and industry (suggested for both university and industry instrument); privatisation and smaller role of the government in the economy for promoting UIC (industry instrument); increasing embargoes by Western countries which can motivate companies for collaboration (industry); and also improving the political situation and Iran entry to the WTO which again can motivate companies for collaboration (industry). These elements also were added to construct the final version of the survey instruments.

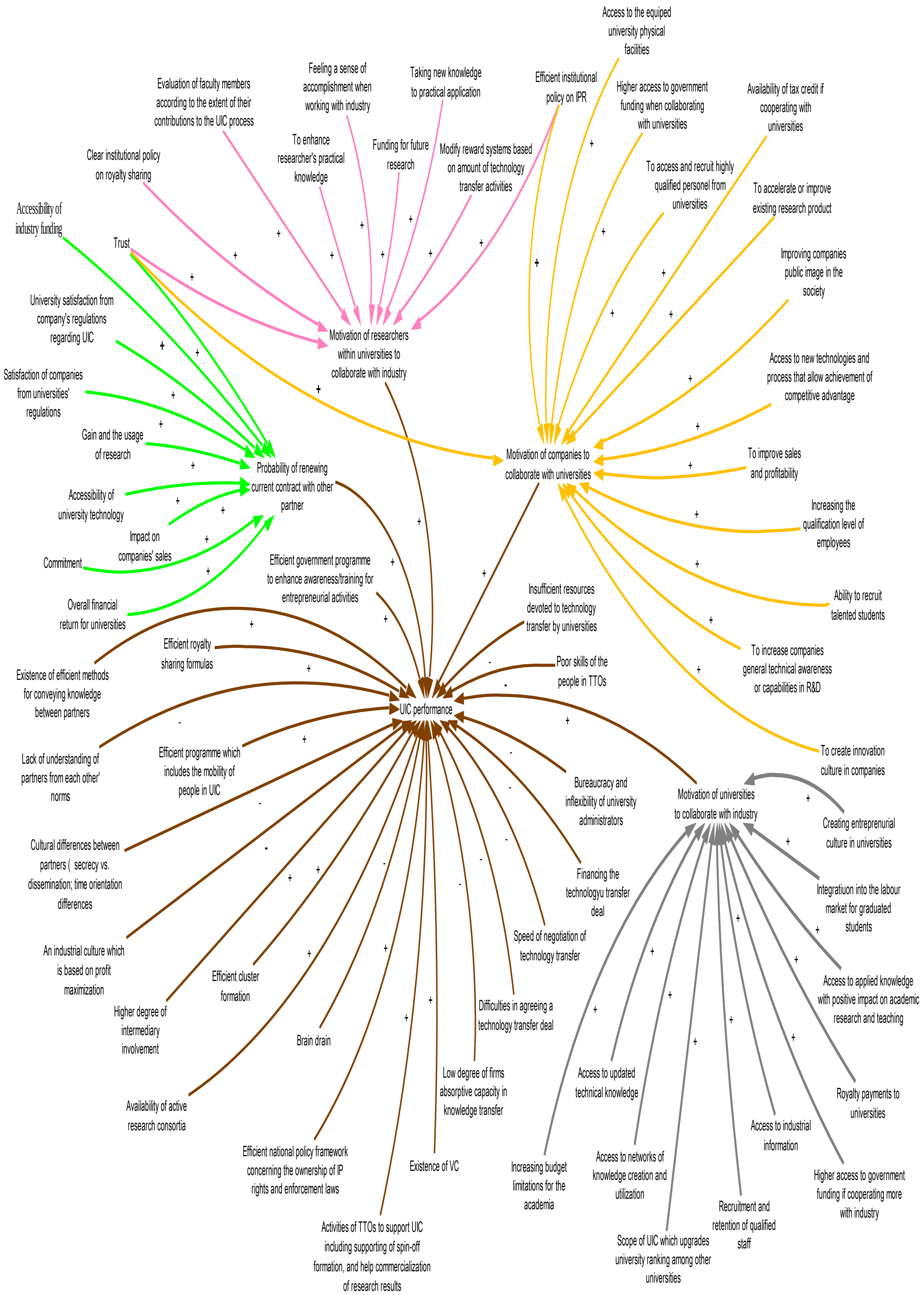


Figure 9.1: Logical map of conceptual model elements to questions

9.3 RESPONSE RATE

A total of 53 responses from university and 45 responses from industry were received of which 5 university samples and 3 industry samples were unusable, leaving 48 university responses and 42 industry responses. The response rate was calculated using the following formula that is presented by Saunders et al., (2007).

$$\text{Response Rate} = \frac{\text{Total number of responses}}{\text{Total number in sample - (ineligible + unreachable)}}$$

Of the original database, on the industry side 38 people and on the university side 32 people were either ineligible or unreachable (due to Email address problems) and were discounted, leaving a population of (161-32) = 129 for university and (156-38) = 118 for industry. Response rates of 37.2 per cent and 35.6 per cent were thus achieved respectively.

A separate section was designed in Survey Monkey in which respondents were asked for feedback regarding the use of this software. Respondents generally indicated the process was straightforward and easy to understand. Some of the respondents mentioned that although the questionnaire was long, thanks to a format which facilitated quick responses, they were not dissuaded from participation.

9.4 THE UNIVERSITY PERSPECTIVE

This part details the salient results of questions, taken from the university side. It should be noted that some questions allowed more than one answer. The university questionnaire is presented in Appendix C. Below the results derived from the university side are examined.

9.4.1 Background of respondents

The results of the questionnaire show the pool of respondents to be 48 from universities; 37 respondents (77%) were from public universities and 11 (23%) from private universities.

Out of 48 academics who participated in this study, 10 (20.8%) were from medical biotechnology groups, 6 (12.5%) were from agricultural biotechnology departments, 3 (6.2%) were from electrical engineering groups, 13 (27.1) were from mechanical engineering groups, 4 (8.3%) were from metallurgical departments, 8 (16.7%) were from molecular biotechnology and genetic engineering departments and finally 4 (8.3%) were from industrial engineering groups.

From 48 respondents, 27 of them (56.2%) were researchers and 21 of them (43.8%) were senior researchers. Out of these 48 respondents, 16 of them (33.3%) had also an administrative job in university and 5 of them (10.4%) had a position in a technology transfer office in university.

9.4.2 Types of university-industry technology transfer

In this section respondents were asked to indicate which types of university-industry technology transfer they have had experience of. According to the results (Table 9.1), the most common forms of technology transfer are consultancy and technical service provision (68.8%) and the less reported type of technology transfer activity was technology licensing activity (12.5%). From the university pool 41.7% of the respondents had collaboration through conferences and publications, 16.7% had been involved in an exchange programme, and 29.2 % in joint ventures of R&D between universities and industry, whilst these was 12.5% in cooperative R&D, 16.7% in contract research, with 18.8% having experienced collaboration through an intermediary agency and finally 8.3% of the respondents had no previous experience in any technology transfer activities from universities to industry. None of the respondents mentioned spin-off formation as a mechanism for technology transfer.

Types of University-Industry Technology Transfer	Frequency	Percent
Conferences and publication	20	41.7
Exchange programme	8	16.7
Consultancy and technical service provision	33	68.8
Joint venture of R&D	14	29.2
Cooperative R&D agreement	6	12.5
Licensing	6	12.5
Contract research	8	16.7
intermediary involvement	9	18.8
Spin-off company formation	-	-
None	4	8.3

Table 9.1: Types of University-Industry Technology Transfer

9.4.3 Reliability of university questionnaire

Analysis of the rating scale questions for the university pool begins in the following sections. Scales were subject to reliability testing. Reliability test results indicate that Cronbach's alpha scores were in an acceptable range for these scales (alpha scores ranged from 0.61 to 0.9 indicating that the items in the scale were measuring the same underlying concept). The overall score for the whole questionnaire was 0.92 (Table 9.2).

Case Processing Summary

		N	%
Cases	Valid	44	91.7
	Excluded[a]	4	8.3
	Total	48	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.92	89

Table 9.2: The overall score for whole questionnaire

9.4.4 Identifying forces related to impact

This section is designed to identify the impact dimension of different factors contributing in the UIC process. Results in this section will be combined with the uncertainty dimension of scenarios/policy changes (Section 9.4.5), in order to identify the critical scenario driving forces/policy levers change. It is worth noting that only those factors which met three criteria at the same time were considered as high impact driving forces. These criteria include: a mean score and median should be five or more and also at least two third of respondents agree on the importance of that factor. In other words, two third of respondents should score the importance of that factor slightly high impact (5) or above. In order to achieve this objective the extra column was designed for each table which indicates the cumulative percent of respondents who selected 5=Slightly High Impact, 6= High Impact and 7=Very High Impact. Information in Table 9.4 for example shows how the cumulative percentage was calculated for trust.

9.4.4.1 Probability of renewing contract in the future

In this section respondents were asked to indicate the impact of the list of factors on increasing the likelihood that their relationship with industry would be renewed at the end of the current contract. They were asked to show the significant of each factor with respect to their own background. The results are shown in Table 9.3.

The highest means and medians were for “trust” and “commitment” respectively. According to the results (Table 9.3), based on mean and median value, trust is considered as the most important element when researchers in universities want to renew their relationships with an industrial partner, and 81.8% of respondents scored it as a high impact factor. Also 88.6% of respondents believed that commitment has a high impact on their decision to renew their current contract with their industrial partner. The information in Table 9.4 shows the frequencies and cumulative percent for trust.

Table 9.3: Renewal of the relationship with industry

Renewal of the Relationship with Industry	N					***Cumulative Percent**
	Valid	Missing	Mean	Median	Std. Deviation	Slightly high impact and above
Degree of satisfaction from company's regulations	44	4	4.66	5	1.446	54.5
Gain and the usage of research	44	4	4.45	5	1.438	52.3
Trust	44	4	**5.59**	**6**	**1.019**	**81.8**
Accessibility of industry funding	44	4	4.16	4	1.238	43.2
Commitment	44	4	**5.41**	**5**	**.897**	**88.6**
Overall financial return for university	44	4	3.93	4	1.265	34.1

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact
*The value of last column indicate the cumulative percentage of three categories of slightly high impact (5), high impact (6) and very high impact (7)

Renewal of the relationship with industry (Trust)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very high impact	9	18.8	20.5	20.5
	High impact	16	33.3	36.4	56.8
	Slightly high impact	11	22.9	25.0	81.8
	Medium impact	8	16.7	18.2	100.0
	Total	44	91.7	100.0	
Missing	System	4	8.3		
Total		48	100.0		

Table 9.4: Renewal of the relationship with industry (Trust)

9.4.4.2 Motivation of individual academics within universities to collaborate with industry

In this part respondents were asked to specify how they might be motivated to collaborate with industry. In order to reach the objectives, predetermined choices were designed and respondents were asked to specify the likely impact of each factor.

According to the results (Table 9.5), the highest means and medians scores were for "trust" and "existence of an efficient institutional policy on intellectual property rights (IPR)" respectively. Most of the respondents (95.8%) emphasized that these two factors have a high impact on motivating individual academics within universities to collaborate with industry. The list of other critical factors (more than two third of respondents agreed with their high impact and also with mean and median scores of equal or more than 5) are: “clear institutional policy for royalty-sharing”, “evaluating faculty members according to the extent of their contributions to the university-industry collaboration processes”, “funding for future research”, and “modify reward systems to reward technology transfer activities”. Results show that more than two-third of the respondents indicated high impact for these factors.

Table 9.5: Motivation of individual academics within universities to collaborate with industry

Motivation of Individual Academics Within Universities to Collaborate with Industry	N		Mean	Median	Std. Deviation	**Cumulative Percent** Slightly high impact and above
	Valid	Missing				
Existence of an efficient institutional policy on IPR	48	0	5.90	6	.881	95.8
Clear institutional policy for royalty sharing	48	0	5.73	6	.962	89.6
Evaluating faculty members according to the extent of their contributions to the university-industry collaboration processes	48	0	5.38	5	.937	79.2
Enhancing researcher's practical knowledge	48	0	4.73	5	1.047	60.4
Feeling a sense of accomplishment	48	0	4.56	5	1.009	52.1
Funding for future research	48	0	5.02	5	1.021	66.7
Taking new knowledge to practical application	48	0	4.73	5	.962	64.6
Trust	48	0	6.15	6	.875	95.8
Modify reward systems to reward technology transfer activities	48	0	5.08	5	.942	75

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

9.4.4.3 Motivation of universities to collaborate with industry

In this section of research the list of potential motivational factors for universities has been prepared and respondents asked to specify the likely impact of different factors on motivating universities to collaborate with industry. The results are shown in Table 9.6.

According to the results (Table 9.6), “higher access to government funding if cooperating more with industry”, “access to applied knowledge, with positive effect on the academic research and teaching", and "creating entrepreneurial culture in universities" are considered respectively as high impact motivational factors for universities with the highest means and medians compared to other factors. More than 90% of respondents considered the impact of these three factors as high. The list of other critical factors (more than two thirds of respondents agreed regarding their high impact and also with mean and median scores of equal or more than 5) are: "royalty payments to universities", and "integration into labour market for graduate students". Results show that more than eighty percent of the respondents indicated a high impact for these factors.

Table 9.6: Motivation of universities to collaborate with industry

Motivation of Universities to Collaborate with industry	N		Mean	Median	Std. Deviation	**Cumulative percent**
	Valid	Missing				Slightly high impact and above
Increasing budget limitations	48	0	4.77	5	1.387	64.6
Integration into the labour market for graduate students	48	0	5.44	5	.920	85.4
Recruitment and retention of qualified staff	48	0	4.33	4	1.478	45.8
Access to updated technical knowledge and good practices	48	0	4.62	4.50	1.265	50
Access to industrial information	48	0	4.44	4	1.029	45.8
Access to the network of knowledge creation	48	0	4.83	5	1.078	64.6
Access to applied knowledge with positive effect on the academic research and teaching	48	0	5.60	6	.792	93.8
Scope of U-I collaboration which upgrades university ranking	48	0	4.35	4	1.313	47.9
Higher access to government funding if cooperating more with industry	48	0	5.88	6	.981	89.6
Royalty payments to universities	48	0	5.48	5	.967	87.5
Creating entrepreneurial culture in universities	48	0	5.73	6	.893	95.8

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

9.4.4.4Promotion of university-industry collaboration

In this section respondents were asked to indicate their views about the potential impact of the prepared list of factors on promoting university-industry collaboration. According to the results (Table 9.7) the highest means and medians were for "the existence of an efficient national policy framework for IPR" and "the existence of an efficient venture capital” respectively. More than 95% of the respondents indicated that the likely impacts of these factors on promoting UIC are high. The list of other critical factors (more than two third of respondents agreed with their high impact and also with mean and median scores of equal or more than 5) are: “clear patent ownership and institutional royalty sharing formulas”, “efficient government programme to enhance awareness/training for entrepreneurial activities”, “existence of efficient methods for conveying knowledge between universities and industry”, “efficient mobility of people in university-industry collaboration”, “availability of active research consortia” and “higher degree of intermediary involvement e.g. technology parks”. Results show that more than three quarter of the respondents indicated high impact for these factors.

Table 9.7: Promotion of U-I collaboration

Promotion of U-I Collaboration	N		Mean	Median	Std. Deviation	**Cumulative percent**
	Valid	Missing				Slightly high impact and above
The existence of an efficient national policy framework for IPR	48	0	6.31	7	.993	95.8
Efficient mobility of people in U-I collaboration	48	0	5.40	5	1.026	83.3
Clear patent ownership and institutional royalty sharing formulas	48	0	6.02	6	.934	91.7
The existence of an efficient venture capital	48	0	6.06	6	.954	95.8
Efficient cluster formation	48	0	4.83	5	1.018	64.6
Higher degree of intermediary involvement	48	0	5.19	5	.960	77.1
Efficient government programme to enhance awareness/training for entrepreneurial activities	48	0	5.62	6	.981	89.6
Existence of efficient method for conveying knowledge between universities and industry	48	0	5.58	6	.821	91.7
Availability of active research consortia	48	0	5.21	5	1.051	79.2

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

- **Analysis of qualitative data**

Eight respondents stressed that most of their universities lack autonomy and the majority of their activities in UIC are controlled by the Ministry of Science, Research and Technology. They declared that if government were to give universities sufficient autonomy and freedom to develop their research policy and relations with companies this could promote university- industry collaboration. Because a large number of respondents agreed on this point it was added to the list of critical factors.

9.4.4.5 Barriers to U-I Collaboration

In this section a list of potential barriers was presented and respondents were asked to show the likely impact of each factor on impeding university-industry collaboration. The results are shown in Table 9.8.

Table 9.8: Barriers to U-I collaboration

Barriers to U-I Collaboration	N					**Cumulative percent**
	Valid	Missing	Mean	Median	Std. Deviation	Slightly high impact and above
Industrial culture which is based on profit maximization	48	0	**5.71**	**6**	**.944**	**91.7**
Cultural differences in terms of secrecy vs. dissemination	48	0	4.62	5	.937	52.1
Time orientation differences	48	0	**5.71**	**6**	**1.148**	**83.3**
Difficulties in agreeing a technology transfer deal	48	0	4.06	4	1.060	29.2
Speed of negotiation of technology transfer	48	0	4.38	4	1.214	47.9
Financing the technology transfer deal	48	0	4.75	5	1.082	56.2
Poor skills of the people in TTOs e.g. marketing and negotiation experts	48	0	**5.33**	**5**	**.907**	**81.2**
Bureaucracy and inflexibility of university administrator	48	0	**5.92**	**6**	**1.028**	**91.7**
Insufficient resources devoted to technology transfer by universities	48	0	4.67	5	1.191	52.1
Lack of understanding of industry norms by university people	48	0	4.62	5	1.196	54.2
Lack of understanding of university norms by industrial people	48	0	**5.60**	**6**	**.962**	**85.4**
Low degree of firm absorptive capacity	48	0	**5.27**	**5**	**1.047**	**75**
Brain drain	48	0	**5.23**	**5**	**1.036**	**72.9**
Instability of government regulations regarding university-industry collaborations	48	0	**6.17**	**6**	**1.078**	**89.6**

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

According to the results (Table 9.8), based on the value of means and medians the main barriers to UIC are “instability of government regulations regarding university-industry collaborations”, “bureaucracy and inflexibility of university administrator” and “industrial culture which is based on profit maximization”, with around 90% of respondents considered high impact for these items. The list of other critical factors (more than two third of respondents agreed with their high impact and also with mean and median scores of equal or more than 5) are: “time orientation differences”, “lack of understanding of university norms by industrial people”, “poor skills of people in Technology Transfer Offices (TTOs) e.g. marketing and negotiation experts”, “low degree of firms absorptive capacity” and “brain drain”. Results show that more than 70% of respondents indicated ‘high impact’ for these factors.

9.4.4.6 Technology transfer office activities

In this section the list of activities of technology transfer offices in universities is presented and respondents were asked to specify the potential impact of these factors to promote university-industry collaboration. According to the results (Table 9.9), “recruiting mixture of skills including scientific, lawyers and businessmen in the office”, “developing a strategy to market the technology” and “support the creation of spin-off companies from universities” are perceived as a most important activities of these offices and about 90% of the respondents confirmed it.

Table 9.9: TTOs activities

TTOs Activities	N					**Cumulative percent**
	Valid	Missing	Mean	Median	Std. Deviation	Slightly high impact and above
Identifying technologies with a commercial potential	48	0	**5.35**	**5**	**.863**	**85.4**
Assisting researchers to patent their inventions	48	0	4.67	5	1.136	56.2
Packaging the technology appropriately to attract industry	48	0	**5.23**	**5**	**.951**	**77.1**
Developing a strategy to market technology	48	0	**5.54**	**6**	**.898**	**87.5**
Leading the license negotiations with potential licensees	48	0	4.79	5	1.071	60.4
Sensitizing researchers and students on the existence of the office	48	0	4.58	4.50	1.182	50
Managing apprenticeship programme with industry	48	0	4.21	4	1.320	41.7
Recruiting mixture of skills including scientific, lawyers and businessmen in the office	48	0	**5.69**	**6**	**.879**	**89.6**
Support the creation of spin-off companies from universities	48	0	**5.52**	**6**	**.825**	**89.6**

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

The list of other critical factors (more than two third of respondents agreed with their high impact and also with mean and median scores of equal or more than 5) are: “identifying technologies with a commercial potential” and “packaging the technology appropriately to attract industry”. More than three-quarters of respondents indicated a high impact for these factors.

9.4.5 Identifying forces related to uncertainty

This section is designed to identify the uncertainty dimension of different factors contributing to UIC activities. Results in this section are combined with the results of Section 9.4.4 in order to identify the critical scenario driving forces/policy levers change.

9.4.5.1 Degree of uncertainty

In this section the majority of the factors in previous sections are also presented, with respondents asked to specify how confident they are about the direction, pace or likelihood of occurrence of the future course of these factors. This section is basically designed to identify the second dimension of this research analysis which was identifying the degree of uncertainty for each specific factor.

According to the results (Table 9.10), the highest means and medians were for “stability of government regulations regarding university-industry collaborations”, “enhancing level of trust”, “existence of an efficient national policy framework for IPR” and “existence of an efficient institutional policy for IPR”. Almost all of the respondents believed that stability of government regulations and the existence of trust between partners are very uncertain in the future. 87.5% of respondents considered high uncertainty for the existence of an efficient national policy framework for IPR and

93.8% of respondents considered high uncertainty for the existence of an efficient institutional policy framework for IPR.

Table 9.10: Degree of uncertainty

Degree of Uncertainty	N: Valid	N: Missing	Mean	Median	Std. Deviation	Cumulative percent: Somewhat Uncertain and above
Existence of an efficient national policy framework for IPR	48	0	6.31	7	1.014	87.5
Existence of an efficient institutional policy framework for IPR	48	0	6.25	6.50	.911	93.8
Existence of an efficient programme which includes mobility of people in U-I collaboration	48	0	5.12	5	1.123	68.8
Availability of an efficient reward system for inventor/researcher	48	0	5.50	6	1.111	83.3
Clear institutional policy on royalty-sharing	48	0	5.71	6	.898	95.8
Availability of additional government funding for universities which collaborate with companies	48	0	5.27	5	1.180	83.3
Increasing amount of royalty payments to universities	48	0	5.38	5.50	1.142	81.2
Efficient cluster formation	48	0	5.00	5	1.072	72.9
Proactive intermediary organization involvement	48	0	5.31	5	.993	79.2
Existence of good mixture of skills in TTOs e.g. marketing and negotiation experts	48	0	5.19	5	1.024	81.2
Decreasing the degree of bureaucracy of universities	48	0	4.73	5	1.047	62.5
Commitment	48	0	5.38	5	1.178	81.2
Enhancing level of trust	48	0	6.38	7	.733	100
Higher accessibility of industry funding	48	0	4.46	5	1.254	54.2
Availability of highly qualified personnel in industry for universities	48	0	4.62	4	1.064	47.9
Availability of efficient methods for evaluating faculty members according to the extent of their contributions to UIC	48	0	5.06	5	1.060	75
Integration into the labour market for graduated students	48	0	4.92	5	1.108	56.2
Equipped universities and availability of R&D facilities	48	0	4.81	5	1.409	62.5
Enhancing firms' absorptive capacity on knowledge transfer	48	0	4.94	5	1.099	64.6
Decreasing cultural differences between universities and industry	48	0	5.08	5	.895	75
Existence of efficient venture capital and investors	48	0	5.44	6	1.183	79.2
High support of Technology transfer office for the creation of spin-off from universities	48	0	4.81	5	1.085	62.5
Efficient policy toward brain drain	48	0	4.81	5	.915	64.6
Efficient government programme to enhance awareness/training for entrepreneurial activities	48	0	5.27	5	1.198	77.1
Availability of active research consortia	48	0	4.62	4	1.044	45.8
Existence of efficient methods for conveying knowledge between universities and industry	48	0	4.88	5	1.142	60.4
Availability of good mixture of scientific, lawyers and businessmen in the TTOs	48	0	4.92	5	1.164	62.5
Stability of government regulations regarding university-industry collaborations	48	0	6.48	7	.714	100

1=Certain, 2=Fairly Certain, 3=Somewhat Certain, 4=Unsure, 5=Somewhat Uncertain, 6=Fairly Uncertain, 7=Uncertain

The list of other critical factors (more than two third of respondents agreed with their high degree of uncertainty and also with mean and median scores of equal or more than 5) are: “clear institutional policy on royalty sharing”, “availability of an efficient reward system for inventor/researcher”, “existence of efficient venture capital and investors”, “increasing amount of royalty payments to universities”, “commitment”, “availability of additional government funding for universities which collaborate with companies”, “efficient government programme to enhance awareness/training for entrepreneurial activities”, “proactive intermediary organizations involvement”, “existence of good mixture of skills in the technology transfer office e.g. marketing and negotiation experts”, “existence of an efficient programme which includes mobility of people in U-I collaboration”, “efficient cluster formation”, “availability of efficient methods for evaluating faculty members according to the extent of their contributions to UIC” and “decreasing cultural differences between universities and industry”. These factors were also included as critical uncertainties for the future of UIC activities in Iran. More than two-thirds of respondents believed that the future state of these factors is highly uncertain.

9.4.6 Critical scenario driving forces for universities

This section combined the result of both Impact and Uncertainty dimension of each factor in order to identify the critical scenario driving forces. Analysis of the data (see Table 9.11) indicates that 34 out of 58 factors (for the university side) are significant, and can be grouped in the three upper right quadrants of the Impact-Uncertainty matrix (high impact/high uncertainty, high impact/medium uncertainty, medium impact/high uncertainty) (see Figure 7.1).

A high category in both uncertainty and impact dimensions indicates that the medians and means for these factors were equal to or more than five, with at least two-thirds of respondents in agreement. Medium category indicates that the medians and means for these factors were equal to or less than five and more than three, with less than two-thirds of respondents in agreement. Low category indicates that the medians and means for these factors were equal or less than three.

For some of the factors in the matrix, only one dimension (Impact) was defined. These factors are shown by (I) in the matrix. These factors with high impact were considered for further analysis and those with medium impact were discarded.

In applying the methods of scenario design (see Section 7.10.1), those factors which proved to be less critical i.e. had a medium score in both uncertainty and impact dimensions were excluded from further analysis. Details are shown in Table 9.11.

Degree of Uncertainty Based on Means, Medians and Percent of Respondents				
Low	**Medium (3-5)**	**High (5-7)**		**Level of Impact**
	Funding for future research which motivate individuals, Integration into the labour market for graduate students, Existence of efficient method for conveying knowledge, Availability of active research consortia, Decreasing bureaucracy of university administrator, Efficient policy to control brain drain, TTOs recruit mixture of experts in the office including scientific, lawyers and businessmen, TTOs support the creation of spin-off companies, Degree of firms absorptive capacity	Trust, Commitment, efficient institutional policy on IPR, Clear institutional policy on royalty sharing, Effective methods for evaluation of faculty members, Modify reward systems, Higher access to government funding, Royalty payments to universities which motivate universities, Efficient national policy framework for IPR, Mobility of staff, Existence of efficient venture capital, Efficient government programme to enhance awareness/training for entrepreneurial activities, TTOs identify technologies with commercial potential (I), TTOs package the technology appropriately (I), TTOs develop strategy to market technology (I), Access to applied knowledge which motivate universities (I), creating entrepreneurial culture in universities (I), Decreasing cultural differences (profit maximization), Availability of various skills of the people in the TTOs e.g. marketing and negotiation experts, understanding of university norms by industrial people, Stability of government regulations, Decreasing time orientation differences, Government give universities autonomy and freedom	**High (5-7)**	
	Recruitment and retention of qualified staff, Resources devoted to technology transfer by universities, Financing the technology transfer deal, Degree of satisfaction from company's regulations (I), Gain and the usage of research (I). Accessibility of industry funding, Financial return for university (I), Enhancing researcher's practical knowledge (I), Feeling a sense of accomplishment (I), Taking new knowledge to practical application (I), Increasing budget limitations for universities (I), Access to updated technical knowledge (I), Access to industrial information (I), Access to the network of knowledge creation (I), Upgrading university ranking (I), Difficulties in agreeing a technology transfer deal (I), Speed of negotiation of technology transfer (I), TTOs assists researchers to patent inventions (I), TTOs leading the license negotiations (I), TTOs sensitizing the researcher on the existence of the office (I), TTOs manage apprenticeship programme (I)	Efficient cluster formation, Higher degree of intermediary involvement, Decreasing cultural differences (secrecy vs. dissemination), Understanding of industry norms by university people	**Medium (3-5)**	
			Low	

Table 9.11: Critical scenario driving forces for universities (Impact/Uncertainty Matrix)

9.5 THE INDUSTRY PERSPECTIVE

This part explains results of questions which were taken from the industry side. It should be noted that some questions had more than one possible answer. The industry questionnaire is presented in Appendix C. Below the results taken from the side of industry will be examined.

9.5.1 Background of respondents

The results of the questionnaire show the pool of respondents to be 42 from industry; 25 respondents (59.5%) were from private companies, with 12 (28.6%) from public companies, and 5 (11.9%) from public-private companies.

Majority of the respondents to the survey (78.6%) were from SMEs. Results show that 16 of the respondents (38.1%) were from small companies (less than 50 employees), 17 of them (40.5%) were from medium sized companies (between 50 and 250 employees) and finally 9 of the respondents (21.4%) were from large companies (more than 250 employees).

22 (52.4%) of the respondents were from automotive related companies and 20 (47.6%) of the respondents were from biotechnology related companies.

According to the results (Table 9.12), 20 (47.6%) of the respondents are senior manager of the company and 22 (52.4%) of them are R&D managers.

	Position of respondents	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Senior management	20	47.6	47.6	47.6
	R&D manager	22	52.4	52.4	100.0
	Total	42	100.0	100.0	

Table 9.12: Position of respondents

9.5.2 R&D expenditure as a percentage of income

In this section the respondents were asked to indicate the amount of R&D expenditure financed by their companies as a percentage of income. According to the results (Table

9.13), approximately 40% of companies spent more than country's average (0.6) (www.mim.gov.ir) on R&D. 2.4% of the respondents spent more than 1% of their income to their R&D activities, 11.9% between 081% to 1%, 26.2% between 0.61% to 0.8%, 31% between 0.41% to 0.6% and 16.7% spend between 0.21% to 0.4% of their income on R&D. 11.9% of respondents said that they are unsure of this figure.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0.21% to 0.4%	7	16.7	16.7	16.7
	0.41% to 0.6%	13	31.0	31.0	47.6
	0.61% to 0.8%	11	26.2	26.2	73.8
	0.81% to 1%	5	11.9	11.9	85.7
	More than 1%	1	2.4	2.4	88.1
	Not sure	5	11.9	11.9	100.0
	Total	42	100.0	100.0	

Table 9.13: R&D expenditure as a percentage of income

9.5.3 Types of university-industry technology transfer

In this section respondents were asked to indicate in which types of university-industry technology transfer they have had experience. According to the results (Table 9.14), the most common form of technology transfers were consultancy and technical service provision (61.9%) and the least reported type of cooperation was technology licensing activity (16.7%). From the industry pool 59.5% of the respondents had experienced collaboration through conferences and publications, 21.4% had been involved in an exchange programme, 23.8 % in joint ventures of R&D between universities and industry, 11.9% in cooperative R&D, 23.8% in contract research, with 23.8% having had collaboration through an intermediary agency and finally 9.5% of the respondent had no previous work experience in any technology transfer activities from universities to industry. None of the respondents had used spin-off formation as a mechanism for university-industry technology transfer.

Types of U-I Technology Transfer	Frequency	Percent
Conferences and publication	25	59.5
Exchange Programme	9	21.4
Consultancy and technical service provision	26	61.9
Joint venture of R&D	10	23.8
Cooperative R&D agreement	5	11.9
Licensing	7	16.7
Contract research	10	23.8
Intermediary involvement	10	23.8
Spin-off company formation	-	-
None	4	9.5

Table 9.14: Types of U-I Technology Transfer

9.5.4 Reliability of industry questionnaire

Analysis of the rating scale questions for the industry pool of respondents will be started from the next section. Scales were subjected to reliability testing. Reliability test results indicate that Cronbach's alpha scores were in an acceptable range for these scales (alpha scores ranged from 0.6 to 0.8 indicating that the items in the scale were measuring the same underlying concept). The overall score for whole questionnaire was 0.855 which is shown in Table 9.15.

Case Processing Summary

		N	%
Cases	Valid	38	90.5
	Excluded[a]	4	9.5
	Total	42	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.855	77

Table 9.15: The overall score for whole questionnaire

9.5.5 Identifying forces related to impact

This section is designed to identify the impact dimension of different factors contributing in UIC process. Results of this section will be combined with uncertainty dimension of scenarios (Section 9.5.6), in order to identify the critical scenario driving forces. As previously mentioned in university side; only those factors which met three criteria at the same time were considered as having high impact driving forces. These criteria include: mean score and median should be five or more and also at least two third of respondents agree on the importance of that factor. In other words, two third of respondents should score the importance of that factor slightly high impact (5) or above. In order to achieve this objective the extra column was designed for each table which indicates the cumulative percent of respondents who selected 5=Slightly High Impact, 6= High Impact and 7=Very High Impact. Table 9.17 for example shows how the cumulative percentage was calculated for trust.

9.5.5.1 Probability of renewing contract

In this section respondents were asked to indicate the impact of the list of factors on increasing the likelihood that the relationship with universities will be renewed at the end of the current contract. They were asked to show the significance of each factor with respect to their own background. The results are shown in Table 9.16.

Table 9.16: Renewal of the relationship with universities

Renewal of the Relationship with universities	N					***Cumulative Percent**
	Valid	Missing	Mean	Median	Std. Deviation	Slightly high impact and above
Degree of satisfaction with university's regulations	38	4	4.53	4	1.224	47.4
Gain and the usage of research	38	4	4.74	5	1.309	55.3
Trust	38	4	**5.95**	**6**	**1.038**	**94.7**
Accessibility of university technology	38	4	4.03	4	1.078	31.6
Commitment	38	4	**5.39**	**5**	**1.152**	**78.9**
Impact on sales	38	4	4.13	4	1.166	42.1

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

*The value of last column indicate the cumulative percentage of three categories of slightly high impact (5), high impact (6) and very high impact (7)

The highest means and medians were for "trust" and "commitment" respectively. According to the results (Table 9.16), trust is considered as a most important element when companies want to renew their relationships with university partners, with 94.7% of respondents scoring it as a high impact factor. Furthermore 78.9% of respondents believed that commitment has a high impact on their decision to renew their current contract with university partner. The information in Table 9.17 shows the frequencies and cumulative percent for trust.

Renewal of the relationship with universities (Trust)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very high impact	12	28.6	31.6	31.6
	High impact	16	38.1	42.1	73.7
	Slightly high impact	8	19.0	21.1	94.7
	Medium impact	1	2.4	2.6	97.4
	Very low impact	1	2.4	2.6	100.0
	Total	38	90.5	100.0	
Missing	System	4	9.5		
Total		42	100.0		

Table 9.17: Renewal of the relationship with universities (Trust)

9.5.5.2 Motivating companies to collaborate with universities

In this part respondents were asked to specify how they might be motivated to collaborate with universities. In order to reach the objectives, predetermined choices were suggested and respondents were asked to specify the likely impact of each factor. Information in Table 9.18 shows the detail for each suggestion.

According to the results (Table 9.18), the highest means and medians scores were for "trust" and "higher access to government funding when collaborating with universities" respectively. More than 95% of the respondents said that these two factors have a high impact on motivating companies to collaborate with university. The list of other critical factors (more than two third of respondents agreed with their high impact and also with mean and median scores of equal or more than 5) are: "increasing the qualification level of employees", "access to new technologies and process that allow achievement of competitive advantage", "availability of tax credit if cooperating with universities", "Creation of innovation culture in the company", "increasing company's general technical awareness and/or capabilities in R&D" and "improving sales and profitability". Results show that more than two-third of the respondents indicated high impact for these factors.

Table 9.18: Motivation of companies to collaborate with universities

Motivation of companies to collaborate with universities	N		Mean	Median	Std. Deviation	**Cumulative Percent**
	Valid	Missing				Slightly high impact and above
Increasing company's general technical awareness and/or capabilities in R&D	42	0	5.45	6	1.041	76.2
Accelerate or improve your existing research project	42	0	4.69	5	1.115	64.3
Improving your public image in the society in which you operate	42	0	4.62	5	1.103	59.5
Increasing the qualification level of employees	42	0	5.79	6	.925	90.5
Improving sales and profitability	42	0	5.00	5	1.126	66.7
To access and recruit highly qualified personnel from universities	42	0	4.36	4.50	.958	50
Existence of an efficient institutional policy on IPR	42	0	4.69	5	.869	59.5
Access to new technologies that allow achievement of competitive advantages	42	0	5.74	6	1.061	90.5
Access to the equipped university physical facilities	42	0	4.48	4	.994	42.9
Higher access to government funding when collaborating with universities	42	0	6.12	6	1.041	95.2
Creation of innovation culture in the company	42	0	5.45	6	1.109	78.6
Ability to recruit talented students	42	0	4.62	5	.909	54.8
Availability of tax credit if cooperating with universities	42	0	5.55	6	1.064	90.5
Increasing embargo imposed by the West	42	0	4.93	5	.973	64.3
Improving political situation and Iranian entry to the WTO	42	0	4.81	5	.943	54.8
Trust	42	0	6.52	7	.74	97.6

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

9.5.5.3 Promotion of University-Industry Collaboration

In this section respondents were asked to indicate their views regarding the potential impact of a prepared list of factors on promoting university-industry collaboration. According to the results (Table 9.19), the highest mean, median and percent of impact was for " effective privatisation and smaller role for the government in the economy". More than 95% of the respondents indicated that the likely impact of this factor on promoting UIC is high. The list of other critical factors (more than two third of respondents agreed with their high impact and also with mean and median scores of equal or more than 5) are: "efficient government programmes to enhance awareness/training for entrepreneurial activities", "efficient cluster formation", "existence of efficient methods for conveying knowledge between universities and industry", "availability of active research consortia" and "existence of an efficient venture capital". Results show that more than seventy percent of the respondents indicated high impact for these factors.

Table 9.19: Promotion of U-I collaboration

Promotion of U-I collaboration	N					**Cumulative Percent**
	Valid	Missing	Mean	Median	Std. Deviation	Slightly high impact and above
The existence of an efficient national policy framework for IPR	42	0	4.48	4	.994	45.2
Efficient mobility of people in U-I collaboration	42	0	4.71	5	1.043	57.1
The existence of an efficient venture capital	42	0	**5.38**	**5**	**1.058**	**76.2**
Efficient cluster formation	42	0	**5.93**	**6**	**1.068**	**88.1**
Higher degree of intermediary involvement	42	0	4.81	5	1.065	64.3
Efficient government programmes to enhance awareness/training for entrepreneurial activities	42	0	**6.07**	**6**	**.997**	**90.5**
Effective privatisation and smaller role for the government in the economy	42	0	**6.26**	**6.50**	**.885**	**95.2**
Existence of an efficient method for conveying knowledge between universities and industry	42	0	**5.60**	**6**	**.912**	**90.5**
Availability of active research consortia	42	0	**5.19**	**5**	**.969**	**73.8**

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

9.5.5.4 Barriers to U-I collaboration

In this section a list of potential barriers was prepared and respondents were asked to show the likely impact of each factor on impeding university-industry collaboration. The results are shown in Table 9.20.

The information in Table 9.20 shows that the main barriers to UIC from industry's point of view are "instability of government regulations regarding university-industry collaborations" and "time orientation differences"; more than 90% of the respondents considered high impact for these items.

The list of other critical factors (more than two third of respondents agreed with their high impact and also with mean and median scores of equal or more than 5) are:

"lack of understanding of industry norms by university people", "poor skills of people in Technology Transfer Offices (TTOs) e.g. marketing and negotiation skills", "cultural differences in terms of secrecy vs. dissemination", "bureaucracy and inflexibility of university administrator", "low degree of firms absorptive capacity" and "brain drain". Results show that more than 70% of the respondents indicated high impact for these factors.

Table 9.20: Barriers to U-I collaboration

Barriers to U-I Collaboration	N		Mean	Median	Std. Deviation	**Cumulative Percent**
	Valid	Missing				Slightly high impact and above
Industrial culture which is based on profit maximization	42	0	4.88	5	1.131	64.3
Cultural differences in terms of secrecy vs. dissemination	42	0	**5.40**	**5**	**1.037**	**83.3**
Time orientation differences	42	0	**5.64**	**6**	**.850**	**92.9**
Difficulties in agreeing a technology transfer deal	42	0	4.79	5	1.048	59.5
Speed of negotiation of technology transfer	42	0	4.71	5	1.066	54.8
Financing the technology transfer deal	42	0	4.90	5	1.008	61.9
Poor skills of the people in TTOs e.g. marketing and negotiation skills	42	0	**5.14**	**5**	**1.002**	**76.2**
Bureaucracy and inflexibility of university administrator	42	0	**5.33**	**5**	**1.162**	**83.3**
Insufficient resources devoted to technology transfer by universities	42	0	4.45	4	1.329	42.9
Lack of understanding of industry norms by university people	42	0	**5.40**	**6**	**1.170**	**78.6**
Lack of understanding of university norms by industrial people	42	0	4.52	4.50	1.065	50
Low degree of firm's absorptive capacity	42	0	**5.07**	**5**	**1.091**	**71.4**
Brain drain	42	0	**5.43**	**5.50**	**1.016**	**81**
Instability of government regulations regarding university-industry collaborations	42	0	**6.17**	**6**	**.824**	**97.6**

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

- **Analysis of Qualitative Data**

Respondents were also asked open-ended questions to encourage their comments related to each section. 8 respondents declared that most major industries still belong to government, and the government is not willing to accept variety in product and sometimes does not care about quality, therefore no urgent need for collaboration was felt. 12 respondents believed that although the privatisation process has started and includes many industries, except oil-related companies, the process has not been successful to date. They declared that because of the government monopolies in the market the need for collaboration is reduced. Since many respondents emphasized the effects of monopoly, this element was added to the list of critical factors.

9.5.6 Identifying forces related to uncertainty

This section is designed to identify the uncertainty dimension of different factors contributing in UIC activities. Results of this section are combined with the results of Section 9.5.5 in order to identify the critical scenario driving forces.

9.5.6.1 Degree of uncertainty

In this section the majority of the factors in previous sections are also presented here with respondents asked to specify how confident they feel about the direction, pace or likelihood of occurrence of the future course of these factors. This section is basically designed to identify a second dimension of research analysis which was to identify the degree of uncertainty for each specific factor.

According to the results (Table 9.21), the highest means and medians were for “political stability and decreasing embargo imposed by west”, “enhancing level of trust”, “stability of government regulations regarding university-industry collaborations” and “existence of an efficient national policy framework regarding IPR”. Almost 90% of respondents believe that the availability of these factors is substantially uncertain in the future.

Table 9.21: Degree of uncertainty

Degree of uncertainty	N Valid	N Missing	Mean	Median	Std. Deviation	Cumulative Percent: Somewhat uncertain and above
Existence of an efficient national policy framework regarding IPR	42	0	5.86	6	.926	95.2
Existence of an efficient institutional policy framework regarding IPR	42	0	5.71	6	1.088	83.3
Availability of additional government funding for companies which collaborate with universities	42	0	4.79	5	.976	64.3
Effective government policy which encourage U-I collaboration (e.g. tax credit)	42	0	5.74	6	1.106	85.7
Efficient cluster formation	42	0	4.52	4	.833	45.2
Proactive intermediary organizations involvement	42	0	4.43	4.50	1.213	50
Existence of good mixture of skills in TTOs e.g. marketing and negotiation experts	42	0	4.40	4	1.037	42.9
Decreasing degree of bureaucracy of universities	42	0	5.21	5	1.180	69
Commitment	42	0	5.07	5	1.022	66.7
Enhancing level of trust	42	0	6.17	6	.881	97.6
Higher accessibility of university technology	42	0	4.48	5	1.292	54.8
Availability of highly qualified personnel in universities for industry	42	0	4.14	4	1.260	38.1
Ability of universities to provide innovative technologies for companies and create innovation culture	42	0	5.10	5	1.206	71.4
Integration into the labour market for graduate students	42	0	5.29	5	1.019	73.8
Equipped universities and availability of R&D facilities	42	0	4.45	4	1.234	47.6
Political stability and decreasing embargoes imposed by West	42	0	6.29	7	1.066	90.5
Enhancing firms' absorptive capacity on knowledge transfer	42	0	4.29	4	1.132	40.5
Iranian entry to the WTO and improving political situation	42	0	5.24	5	1.100	78.6
Existence of active research consortia	42	0	4.69	5	1.158	52.4
Effective privatisation strategy and a smaller role for the government in the economy	42	0	5.48	6	1.087	81
Efficient policy toward brain drain	42	0	5.40	5	1.083	81
Efficient government programme to enhance awareness/training for entrepreneurial activities	42	0	5.69	6	.897	90.5
Decreasing cultural differences between universities and industry	42	0	4.74	5	1.106	64.3
Existence of efficient venture capital and investors	42	0	4.69	5	1.115	61.9
Ability of universities in providing technologies that give your company a competitive advantage	42	0	4.48	4.50	1.110	50
Existence of efficient methods for conveying knowledge between universities and industry	42	0	4.67	5	1.074	52.4
Existence of efficient programme which includes mobility of people in U-I collaboration	42	0	5.26	5	1.170	71.4
Stability of government regulations regarding university-industry collaborations	42	0	6.14	6	.926	95.2
Ability of universities to increase your general technical awareness in R&D	42	0	4.29	4	1.195	45.2

1=Certain, 2=Fairly Certain, 3=Somewhat Certain, 4=Unsure, 5=Somewhat Uncertain, 6=Fairly Uncertain, 7=Uncertain

The list of other critical factors (more than two third of respondents agreed with their high degree of uncertainty and also with mean and median scores of equal or more than 5) are: “existence of an efficient institutional policy framework regarding IPR”, “effective government policy which encourage university-industry collaboration e.g. tax credit”, “commitment”, “availability of additional government funding for companies which collaborate with universities”, “efficient government programme to enhance awareness/training for entrepreneurial activities”, “existence of an efficient programme which includes mobility of people in U-I collaboration”, “decreasing degree of bureaucracy in universities”, “ability of universities to provide innovative technologies for companies and create innovation culture”, “integration into the labour market for graduate students”, “Iranian entry to the WTO and improving political situation”, “effective privatisation strategy and a smaller role for the government in the economy” and “efficient policy toward brain drain”. These factors were also included as critical uncertainties for the future of UIC activities in Iran. More than two-third of the respondents believed that the future state of these factors is highly uncertain.

9.5.7 Critical scenario driving forces for industry

This section combined the result of both Impact and Uncertainty dimensions of each factor in order to identify the critical scenario driving forces. Analysis of the data (Table 9.22) indicated that 29 out of 45 factors (for industry) are significant, and can be grouped in the three upper right quadrants of the Impact-Uncertainty matrix (high impact/high uncertainty, high impact/medium uncertainty, medium impact/high uncertainty).

A high category in both uncertainty and impact dimensions indicates that the medians and means for these factors were equal or more than five, with at least two third of respondents in agreement. Medium category indicates that the medians and means for these factors were equal or less than five and more than three, with less than two-third of respondents in agreement. The Low category indicates that the medians and means for these factors were equal or less than three.

Degree of Uncertainty Based on Means, Medians and Percent of Respondents				
Low	**Medium (3-5)**	**High (5-7)**		**Level of Impact**
	Increasing general technical awareness in R&D, Access to new technologies that allow achievement of competitive advantage, Higher access to government funding, The existence of an efficient venture capital, Efficient cluster formation, Existence of efficient methods for conveying knowledge, Availability of active research consortia, Decreasing cultural differences (secrecy vs. dissemination), Decreasing time orientation differences, Availability of various skills of the people in TTOs e.g. marketing and negotiation experts, Understanding of industry norms by university people, Degree of firms absorptive capacity, High degree of intermediary involvement	Trust, Commitment, Efficient government programme to enhance awareness/training for entrepreneurial activities, Decreasing bureaucracy of university administrator, Effective privatisation strategy, Efficient policy to control brain drain, Stability of government regulations, Increasing the qualification level of employee (I), Improving sales and profitability (I), Creation of innovation culture in the company, Availability of tax credit, Decreasing Monopolies of the government in the market	**High (5-7)**	
	Decreasing cultural differences (profit maximization), Access to the equipped university physical facilities, To recruit qualified personnel from university, Understanding of university norms by industrial people, Accessibility of university technology, Resources devoted to technology transfer by universities, Degree of satisfaction from university's regulations (I), Gain and the usage of research (I), Impact on sales (I), Accelerate or improve existing research project (I), Improving university public image in society (I), Difficulties in agreeing a technology transfer deal (I), Speed of negotiation (I), Financing the technology transfer deal (I),	Efficient institutional policy on IPR, Ability to recruit talented students, Decreasing embargoes imposed by the West, Improving political situation and entry to the WTO, National policy framework for IPR, Mobility of staff	**Medium (3-5)**	
			Low	

Table 9.22: Critical scenario driving forces for industry (Impact/Uncertainty Matrix)

For some of the factors in the matrix, only one dimension (Impact) was defined. These factors are shown by (I) in the matrix. These factors with high impact were considered for further analysis and those with medium impact were discarded.

In applying the methods of scenario design (Section 7.10.1), those factors which proved to be less critical i.e. had a medium score in both uncertainty and impact dimensions were excluded from further analysis. Details are shown in Table 9.22.

9.6 SUMMARY OF RESULTS

The results of the analysis were collected in a systems perspective to form a direct force model of the Iranian UIC system (see Figure 9.2). This model discarded those forces in figure 9.1 which were not considered as critical scenario driving forces for UIC in Iran. Also Figure 9.2 include two additional forces appeared during a survey (as a result of qualitative analysis of open-ended questions in a survey). These two forces are autonomy of university from government, and also degree of monopoly of government in market. Results of the systems model (Figure 9.2) will be combined with the second and third order impact forces (black arrows) in the conceptual model (Figure 7.2) to form a logical map of system elements to interview instruments (Figure 10.1).

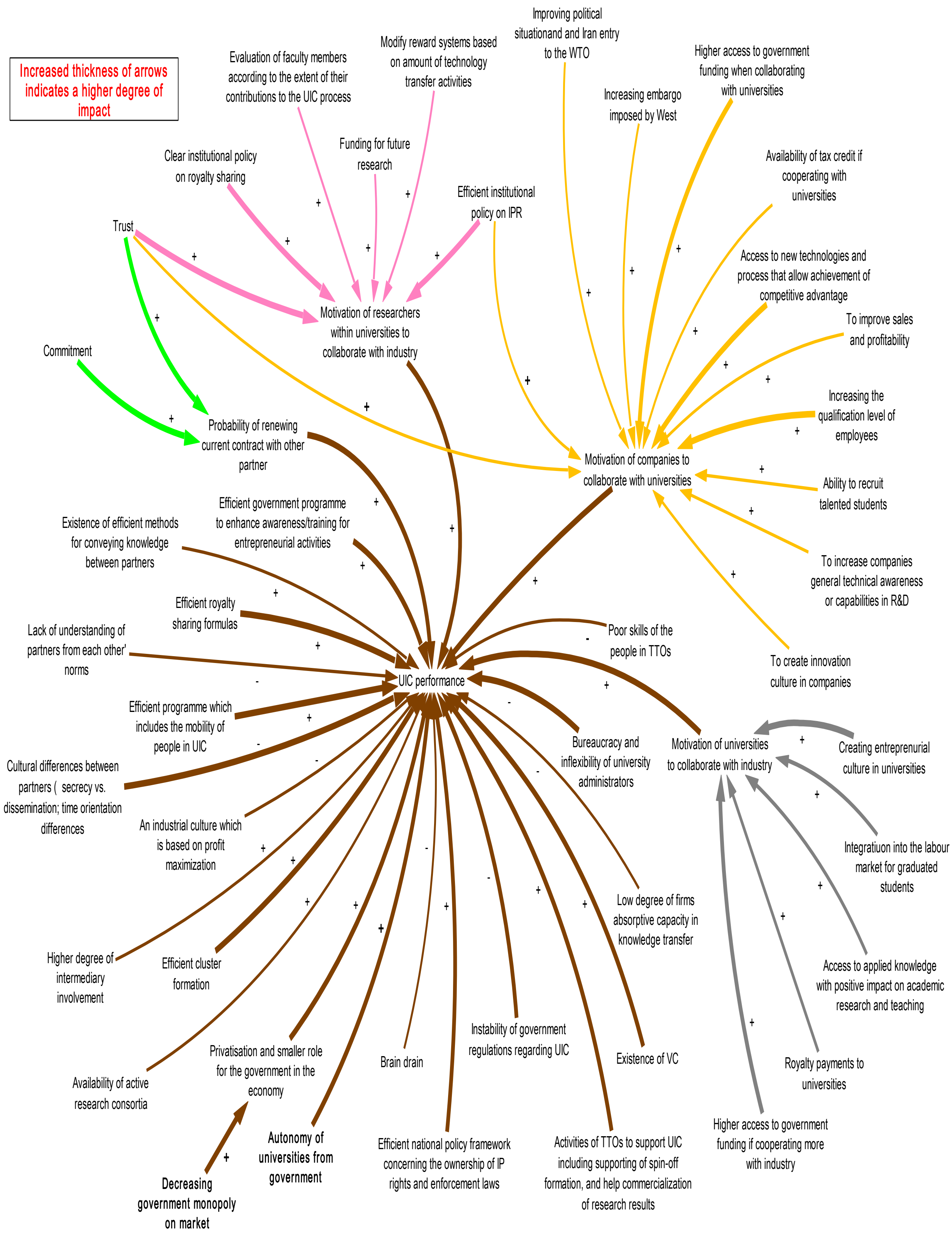


Figure 9.2: Direct Force Model of the UIC System

9.7 ESTABLISHING THE SCENARIO LOGICS

A search for a simplified logical structure for the scenario led into a prolonged discussion of the 34 out of 58 factors (for the university side- see Section 9.4.6) and 29 out of 45 factors (for industry- see Section 9.5.7) which are significant and can be grouped in the three upper right quadrant of the Impact-Uncertainty matrix (scenario driving forces).

The most important aim of this step was to develop a structure that would produce a manageable number of scenarios in a logical way (see Section 8.7.2.4).

In order to achieve this objective, factors obtained from the survey results were grouped under common headings. It was assumed that for the university-industry collaboration in Iran, the truly critical scenario forces are clustered around five factor groupings of the Iranian system. These five factor groupings are represented as sub-systems in the UIC system model (see Section 10.3.3).

- Organizational Structures to Coordinate and Support Partnerships (OS)
- Asset Management (AST)
- Leadership and Culture (LC)
- Organizational Capabilities (OC)
- Creation of an Enabling Environment by Government (GOV)

From different organisational perspectives (universities and industry) these component factors include:

A- Organizational Structures to Coordinate and Support Partnerships (OS)

- OS1: The existence of an efficient institutional policy on IPR which can motivate individuals within universities to collaborate with industry (university)
- OS1: The existence of an efficient institutional policy on IPR which can motivate industry to collaborate with universities (industry)
- OS2: Efficient structure of technology transfer offices in universities; and recruiting mixture of skills including scientific, lawyers and businessmen in the office which can promote UIC (university)

- OS3: Clear institutional policy on royalty sharing which can motivate individuals within universities to collaborate with industry (university)
- OS4: Efficient structure to evaluate faculty members based on their extent of relations with industry which can motivate individuals within universities to collaborate with industry (university)
- OS5: Existence of efficient methods for conveying knowledge between universities and industry which can promote UIC (university, industry)
- OS6: Bureaucracy and inflexibility of university administrators which can impede UIC (university, industry)
- OS7: Efficient programmes which include mobility of people between partners which can promote UIC (university, industry)

B- Asset Management (AST)

- AST1: Modify reward system for researcher to reward technology transfer activities which can motivate individuals within universities to collaborate with industry (university)
- AST2: Availability of various skills in technology transfer offices e.g. marketing and negotiation experts which can promote UIC (university, industry)
- AST3: Effective TTOs Spin-off creation support strategy which can promote UIC (university)
- AST4: Commercialization activities of TTOs which can promote UIC and include: (university)
    - Efficient strategy of TTOs to market the technology which can promote UIC (university)
    - TTOs identifying technology with commercial potential which can promote UIC (university)
    - TTOs package the technology appropriately which can promote UIC (university)
- AST5: Royalty payments to universities which can motivate universities to collaborate with industry (university)
- AST6: Integration into the labour market for graduated students which can motivate universities to collaborate with industry (university)
- AST7: Access to additional funding for individual future research which can motivate individuals within universities to collaborate with industry (university)
- AST8: Ability of companies to recruit talented students which can motivate companies to collaborate with universities (industry)

C- Leadership and Culture (LC)

- LC1: Cultural differences in university-industry collaboration which can impede UIC (secrecy vs. dissemination) (university, industry)
- LC2: Cultural differences in university-industry collaboration which can impede UIC (time orientation differences) (university, industry)
- LC3: Cultural differences in university-industry collaboration which can impede UIC (profit maximization) (university)

- LC4: Lack of understanding of industry norms by university people which can impede UIC (industry, university)
- LC5: Lack of understanding of university norms by industrial people which can impede UIC (university)
- LC6: Trust formation between partners includes:
    - Trust formation between partners which can motivate individuals within university to collaborate with industry partner (university)
    - Trust formation between partners which can motivate industry to collaborate with university partner (industry)
    - Trust formation between partners which can increase the probability of renewing contract in the future (university, industry)
- LC7: Commitment between partners which can increase the probability of renewing contract in the future (university, industry)

D- Organizational Capabilities (OC)

- OC1: Availability of active research consortia which can promote UIC (university, industry)
- OC2: Low degree of firms' absorptive capacity on knowledge transfer which can impede UIC (industry, university)
- OC3: To increase university's teaching and research performance which can motivate universities to collaborate with industry (university)
- OC4: To create entrepreneurial culture in universities which can motivate universities to collaborate with industry (university)
- OC5: To increase firm's capabilities in R&D which can motivate companies to collaborate with universities (industry)
- OC6: To create innovation culture in industry if cooperating with universities which can motivate companies to collaborate with universities (industry)
- OC7: To achieve competitive advantage for companies which can motivate companies to collaborate with universities (industry)
- OC8: To increase the qualification level of employees in companies which can motivate companies to collaborate with universities (industry)
- OC9: Ability of universities to improve sales and profitability of industry which can motivate companies to collaborate with universities (industry)

E- Creation of an Enabling Environment by Government (GOV)

- GOV1: Higher access to government funding when collaborate with other partner which motivate university and industry to collaborate with each other (university, industry)
- GOV2: Existence of an efficient reward and incentive systems for innovative firms which can motivate companies to collaborate with universities (industry)
- GOV3: Stability of government regulations regarding U-I collaborations which can promote UIC (university, industry)
- GOV4: Government giving more autonomy to universities which can promote UIC (university); See Section 9.4.4.4

- GOV5: Efficient national policy on IPR and enforcement laws which can promote UIC (university, industry)
- GOV6: The existence of an efficient venture capital which can promote UIC (university, industry)
- GOV7, GOV13, GOV14, GOV15, GOV18: (see Section 10.3.5)
- GOV8: High degree of intermediary involvement which can promote UIC (university, industry)
- GOV9: Efficient cluster formation which can promote UIC (university, industry)
- GOV10: Brain drain which can impede UIC (university, industry)
- GOV11: Effective privatisation policy which can promote UIC (industry)
- GOV12: Degree of government monopolies in market which can impede privatisation process (industry) – see Section 9.5.5.4
- GOV16: Improving political situation and Iranian entry to the WTO which can motivate companies to collaborate with universities (industry)
- GOV17: Increasing embargoes imposed by the West which can motivate companies to collaborate with universities (industry)
- GOV19: Efficient government programmes to enhance awareness/training for entrepreneurial activities which can promote UIC (university, industry)

9.8 FACTOR GROUPINGS IMPACT ON UIC ACTIVITIES

This section summarises the impact of five factor grouping on motivation of individuals within universities to collaborate with companies, motivation of companies to collaborate with universities, UIC performance, and motivation of universities to collaborate with industry. The summary of this is depicted in Figure 9.3.

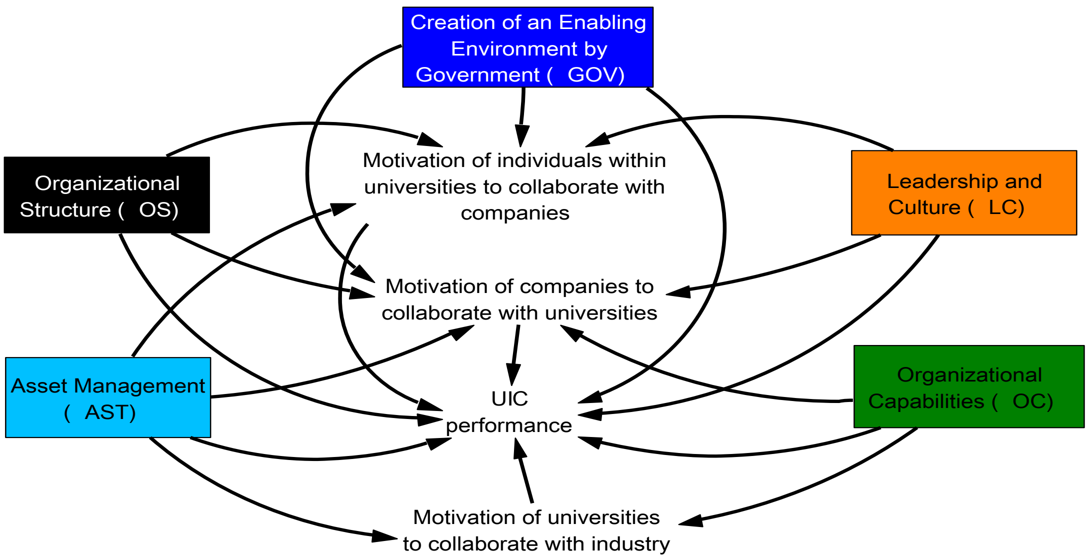


Figure 9.3: Factor groupings impact on UIC activities

9.9 DEVELOPING SCENARIO THEMES

At this stage several perspectives or scenario themes based on the findings need to be developed. Events from the scenario logic were selected and reorganized into several scenario themes. A large number of scenario themes/policy pathways could be developed at this stage. These themes range from a significantly backward future to an evolutionary future of the country. This research focuses on the policy planning framework necessary to optimize the UIC contribution for Iran to develop, i.e. to consider the conditions to create an aspirational but pragmatic scenario rather than optimistic, sub-optimal or worse-case ones (see Section 8.7.2.5).

Based on consideration of these criteria and in order to be more logical in the process of selecting scenario themes (Ward and Schrierfer, in Fahey and Randall, 1998), the procedures of special metrics were followed (e.g. global competitiveness index, 2008; Triple Helix I, II, III; National systems of innovation including Passive NLS, Active NLS and NIS) which cover all the related criteria for economic development. The logic behind using these metrics was to limit scenario themes to those considered pertinent to the evolutionary stages of development. As a result of using these metrics, three preliminary scenario themes emerged.

Names were assigned to each scenario theme that symbolised its core conditions.

- **Scenario theme A:** Stagnation

This scenario theme is recognized as "stagnation" which means that the focus of this theme is on the factors from Section 9.7 that focus on the future of Iran (15 years) and assume that the future will resemble the current situation of the country with no changes. According to World Economic Forum (2008) countries at this stage of development has a weak position regarding efficiency enhancing factors, and innovation and sophistication factors.

- **Scenario theme B:** Efficiency driven

This scenario theme is recognized as “Efficiency driven” which means that the focus of this theme is on the factors from Section 9.7 that focus on the future of Iran and assume that the country will be in the position that well-developed the basic requirements and trying to promote some of the activities regarding efficiency enhancement stage of development. At this theme the country is ready to move to the next stage of economic development which is efficiency-driven economy. Based on the World Economic Forum (2008) countries at this stage of development has a better position regarding efficiency enhancing factors compared with the previous theme; but they still have a weak position in terms of innovation and sophistication factors.

- **Scenario theme C:** Innovation driven

This scenario theme is recognized as “Innovation driven” which means that the focus of this theme is on the factors from Section 9.7 that focus on the future of Iran and assume that the country will be in the position that well-developed basic requirements, have a good position regarding efficiency enhancement stage and trying to promote some of the activities regarding innovation stage of development. At this theme the country is ready to move to the next stage of economic development which is an innovation-driven economy. According to World Economic Forum (2008) this theme is related to those countries trying to develop innovation and sophistication factors including business sophistication. Countries at this stage of development have achieved an elevated position in terms of innovation and sophistication factors.

9.10 DISCERNING PATTERNS OF BEHAVIOUR

This step involves using these scenario themes in order to identify crucial events and factors which underpin the story of the selected theme. The five factor groupings are required to be set in accordance with the suggested transition patterns from the global competitiveness index report (2008); Triple Helix (I, II, III); National systems of innovation (including passive NLS, active NLS and NIS) which describes in detail the necessity of existence of every factor within these groupings in different stages of evolution. Many of these factors are common amongst different themes and only the strength of these factors differ through stage transitions (Wignaraja, 2003; Lee and Tunzelmann, 2005; Dzisah and Etzkowitz, 2008; World Economic Forum, 2008). Using these concepts and the outcomes of the analysis on the current state of Iran (see Chapter 2), all of the critical factors necessary for economic development were found in Iran albeit in a primitive and incoherent state.

The next step (see Chapter 10) is how to project these factor changes over time and analyze how they could be link in relationships.

9.11 TWO INDUSTRY SECTORS (AUTOMOTIVE AND BIOTECHNOLOGY) COMPARISONS

Data analysis consists of bivariate tests of differences in order to validate whether any differences found between two industrial sectors selected in this research were statistically significant. As all responses are in the form of Likert scale scores, the non-parametric Mann-Whitney U test was employed (Levin, 1999; Keller and Warrak, 2000).

Several hypotheses were developed to test if there are any differences between these two sectors. The null hypothesis here is that there are no differences between biotechnology and automotive sector regarding different aspects of UIC activities.

1- There are no differences between these two sectors regarding the impact of the barriers to UIC.
2- There are no differences between these two sectors regarding the impact of the promoting factors on UIC.
3- There are no differences between these two sectors regarding the impact of the motivational factors on UIC.

9.11.1 Barriers to UIC

Analysis of the data using Mann-Whitney U test (see Appendix F) revealed that the differences between automotive and biotechnology sector regarding the impact of barriers to UIC were not significant. Therefore, by comparing these two sectors the hypotheses that each barrier has the same or similar impact on impeding UIC from both sectors' point of views were accepted.

9.11.2 Promotion of UIC

Analysis of the data using Mann-Whitney U test (see Appendix F) revealed that the differences between automotive and biotechnology sector regarding the impact of drivers to UIC were not significant. Therefore, by comparing these two sectors the hypotheses that each driver has the same or similar impact on promoting UIC from both sectors' point of views were accepted.

9.11.3 Motivation for UIC

Analysis of the data using Mann-Whitney U test (see Appendix F) revealed that the differences between automotive and biotechnology sector regarding the impact of motivational factors for UIC were not significant. Therefore, by comparing these two sectors the hypotheses that each motivational factor has the same or similar impact on motivation of these two sectors for collaboration with universities were accepted.

9.12 OTHER FINDINGS: UNIVERSITY AND INDUSTRY COMPARISONS

Data analysis consists of bivariate tests of differences in order to validate whether any differences found between the University and Industry samples were statistically significant. As all responses are in the form of Likert scale scores, the non-parametric Mann-Whitney U test was employed (see Section 8.7.2.3) (Levin, 1999; Keller and Warrak, 2000).

Several hypotheses were developed to test if there are any differences in the university and industry sample. The null hypothesis here is that there are no differences between universities and industry regarding different aspects of UIC activities.

1- There are no differences between university and industry's views regarding the impact of the barriers to UIC.
2- There are no differences between university and industry's views regarding the impact of the promoting factors on UIC.
3- There are no differences between university and industry's views regarding the impact of the factors on the probability of renewing contracts.
4- There are no differences between university and industry's views regarding the impact of the motivational factors on UIC.
5- There are no differences between university and industry's view about the degree of uncertainty they perceived regarding the future course of particular factor that has an impact on the UIC process.

Results of testing these hypotheses are available in Appendix H.

CHAPTER 10

ANALYSIS OF INTERVIEWS: CONSTRUCTING THE DYNAMIC SYSTEMS MODEL OF UIC

10.1 INTRODUCTION

The analysis of the interview data is structured as follows:

1- Demographic information of respondents
2- Constructing unified Dynamic Systems Model (DSM): A policy neutral model of a UIC system

The second step involves the process of constructing the unified Dynamic Systems Model (DSM) which is used as a platform to develop three scenario scripts.

10.2 BACKGROUND OF RESPONDENTS

To develop informed views of the current and future direction of UIC in Iran, a group of the most knowledgeable professionals in the case fields of the study were selected for interviews. Thirty two respondents from university, industry and government ministries participated in this study; eleven from the university side, nine from the industry side and twelve from government ministries located in Tehran and Mashhad. Details of each category are described below:

10.2.1 Academic side

As mentioned earlier in this study four universities were chosen from the two provinces of Khorasan-Razavi and Tehran. According to the Ministry of Science, Research and Technology reports, these universities are active in both Biotechnology and Automotive related research and these four universities are recognized as the main pillars of the

Biotechnology and Automotive clusters in these two regions (Ministry of Science, Research and Technology, www.msrt.ir, 2001). Their structure are described in Appendix B.

Of the Four universities considered in this research, two (Tehran university and Sharif University) are located in Tehran (both are public universities); the other two (Ferdowsi university and Azad university) are located in Mashhad (the former is public and the latter is a private university). From the eleven professors who participated in this study, three of them are from Metallurgy engineering groups, two are from mechanical engineering departments, and six are from Biotechnology-related departments. Six of these professors also held senior administrative positions in their universities and three of them were part of the top management of TTO in their institutions. Details of these participants are shown in Table 10.1.

	Position	**Department**	**University**
1	Assistant Professor, former manager of TTO	Metallurgy Department	Azad University of Mashhad
2	Professor of Metallurgy, Director of the Office of Entrepreneurship and Intellectual Properties	Metallurgy Department	Ferdowsi University of Mashhad
3	Assistant Professor, Head of Industry Liaison Office in Faculty of Engineering	Mechanical Engineering	Ferdowsi University of Mashhad
4	Professor, Manager of Industry Liaison Office	Mechanical Engineering	Sharif University of Technology
5	Assistant Professor, Manager of scientific relation between university and society	Metallurgy Department	Tehran University
6	Associate Professor, Vice president for research	Biotechnology	Ferdowsi University of Mashhad
7	Professor, Former Vice president for research	Faculty of Pharmocognosy & Biotechnology	Ferdowsi University of Mashhad
8	Professor, Manager of research and technology development	Faculty of Pharmocognosy & Biotechnology	Ferdowsi University of Mashhad
9	Associate Professor, Manager of incubation centre	Faculty of Pharmaceutical Chemistry Department	Tehran University
10	Assistant Professor, former Manager of research and technology development	Biotechnology Research Department	Sharif University of Technology
11	Assistant Professor	School of Biology Department of Molecular Biotechnology and genetic engineering	Azad University of Mashhad

Table 10.1: Respondents from academic side

10.2.2 Industry side

Nine companies were considered in this research; four located in Tehran and the other five in Mashhad. These two regions were chosen due to their identified high potential for cluster formation in both biotechnology and automotive related areas (Ministry of Industry and Mines Portal, http://www.mim.gov.ir/).

From the nine companies which participated in this study, four of them are active in automotive-related industries and five of them active in Biotechnology-related fields. All respondents had key positions in their institutions, represented at the levels of CEO and R&D manager. Six of these can be classified as SMEs and three of them as large companies. Six of these companies were private, one of them was public and two of them were public companies in the process of privatisation (Table 10.2).

	Position	Category of Industry	Region	Number of Employees	Ownership
1	CEO, Manufacturer of automotive parts and other industrial rubber products	Automotive-related	Mashhad	More than 250	Private
2	CEO	Automotive Manufacturer	Mashhad	More than 250	Public/ Private
3	CEO	Automotive related	Tehran	Between 50 and 250	Private
4	Former CEO and Member of the Board of Directors	Automotive	Tehran	Between 50 and 250	Public
5	Strategic studies officer, Managing Director's authority to QC, QA, R&D, and RA	Bio-Pharmaceutical	Mashhad	More than 250	Public/ Private
6	CEO	Biotechnology	Mashhad	Less than 50	Private
7	R&D Manager	Biomedical	Mashhad	Between 50 and 250	Private, Multinational
8	CEO	Biotechnology	Tehran	Between 50 and 250	Private
9	R&D Manager	Bio-Pharmaceutical	Tehran	Less than 50	Private

Table 10.2: Respondents from industry side

10.2.3 Government Ministries

Twelve people from different but related government ministries also participated in the study. They were chosen from five ministries connected to the process of transferring technology from universities to industry for the biotechnology and automotive sectors. Eight respondents were more aware of the industry environment, four of them were more related to the university environment and one of the respondents also had a key position in one of the vice presidency posts in Tehran, and was aware of both university and industry activities, details of respondents are shown in Table 10.3.

	Position	Ministries
1	Director of Research and Education	Ministry of Industry and Mines (*MIM), Tehran
2	Vice president of planning and technology development	Ministry of Industry and Mines, Tehran
3	Director of planning and industrial development	Ministry of Industry and Mines, Tehran
4	Vice President in small industries, Iran Small Industries and Industrial parks organization	Ministry of Industry and Mines, Mashhad
5	Vice President in technology development, Iran Small Industries and Industrial parks organization	Ministry of Industry and Mines, Mashhad
6	Manager of technology development Department, Iran Small Industries and Industrial parks organization	Ministry of Industry and Mines, Mashhad
7	Vice president in Research and Development	Ministry of JIHAD-E-Agriculture, Mashhad
8	President of Khorasan Razavi Province Branch	Ministry of Labour and Social Affairs, Mashhad
9	Vice president of Research	Ministry of Medical Sciences, Tehran
10	Management of Intellectual Property Rights	Ministry of Science, Research and Technology (**MSRT) (Iran Research Organization for Science and Technology), Tehran
11	Director of supporting Research and Technology	Ministry of Science, Research and Technology (Iran Research Organization for Science and Technology), Tehran
12	Manager of Technology Development Department	Vice Presidency In Science and Technology(Researchers' Supporting Foundation), Tehran

Table 10.3: Respondents from government side

*MIM=Ministry of Industry and Mines **MSRT: Ministry of Science Research and Technology

10.3 CONSTRUCTING THE UNIFIED DYNAMIC SYSTEMS MODEL (DSM)

10.3.1 Introduction to DSM

Although the systems model output from the survey analysis (see Chapter 9) has confirmed and clarified the conceptual model (see Section 7.13), this model lacks the connective complexity of the real-world problem as illustrated in the conceptual model. The Systems Model output from the survey analysis is a simple map of the direct forces on the primary factor groups. This model requires further development to incorporate the known second and third order connections (conceptual model), system archetypes including feedback loops, and indirect (but important) features. These developments can be considered as adding essential dynamic features to the model.

According to Lee and Tunzelmann (2005) the dynamism of a system depends on the availability of feedback (interaction), without which, the system is static. In systems which develop feedback mechanisms, the behaviour of an entity which includes elements, attributes and relationships changes over time. The intention in developing a dynamic model is to understand possible feedback loops in the system. Such a dynamic model is a more accurate reflection of the real-world UIC system and is intended to provide a more accurate predictive capability of any policy or other changes to the system elements. These policy change sets are considered as scenarios in the current research design.

The semi-structured interview instrument contained two distinct components. Part 1 which was used to develop Dynamic Systems Model (DSM), and Part 2 was a set of what-if scenario questions to obtain future insight to policy changes.

10.3.2 Logical map of system elements to interview instruments

Part 1 uses the systems model outcomes from survey analysis (see Chapter 9, Figure 9.2) and the conceptual model (see Section 7.13); a logical map of the necessary inquiries was used to produce a semi-structured interview instrument to develop a dynamic perspective of a UIC system. This logical map is shown in Figure 10.1. Figure 10.1 consists of all the forces identified in Figure 9.2 and also it incorporates all the second and third order impact forces in Figure 7.2 (these connections are shown in black arrows). At this stage, the intention was to test all connections in a conceptual model and also include those that were not addressed in the survey.

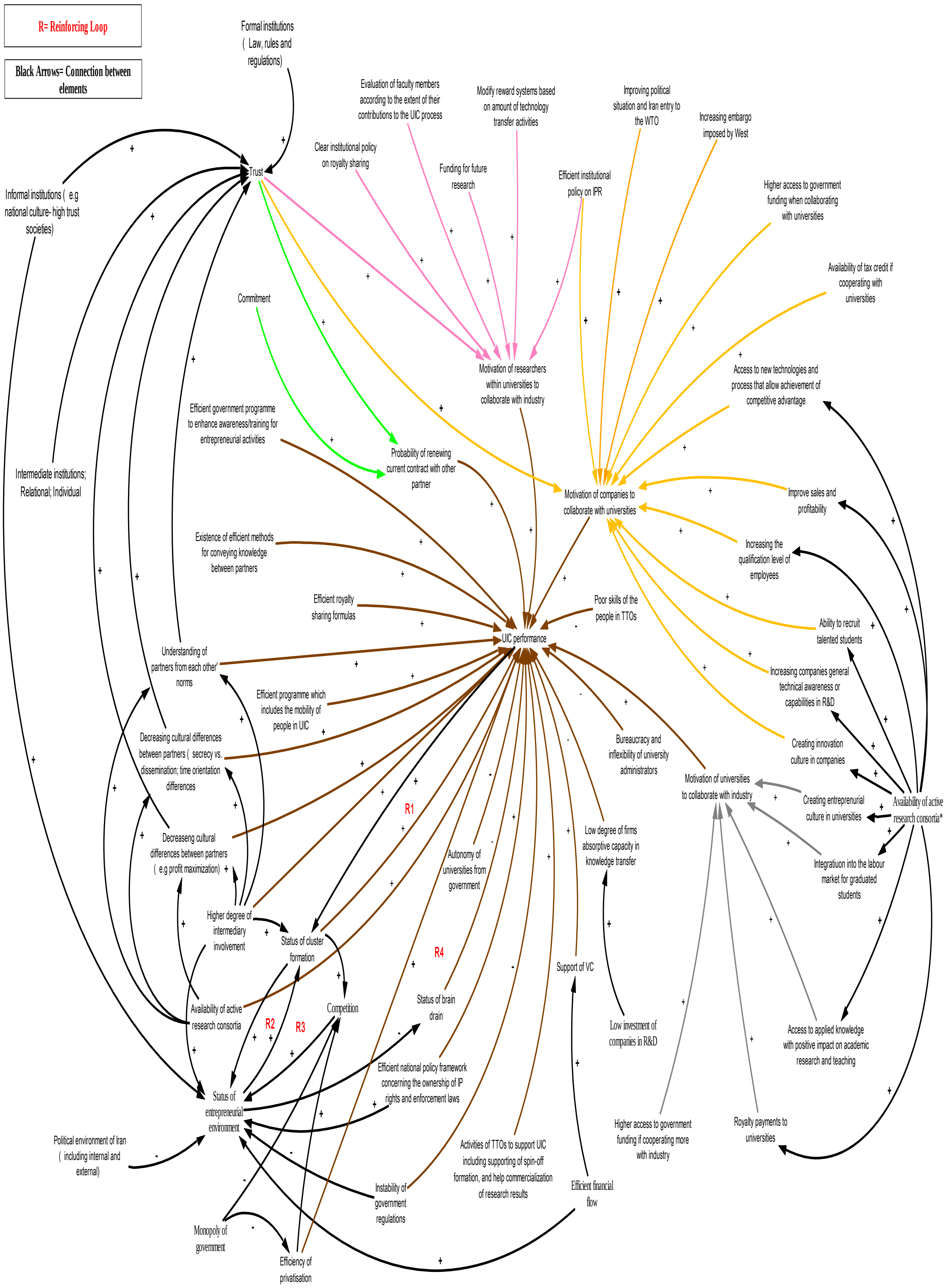


Figure 10.1: Logical map of system elements to interview instruments

10.3.3 Constructing the DSM

Questions were organized based on a set of 5 identified factor groupings:

- Organizational Structures to Coordinate and Support Partnerships (OS)
- Asset Management (AST)
- Leadership and Culture (LC)
- Organizational Capabilities (OC)
- Creation of an Enabling Environment by Government (GOV)

Some questions were also added based on the literature (conceptual model) to find out the relationships between the forces within the same category or between categories. Respondents were also free to add other linkages to the system in order to make it compatible with their knowledge of the Iranian case. Therefore, there was a possibility of interaction between categories (sub-systems) as well.

The DSM which is formed by developing a series of influence diagrams (as a result of interviews) is then used as a platform for developing different future transition scenarios for Iran. In order to design this platform, all the questions designed for developing DSM had a neutral direction (see Appendix D). The DSM can be used by industry, university and government bodies to provide a general understanding of the relationships between the factors that form the innovation system. Through an understanding of the details of each of these factors and interactions, opportunities are created to study all the crucial elements involved in a system of innovation and to analyze the likely influences they have on each other as well as on the whole system.

Central to the research question in this thesis, are considerations of what institutions, interactions and driving forces are associated with the structure of UIC in Iran and how can these be modelled through a series of influence diagrams. Although it is also possible to analyze the effect of changing the rates of interaction of some key variables for UIC collaboration, these quantitative model elements are not considered- suited to the behavioural nature of many of the system elements e.g. trust and culture.

10.3.4 Calibration of the DSM

Although each interviewee constructed his/her own version of a DSM and developed three scenarios based on their version; for the combined analysis and consequently modelling of all interviews (including scenario development), it was essential to calibrate five sub-systems of the model (including the DSM and scenarios) based on a high level of agreement amongst the respondents. This calibrated model also captures all the forces and their connections including those that appeared during the interviews. In the majority of the system features, the interactions among forces in the DSM were coincident with the literature, but additional features were discovered in the current case analysis. The similarities and differences are discussed where applicable. The calibrated version of the DSM constitutes a unique outcome of this research.

10.3.5 Sub-systems of the model

The present modelling approach includes five sub-systems. The first one, referred to as the ‘Organizational Structure sub-system’ (OS), responsible for coordinating and supporting partnerships. The second is the ‘Asset Management sub-system’ (AST) which is responsible for commercializing the research results from university and creating opportunity for the future career of the students. The third is ‘Leadership and Culture sub-system’ (LC) involves the type of leadership in the considered organizations (universities, industry and government) and the cultural differences that exist between these three spheres. It also considers elements related to national culture. The forth is ‘Organizational Capabilities sub-system’ (OC) which has responsibility to enhance the level of organizational capabilities, and finally the last is ‘Creation of an Enabling Environment by Government sub-system’ or alternatively called ‘Government sub-system’ (GOV) which is responsible for creation of an enabling environment for both universities and companies in order to increase performance of UIC and promote an entrepreneurial environment in the country.

This section introduces the major elements (forces) in each sub-system. The majority of these elements within the five sub-systems are adopted from the analysis of the survey (see Section 9.7). Other critical forces were obtained from the results of the first part of the interviews, when respondents were asked to construct their DSM. These were added to each sub-systems' category. These forces are marked with an asterix (*) in each table. The criteria to include these additional forces as a critical elements of the DSM was a large agreement among interviewees (>6 people) regarding the importance of these elements. Therefore, at this stage the critical forces of each sub-system are shown from Tables 10.4 to 10.8. These elements are codified based on each sub-system's category.

Elements of Sub-System 1: Organizational Structure to Coordinate and Support Partnerships (OS)	
• **OS1**: Efficiency of institutional policy on IP rights (university, industry, government) • **OS2**: The structure of technology transfer office in universities (university, government) • **OS3**: Efficiency of institutional policy on royalty sharing (university, government) • **OS4**: Availability of programme which evaluate faculty members based on their extent of relations with industry (university, government)	• **OS5**: Efficiency of methods for conveying knowledge between universities and industry (university, industry) • **OS6**: Degree of bureaucracy and inflexibility of university administrators (university, industry) • **OS7**: Efficiency of programmes which includes mobility of people between partners (university, industry, government)

Table 10.4: Elements of sub-system 1: Organizational Structure to Coordinate and Support Partnerships (OS)

Elements of Sub-System 2: Asset Management (AST)	
• **AST1**: Status of reward system to reward technology transfer activities of researchers (university) • **AST2**: Availability of various skills in technology transfer offices (university, industry, government) • **AST3**: TTOs Spin-off creation support strategy (university) • **AST4**: The activities of TTOs to commercialize the technology including: Strategy of TTOs to market the technology (university),	TTOs activities to identify technology with commercial potential (university), Appropriateness of TTO's activities to package the technology appropriately (university) • **AST5**: Amount of royalty payments to universities (university, government) • **AST6**: Integration into the labour market for graduated students (university, government) • **AST7**: Amount of additional funding for individual future research (university, government) • **AST8:** Ability of companies to recruit talented students (industry, government)

Table 10.5: Elements of sub-system 2: Asset Management (AST)

Elements of Sub-System 3: Leadership and Culture (LC)	
• **LC1:** Degree of cultural differences in university-industry collaboration(secrecy vs. dissemination) (university, industry, government) • **LC2:** Degree of cultural differences in university-industry collaboration (time orientation differences) (university, industry, government) • **LC3:** Degree of cultural differences in university-industry collaboration (profit maximization) (university, government), • **LC4:** Degree of lack of understanding of industry norms by university people (industry, university, government)	• **LC5**: Degree of lack of understanding of university norms by industrial people (university, government) • **LC6**: Degree of trust formation between partners (university, industry, government) • **LC7**: Degree of commitment between partners (university, industry) • ***LC8:** Team working and cooperation culture (industry, university, government- added from interview's results) • ***LC9:** Style of management in SMEs (university, industry, government- added from interview's results) • ***LC10:** Pace of trust formation between strangers (university, industry, government- added from interview's results)

Table 10.6: Elements of sub-system 3: Leadership and Culture (LC)

*These elements are added to the results of quantitative analyses during interviews

Elements of Sub-System 4: Organizational Capabilities (OC)	
• **OC1:** Performance of research consortia and other similar kind of mechanisms for collaboration (university, industry, government). • **OC2**: Degree of firms' absorptive capacity on knowledge transfer (industry, university, government) • **OC3**: Level of university access to applied knowledge with positive impact on research and teaching (university) • **OC4:** Probability of generating entrepreneurial culture in universities (university)	• **OC5**: Level of firms' capabilities in R&D (industry) • **OC6**: Degree of generating innovation culture in companies (industry) • **OC7**: Degree of achieving competitive advantage for companies (industry) • **OC8:** Status of qualification level of employees in companies (industry) • **OC9:** Ability of universities to improve sales and profitability of industry (industry)

Table 10.7: Elements of sub-system 4: Organizational Capabilities (OC)

Elements of Sub-System 5: Creation of an Enabling Environment by Government (GOV)	
• **GOV1**: Degree of access to government funding when collaborating with partner (university, industry, government) • **GOV2**: Efficiency of reward and incentive systems for innovative firms when collaborating with universities (industry, government) • **GOV3**: Degree of stability of government regulations (university, industry, government) • **GOV4**: Degree of university autonomy from the government (university, government) • **GOV5**: Efficiency of national policy on IP rights and enforcement of laws (university, industry, government) • **GOV6**: Efficiency of venture capital (university, industry, government) • ***GOV7**: Status of government financing support system (university, industry, government - added from interview's results) • **GOV8**: Performance of intermediary agents like science and technology parks and incubators (university, industry, government) • **GOV9**: Status of cluster formation and favourability of entrepreneurial environment (university, industry, government) • **GOV10**: Status of brain drain (university, industry, government), • **GOV11**: Degree of efficiency of privatisation policy (industry, government)	• **GOV12**: Degree of government monopolies in market (industry, government) • ***GOV13**: Availability of databases for entrepreneurs (university, industry, government - added from interview's results) • ***GOV14:** Amount of government natural resources income (university, industry, government - added from interview's results) • ***GOV15:** Degree of government value people creativity (university, industry, government - added from interview's results) • **GOV16:** Political situation status and probability of entry to the WTO (industry, government) • **GOV17:** Degree of embargos imposed (industry, government) • ***GOV18:** export opportunities and the risk of investment (industry, government - added from interview's results) • **GOV19:** Efficiency of government programmes to enhance awareness/training for entrepreneurial activities (university, industry, government) • ***GOV20:** Degree of corruption in government (university, industry, government- added from interview's results) • ***GOV21:** Degree of trust formation between entrepreneurs and government (university, industry, government- added from interview's results)

Table 10.8: Elements of sub-system 5: Creation of Enabling Environment by Government (GOV)

*These elements are added to the results of quantitative analyses during interviews

10.3.6 Results: connections between elements of the same sub-system and other sub-systems in the DSM

The interactions between all forces included in the constructed DSM are provided in this section (both in table and diagram format). This section also provides the structure of the five sub-systems of the DSM. The relevant coding was assigned to each force in order to track the relationships between forces. Stakeholders in the model UIC are also shown in the coding. For example, university is shown by (U), Industry by (I), and government by (G). Tables 10.9 to 10.13 categorize each force in the DSM based on: description for each force, connection of each force to other forces (elements) and components in the same sub-system or in the other sub-systems of the DSM. It also shows the number of respondents who identified specific connection between elements. A number of loops were identified during interviews. These loops are shown in Tables 10.9 to 10.13. A list of all loops is in Appendix E.

10.3.6.1 Organizational Structure sub-system (OS)

Table 10.9 includes results related to each element of the Organizational Structure sub-system and shows the way each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td rowspan="3">OS1</td><td rowspan="3">“Efficiency of institutional policy on IP rights for universities that consider issues relating to IP ownership with collaborative research programme and/or other contractual agreement with various partners”</td><td colspan="2">LC6 (11U, 9I, 12G) (Figure 10.7)
OC1 (11U, 9I, 12G) (Figure 10.7)
GOV8 (11U, 9I, 12G) (Figure 10.7)</td></tr>
<tr><td>Motivation of companies to collaborate with universities (7I, 9G)</td><td>UIC performance (7I, 9G) (Figure 10.2)</td></tr>
<tr><td>Motivation of individuals within universities to collaborate with companies (11U, 4G)</td><td>UIC performance (11U, 4G) (Figure 10.2)</td></tr>
<tr><td colspan="4">*Additional comments:

(2I): Degree of motivation of companies is not heavily influenced by efficiency of institutional policy on IPR. Companies do not rely only on this kind of contract and in addition to this; they also need a form of internal contract to be signed by both partners.</td></tr>
<tr><td>OS2</td><td>“The structure of technology transfer offices in universities and degree of availability of multidisciplinary team including legal, IP, business development and financial issues expert”</td><td colspan="2">UIC performance (11U, 4G) (Figure 10.2)
OS1 (8U, 2G) (Figure 10.2)
OS3 (8U, 2G) (Figure 10.2)
AST3 (6U) (Figure 10.7)
AST4 (6U) (Figure 10.7)
LC7 (3U, 1G) (Figure 10.7)</td></tr>
</table>

Table 10.9: Organizational Structure sub-system and its related elements and connections

Coding	Description	Connections and weights	
OS3	"Efficiency of institutional policy on royalty sharing"	Motivation of individuals within universities (11U, 4G)	UIC performance (11U, 4G) (Figure 10.2)
OS4	"Availability of programme which evaluate faculty members based on their extent of relations with industry"	Motivation of individuals within universities (11U, 4G)	UIC performance (11U, 4G) (Figure 10.2)
OS5	"Efficiency of methods for conveying knowledge between universities and industry e.g. frequency of site visits by industry and plant visits by researchers"	UIC performance (11U, 9I) (Figure 10.2)	
***Additional comments:** (11U, 9I): The frequency of site visits by industry and plant visits by researchers during technology transfer process facilitate the degree of conveying tacit knowledge. (5U, 7I): Availability of IPR contract only facilitates the transfer of explicit knowledge. Therefore, the degree of efficiency of methods for conveying knowledge between universities and industry will have an impact on the degree of transferring tacit knowledge as well.			
OS6	"Degree of bureaucracy and inflexibility of university administrators"	UIC performance (11U, 9I) (Figure 10.2) OC1 (5U, 7I) (Figure 10.7) GOV8 (5U, 7I) (Figure 10.7)	
***Additional comments:** (3U, 4I): The degree of bureaucracy will have a direct impact on companies' decision whether to follow or terminate the potential technology transfer activities with universities in the future.			
OS7	"Efficiency of programmes which includes mobility of people between partners"	UIC performance (9U, 6I, 7G) (Figure 10.2) LC1 (5U, 3I, 5G) (Figure 10.7) LC2 (5U, 3I, 5G) (Figure 10.7) LC3 (5U, 3I, 5G) (Figure 10.7) LC4 (5U, 3I, 5G) (Figure 10.7) LC5 (5U, 3I, 5G) (Figure 10.7)	

Table 10.9 (continued): Organizational Structure sub-system and its related elements and connections.

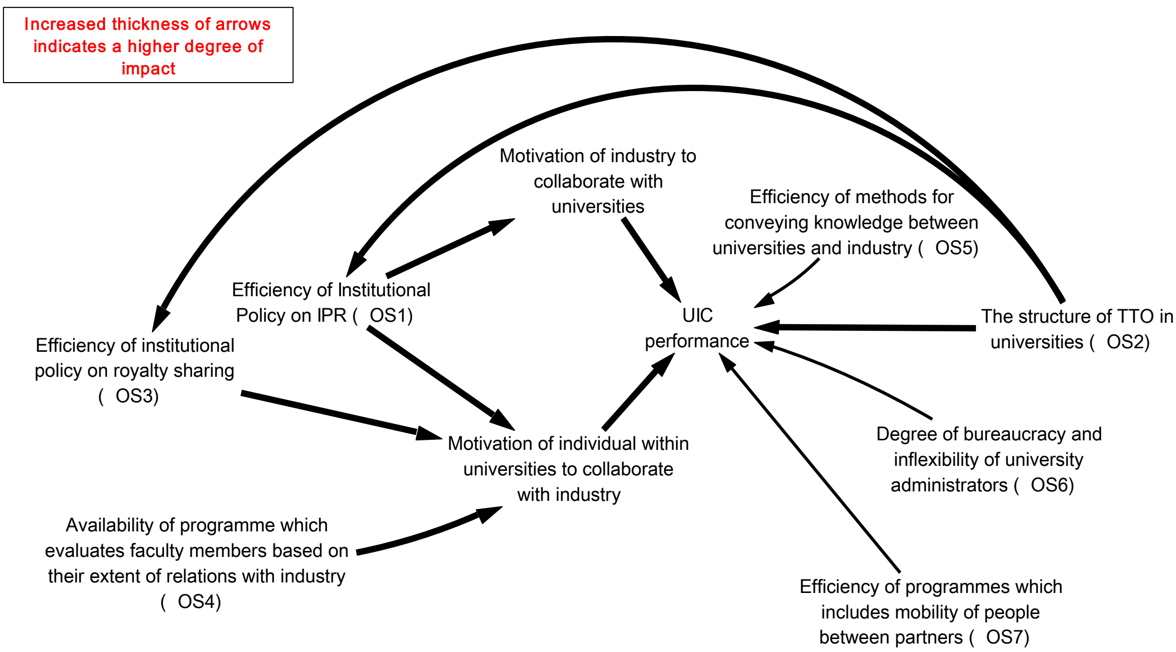


Figure 10.2: Organizational Structure sub-system: constructed from the results in Table 10.9

10.3.6.2 Asset Management sub-system(AST)

Table 10.10 includes results related to each element of the Asset Management sub-system and shows the way each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>AST1</td><td>“Status of reward system to reward technology transfer activities of researchers”</td><td>Motivation of individuals within universities (11U)</td><td>UIC performance (11U) (Figure 10.3)</td></tr>
<tr><td>AST2</td><td>“Availability of various skills in technology transfer offices e.g. marketing and negotiation skills”</td><td colspan="2">UIC performance (11U, 9I, 12G) (Figure 10.3)</td></tr>
<tr><td colspan="4">*Additional comments:

(8U, 4I, 6G): Availability of marketing and negotiation skills in the TTOs has an impact on the degree of connection between universities and industry. Degree of awareness from potential partner’s capabilities is also influenced by availability of such a skill. The degree of trust formation between partners in collaboration is also heavily influenced by the negotiation skills of the people in these offices.</td></tr>
<tr><td>AST3</td><td>“TTOs Spin-off creation support strategy”</td><td colspan="2">UIC performance (11U) (Figure 10.3)</td></tr>
<tr><td colspan="4">*Additional comments:

(4U): The appropriateness of strategy of these offices to support researchers during development phase of their idea and also the degree of connectedness of these offices to potential venture capitals are the vital elements which define the degree of success of spin-off formation from universities and overall UIC performance.</td></tr>
<tr><td>AST4</td><td>“The activities of TTOs to commercialize the technology including: Strategy of TTOs to market the technology, TTOs activities to identify technology with commercial potential, Appropriateness of TTOs activities to package the technology appropriately”</td><td colspan="2">UIC performance (11U) (Figure 10.3)</td></tr>
<tr><td colspan="4">*Additional comments:

(9U): Ability of TTOs to identify the technology with a commercial potential have an impact on the degree of success of commercialization process; because it may lead to overestimation or underestimation of the commercialization success. Also the style of presenting the technology as to attract potential companies is another major issue which was raised by seven professors. Nine respondents commented that although the marketing ability is the main issue and can be followed in different ways; however, the ability of TTOs to identify the companies which are interested and need the technology during product development has an impact on the degree of success of commercialization process.</td></tr>
<tr><td>AST5</td><td>“Amount of royalty payments to universities”</td><td>Motivation of universities (9U, 4G)</td><td>UIC performance (9U, 4G) (Figure 10.3)</td></tr>
<tr><td colspan="4">*Additional comments:

(2U- administration section): Motivation of universities to collaborate with companies based on amount of royalty payments available for them is heavily influenced by the extent of government budget which is allocated to universities. If the difference between government budget and royalty payments is high, then there will be no motivation for universities. In other case where this difference is low, the level of motivation is influenced by the amount of royalty payments to universities.</td></tr>
</table>

Table 10.10: Asset Management sub-system and its related elements and connections

Coding	Description	Connections and weights	Coding
AST6	"Integration into the labour market for graduated students "	Motivation of universities (10U, 4G)	UIC performance (10U, 4G) (Figure 10.3)
AST7	"Amount of additional funding for individual future research"	Motivation of individuals within universities (11U, 1G)	UIC performance (11U, 1G) (Figure 10.3)
***Additional comments:** (3U): Amount of additional funding for individual future research has a very high impact on the level of motivation of researchers especially in the situation that researchers want to pursue their research individually.			
AST8	"Ability to recruit talented students"	Motivation of companies (6I, 9G)	UIC performance (6I, 9G) (Figure 10.3)
***Additional comments:** (3I): Their degree of motivation is not influenced by their ability to recruit talented students. Based on their experience, they need to train them and in many circumstances because of lack of experience of these students they make a problem for them. Therefore, they prefer searching for those who already have enough industrial experience.			

Table 10.10 (continued): Asset Management sub-system and its related elements and connections.

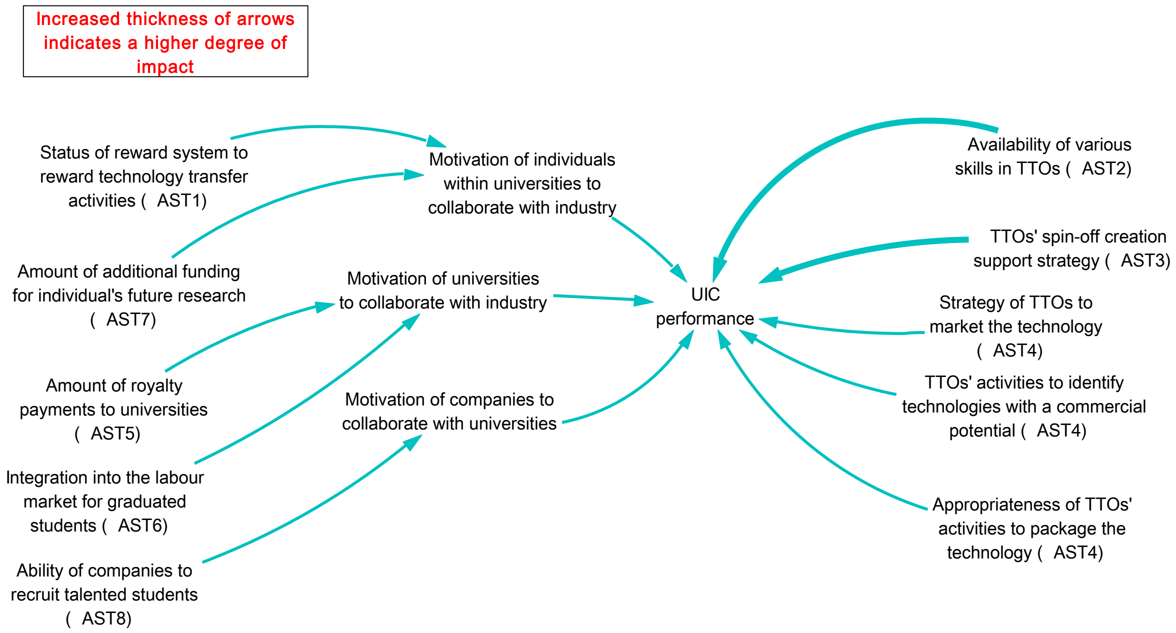


Figure 10.3: Asset Management sub-system: constructed from the results in Table 10.10

10.3.6.3 Leadership and Culture sub-system(LC)

Table 10.11 includes results related to each element of the Leadership and Culture sub-system and shows the way each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>LC1</td><td>“Degree of cultural differences in university-industry collaboration (secrecy vs. dissemination)”</td><td colspan="2">LC6 (11U, 9I, 12G) (Figure 10.4)

UIC performance (11U, 9I, 12G) (Figure 10.4)</td></tr>
<tr><td colspan="4">*Additional comments:

(2U, 3G): University culture is heavily influenced by dissemination of knowledge and their contribution to the knowledge of society. Also the degree of promotion status of all researchers is mainly based on the amount of their publications.</td></tr>
<tr><td>LC2</td><td>“Degree of cultural differences in university-industry collaboration (time orientation differences)”</td><td colspan="2">LC6 (11U, 7I, 12G) (Figure 10.4)

UIC performance (11U, 7I, 12G) (Figure 10.4)</td></tr>
<tr><td colspan="4">*Additional comments:

(3I): Degree of success of the project depends on the commitment of the universities to finish the project on time. Therefore, the degree of trust to partner depends on the extent they respect each other time frame and in this case universities are notorious. However, two people in industry side who did not agree to this statement declared that, as long as university people are committed to their work, UIC performance is not influenced by time orientation differences between partners.</td></tr>
<tr><td>LC3</td><td>“Degree of cultural differences in university-industry collaboration (profit maximization)”</td><td colspan="2">LC6 (11U, 12G) (Figure 10.4)

UIC performance (11U, 12G) (Figure 10.4)</td></tr>
<tr><td colspan="4">*Additional comments:

(11U, 12G): This issue has an influence on the degree of trust formation between partners as well. Two respondent from university side commented that sometimes the degree of willingness of the companies to maximise their profit have an influence on the degree of their commitment to university partners and the degree of obligation to their contract.</td></tr>
<tr><td>LC4</td><td>“Degree of lack of understanding of industry norms by university people”</td><td colspan="2">LC6 (8U, 9I, 12G) (Figure 10.4)
UIC performance (8U, 9I, 12G) (Figure 10.4)</td></tr>
<tr><td colspan="4">*Additional comments:

(3U): The length of working experience in industry by university people has an impact on this process. Therefore, from the point of views of those academics who had a working experience in industry and already understand the industry norms, the degree of lack of understanding of industry norms by university people is not an important factor to influence UIC performance.</td></tr>
<tr><td>LC5</td><td>“Degree of lack of understanding of university norms by industrial people”</td><td colspan="2">LC6 (11U, 12G) (Figure 10.4)

UIC performance (11U, 12G) (Figure 10.4)</td></tr>
<tr><td rowspan="3">LC6</td><td rowspan="3">“Degree of trust formation between partners”</td><td>Motivation of companies (9I, 9G)</td><td>UIC performance (9I, 9G) (Figure 10.4)</td></tr>
<tr><td>Motivation of individuals within universities (11U, 4G)</td><td>UIC performance (11U, 4G) (Figure 10.4)</td></tr>
<tr><td>Probability of renewing contract in the future (11U, 9I)</td><td>UIC performance (11U, 9I) (Figure 10.4)</td></tr>
<tr><td rowspan="2">LC7</td><td rowspan="2">“Degree of commitment between partners”</td><td colspan="2">LC6 (3U, 5I, 1G) (Figure..)</td></tr>
<tr><td>Probability of renewing contract in the future (9U, 9I)</td><td>UIC performance (9U, 9I) (Figure 10.4)</td></tr>
<tr><td>LC8</td><td>“Team working and cooperation culture”</td><td colspan="2">OC1 (2U, 3I, 2G) (Figure 10.7)
GOV8 (2U, 4I, 2G) (Figure 10.7)
UIC performance (2U, 7I, 5G) (Figure 10.4)</td></tr>
<tr><td>LC9</td><td>“Style of management in SMEs”</td><td colspan="2">OC1 (4U, 2I, 3G) (Figure 10.7)
GOV8 (4U, 2I, 3G) (Figure 10.7)
UIC performance (6U, 2I, 3G) (Figure 10.4)</td></tr>
<tr><td>LC10</td><td>“Pace of trust formation between strangers”</td><td colspan="2">LC6 (3U, 5I) (Figure 10.4)</td></tr>
</table>

Table 10.11: Leadership and Culture sub-system and its related elements and connections

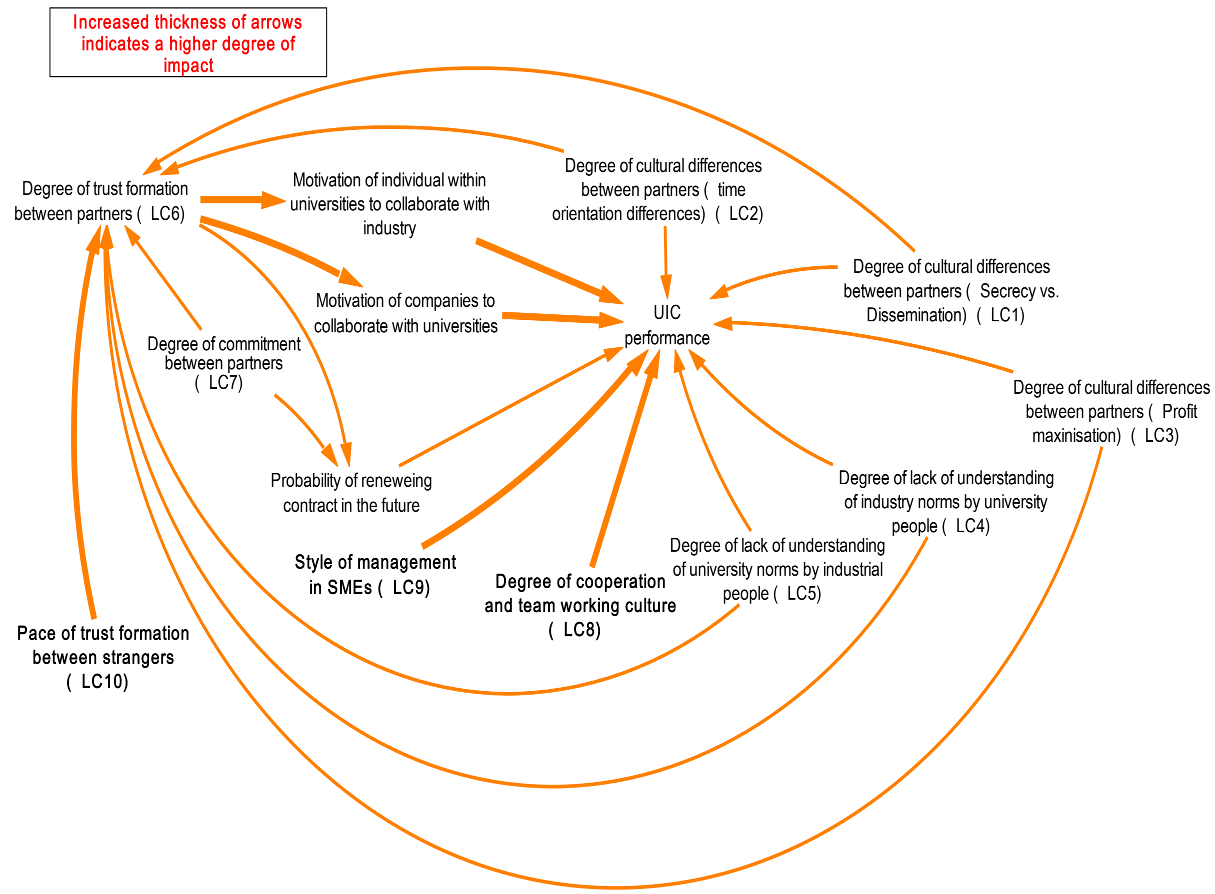


Figure 10.4: Leadership and Culture sub-system: constructed from the results in Table 10.11

10.3.6.4 Organizational Capabilities sub-system (OC)

Table 10.12 includes results related to each element of the Organizational Capabilities sub-system and shows the way each element links to other elements in the same sub-system or other sub-systems.

Coding	Description	Connections and weights	
OC1	"Performance of research consortia and other similar kind of mechanisms for collaboration (e.g. R&D contract or joint activities)"	AST5 (11U, 4G) (Figure 10.7) AST6 (11U, 4G) (Figure 10.7) AST7 (11U, 1G) (Figure 10.7) AST8 (9I, 9G) (Figure 10.7) LC1 (11U, 9I, 12G) (Figure 10.7) LC2 (11U, 7I, 12G) (Figure 10.7) LC3 (11U, 12G) (Figure 10.7) LC4 (8U, 9I, 12G) (Figure 10.7) LC5 (11U, 12G) (Figure 10.7) LC7 (3U, 5I, 1G) (Figure 10.7) OC2 (11U, 9I, 12G) (Figure 10.5) OC3 (11U) (Figure 10.5) OC4 (8U) (Figure 10.5) OC5 (9I) (Figure 10.5) OC6 (8I) (Figure 10.5) OC7 (8I) (Figure 10.5) OC8 (7I) (Figure 10.5) OC9 (7I) (Figure 10.5) GOV9 (5U, 3I, 3G) (Figure 10.7) UIC performance (11U, 9I, 12G) (Figure 10.5)	
OC2	"Degree of firms' absorptive capacity on knowledge transfer"	UIC performance (11U, 9I, 12G) (Figure 10.5)	
LOOPS	"UIC performance"	OC1 (23 people in the pool) (See Loops R3, R9) (Figure 10.5)	
OC3	"Level of university access to applied knowledge with positive impact on research and teaching"	Motivation of universities (11U)	UIC performance (11U) (Figure 10.5)
OC4	"Probability of generating entrepreneurial culture in universities"	Motivation of universities (8U)	UIC performance (8U) (Figure 10.5)
LOOPS	"UIC performance"	OC1 (7U) (See Loops R1, R2) (Figure 10.5)	
OC5	"Level of firms' capabilities in R&D"	Motivation of companies (9I)	UIC performance (9I) (Figure 10.5)
OC6	"Degree of generating innovation culture in companies"	Motivation of companies (8I)	UIC performance (8I) (Figure 10.5)
OC7	"Degree of achieving competitive advantage for companies"	Motivation of companies (8I)	UIC performance (8I) (Figure 10.5)
OC8	"Status of qualification level of employee in companies"	Motivation of companies (7I)	UIC performance (7I) (Figure 10.5)
OC9	"Ability of universities to improve sales and profitability of industry"	Motivation of companies (7I)	UIC performance (7I) (Figure 10.5)
LOOPS	"UIC performance"	OC1 (6I) (See Loops R4, R5, R6, R7, and R8) (Figure 10.5)	
LOOPS	"UIC performance"	OC1 (7U) (See Loops R22, R23, R25) (Figure 10.7) OC1 (4I, 8G) (See Loop R24) (Figure 10.7)	
LOOPS	"UIC performance"	OC1 (23 people in the pool) (See Loops R30, R31, R32, R44, R45, R46) (Figure 10.7) OC1 (19 people in the pool) (See Loops R36, R37, R38, R40) (Figure 10.7)	

Table 10.12: Organizational Capabilities sub-system and its related elements and connections

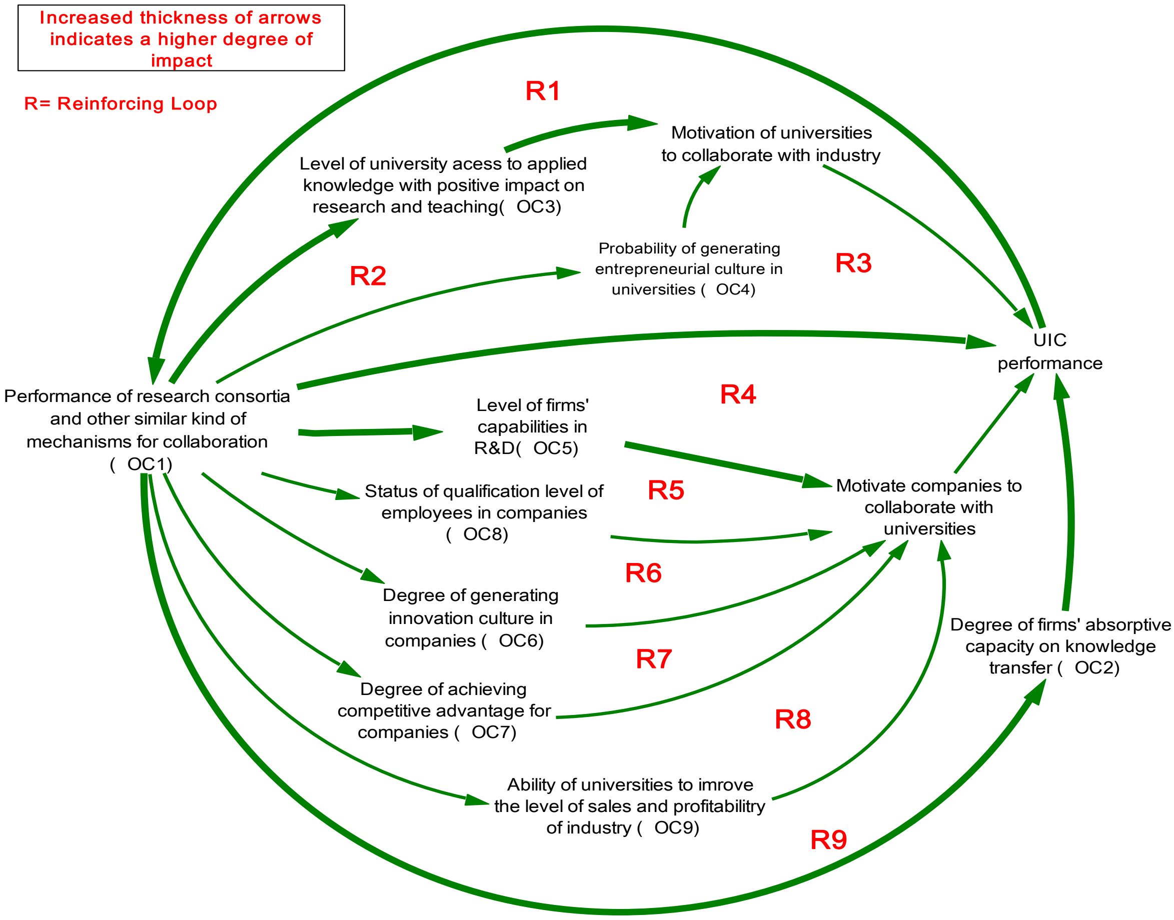


Figure 10.5: Organizational Capabilities sub-system: constructed from the results in Table 10.12

10.3.6.5 Government sub-system (GOV)

Table 10.13 includes results related to each element of the Government sub-system and shows the way each element links to other elements in the same sub-system or other sub-systems.

Coding	Description	Connections and weights		
GOV1*	"Degree of access to government funding by universities (changing university's allocated budget) when collaborating with companies"	Motivation of universities (11U, 4G)	UIC performance (11U, 4G)	**GOV1*** (7U, 3G); See Loop R12* (Figure 10.6)
GOV1	"Degree of access to government funding when collaborating with other partner"	Motivation of universities (11U, 4G)	UIC performance (11U, 4G)	**GOV1** (7U, 5I, 9G); See Loops R12, R14 (Figure 10.6)
		Motivation of companies(9I, 9G)	UIC performance (9I, 9G)	

Table 10.13: Government sub-system and its related elements and connections

Coding	Description	Connections and weights
GOV2	"Efficiency of reward and incentive systems for innovative firms when collaborating with universities"	Motivation of companies (8I, 9G) | UIC performance (8I, 9G) | **GOV2** (5I, 6G); See Loop R10 (Figure 10.6)
GOV3	"Degree of stability of government regulations regarding UIC"	GOV1* (11U, 9I, 12G) (Figure 10.6) GOV2 (9I, 9G) (Figure 10.6) UIC performance (11U, 9I, 12G) (Figure 10.6)
GOV4	"Degree of university autonomy from the government"	OS2 (6U, 2G) (Figure 10.7) UIC performance (11U, 4G) (Figure 10.6)
GOV5	"Efficiency of national policy on IP rights and strength of enforcement of laws"	UIC performance (11U, 9I, 12G) (Figure 10.6) OS1 (11U, 9I, 12G) (Figure 10.7) OC1 (11U, 9I, 12G) (Figure 10.7) GOV8 (11U, 9I, 12G) (Figure 10.6) GOV9 (11U, 9I, 12G) (Figure 10.6)
GOV6	"Efficiency of venture capital"	UIC performance (11U, 9I, 12G) (Figure 10.6) AST3 (6U) (Figure 10.7) GOV8 (11U, 9I, 12G) (Figure 10.6) GOV9 (11U, 9I, 12G) (Figure 10.6)
GOV7	"Status of government financing support system"	GOV6 (4U, 6I, 9G) (Figure 10.6)
GOV8	"Performance of intermediary agents e.g. science and technology parks and incubators"	UIC performance (9U, 7I, 12G) (Figure 10.6) LC1 (9U, 7I, 12G) (Figure 10.7) LC2 (9U, 7I, 12G) (Figure 10.7) LC3 (9U, 7I, 12G) (Figure 10.7) LC4 (8U, 7I, 12G) (Figure 10.7) LC5 (9U, 12G) (Figure 10.7) LC7 (3U, 5I, 1G) (Figure 10.7) GOV9 (9U, 7I, 12G) (Figure 10.6)
***Additional comments:** Two respondents from industry side which were mostly large companies and also two respondents from university did not consider the level of performance of intermediary agents as an important factor to influence either UIC performance or status of cluster formation and favourability of entrepreneurial environment (GOV9). (2U, 5I, 4G): Level of impact of performance of intermediary agents on degree of cultural differences between partners and also on degree of lack of understanding of partners from each other's norms, heavily depends on the length of interaction they have in this kind of intermediary institutions. One person from government side also commented that "*number of interaction with the same partner, would intensify this relationship*".		
LOOPS	"UIC performance"	GOV8 (19 people in the pool) (See Loops R27, R28, R29, R41, R42, R43, R33, R34, R35, R39) (Figure 10.7)
GOV9	"Status of cluster formation and favourability of entrepreneurial environment"	UIC performance (11U, 9I, 12G) (Figure 10.6) LC9 (4U, 2I, 3G) (Figure 10.7) LC8 (2U, 4I, 2G) (Figure 10.7) GOV10 (6U, 7I, 11G) (Figure 10.6)- See following comments
***Additional comments:** (5U, 2I, 1G): Apart from status of cluster formation and favourability of entrepreneurial environment, other factors such as political issues and the situation of the country in terms of standards of living are more important factors which have an influence on status of brain drain (GOV10).		
LOOPS	"UIC performance"	GOV8 (7U, 4I, 6G) (See Loops R15, R16a) (Figure 10.6) GOV9 (7U, 4I, 6G) (See Loop R16b) (Figure 10.6) OC1 (5U, 3I, 3G) (See Loop R18a) (Figure 10.7)
GOV10	"Status of brain drain"	UIC performance (11U, 9I, 12G) (Figure 10.6)
LOOPS	"UIC performance"	GOV8 (2U, 3I, 5G) (See Loop R17a) (see Figure 10.6) GOV9 (2U, 3I, 5G) (See Loop R17b) (see Figure 10.6) OC1 (5U, 3I, 3G) (See Loop R18b) (see Figure 10.7)

Table 10.13 (continued): Government sub-system and its related elements and connections.

Coding	Description	Connections and weights
GOV11	"Degree of efficiency of privatisation policy"	UIC performance (9I, 9G) (Figure 10.6) GOV9 (7I, 6G) (Figure 10.6)
***Additional comments:** (3G): Degree of efficiency of privatisation policy has an impact on probability of applying a rational approach in privatised companies.		
GOV12	"Degree of government monopolies in market"	GOV9 (7I, 6G) (Figure 10.6) GOV11 (9I, 9G) (Figure 10.6)
***Additional comments:** (3I): Degree of efficiency of privatisation policy (GOV11) and level of government monopolies in market (GOV12) has an impact on degree of trust formation between entrepreneurs and government. This in turn has an impact on degree of motivation of entrepreneurs to involve in economic activities and also has an impact on status of cluster formation and favourability of entrepreneurial environment (GOV9).		
GOV13	"Availability of databases for entrepreneurs"	GOV9 (2U, 7I, 5G) (Figure 10.6)
GOV14	"Amount of government natural resources income"	GOV15 (1U, 3I, 4G) (Figure 10.6)
GOV15	"Degree of government value people creativity"	GOV9 (1U, 3I, 4G) (Figure 10.6)
GOV16	"Political situation status and probability of entry to the WTO"	GOV5 (2G) (Figure 10.6) GOV9 (3I, 5G) (Figure 10.6) Motivation of companies (5I, 9G) UIC performance (5I, 9G) (Figure 10.6)
***Additional comments:** Four people from industry side had different views. These people who mostly came from large companies and had a better relation with foreign partners did not consider probability of entry to WTO as an important factor to influence their level of motivation for collaboration with domestic universities.		
GOV17	"Degree of embargos imposed"	Motivation of companies (7I, 9G) UIC performance (7I, 9G) (Figure 10.6) GOV18 (6I, 5G) (Figure 10.6)
***Additional comments:** Two people from industry declared that, degree of motivation of companies will be weakly influenced by degree of embargos imposed. They explained that, changing level of embargoes only will change level of efforts to find alternative ways of linking to foreign partners.		
GOV18	"Export opportunities and the risk of investment "	GOV9 (6I, 5G) (Figure 10.6)
GOV19	"Efficiency of government programmes to enhance awareness/training for entrepreneurial activities"	UIC performance (8U, 6I, 12G) (Figure 10.6) GOV9 (8U, 6I, 12G) (Figure 10.6)
***Additional comments:** (3U, 3I): Efficiency of government programmes to enhance awareness/training for entrepreneurial activities do not have an impact on willingness of the people to act entrepreneurially. They added that entrepreneurs are born like entrepreneurs and these characters are developed from their early childhood. Therefore, availability of these programmes has low impact on degree of people's willingness to act entrepreneurially and as a result it neither has an influence on UIC performance nor on cluster activities (GOV9).		

Table 10.13 (continued): Government sub-system and its related elements and connections

Coding	Description	Connections and weights			
GOV20	"Degree of corruption in government for allocating resources to entrepreneurs"	GOV21 (2U, 2G) (Figure 10.6) GOV21* (3I, 2G) (Figure 10.6)			
GOV21	"Degree of trust formation between entrepreneurs within universities and government"	Motivation of individuals within universities (2U, 2G)	UIC performance (2U, 2G)	**GOV21** (2U, 2G); See Loop R11 (Figure 10.6)	
GOV21*	"Degree of trust formation between entrepreneurs and government"	Motivation of companies (3I, 2G)	UIC performance (3I, 2G)	**GOV21*** (3I, 2G); See Loop R13 (Figure 10.6)	
LC8	"Team working and cooperation culture"	UIC performance (2U, 4I, 2G)	GOV9 (2U, 4I, 2G)		LC8 (2U, 4I, 2G) See Loop R26b (Figure 10.7)
		UIC performance (2U, 4I, 2G)	GOV8(2U, 4I, 2G)	GOV9(2U , 4I, 2G)	LC8 (2U, 4I, 2G); See Loops R19, R21 (Figure 10.7)
		UIC performance (2U, 3I, 2G)	OC1 (2U, 3I, 2G)	GOV9 (2U, 3I, 2G)	LC8 (2U, 3I, 2G); See Loops R20, R26a (Figure 10.7)
LC9	"Style of management in SMEs"	UIC performance (4U, 2I, 3G)	GOV9 (4U, 2I, 3G)		LC9 (4U, 2I, 3G); See Loop R51(Figure 10.7)
		UIC performance (4U, 2I, 3G)	GOV8(4U, 2I, 3G)	GOV9 (4U, 2I, 3G)	LC9 (4U, 2I, 3G); See Loops R47, R49 (Figure 10.7)
		UIC performance (4U, 2I, 3G)	OC1 (4U, 2I, 3G)	GOV9 (4U, 2I, 3G)	LC9 (4U, 2I, 3G); See Loops R48, R50 (Figure 10.7)

Table 10.13 (continued): Government sub-system and its related elements and connections

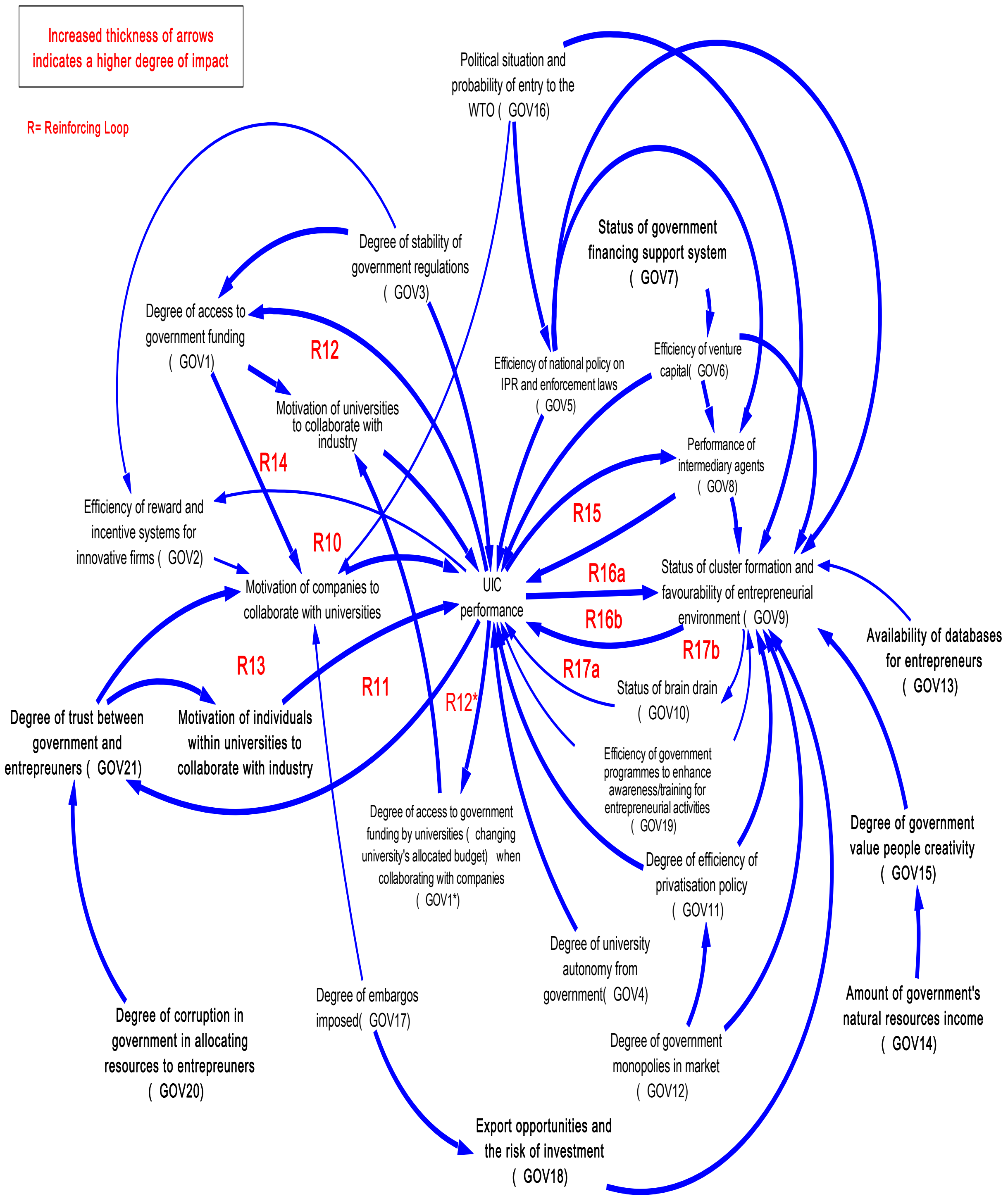


Figure 10.6: Government sub-system: constructed from the results in Table 10.13

10.3.6.6 Connection between sub-systems

The complete picture of connection between the elements of different sub-systems and also all other reinforcing loops is presented in Figure 10.7.

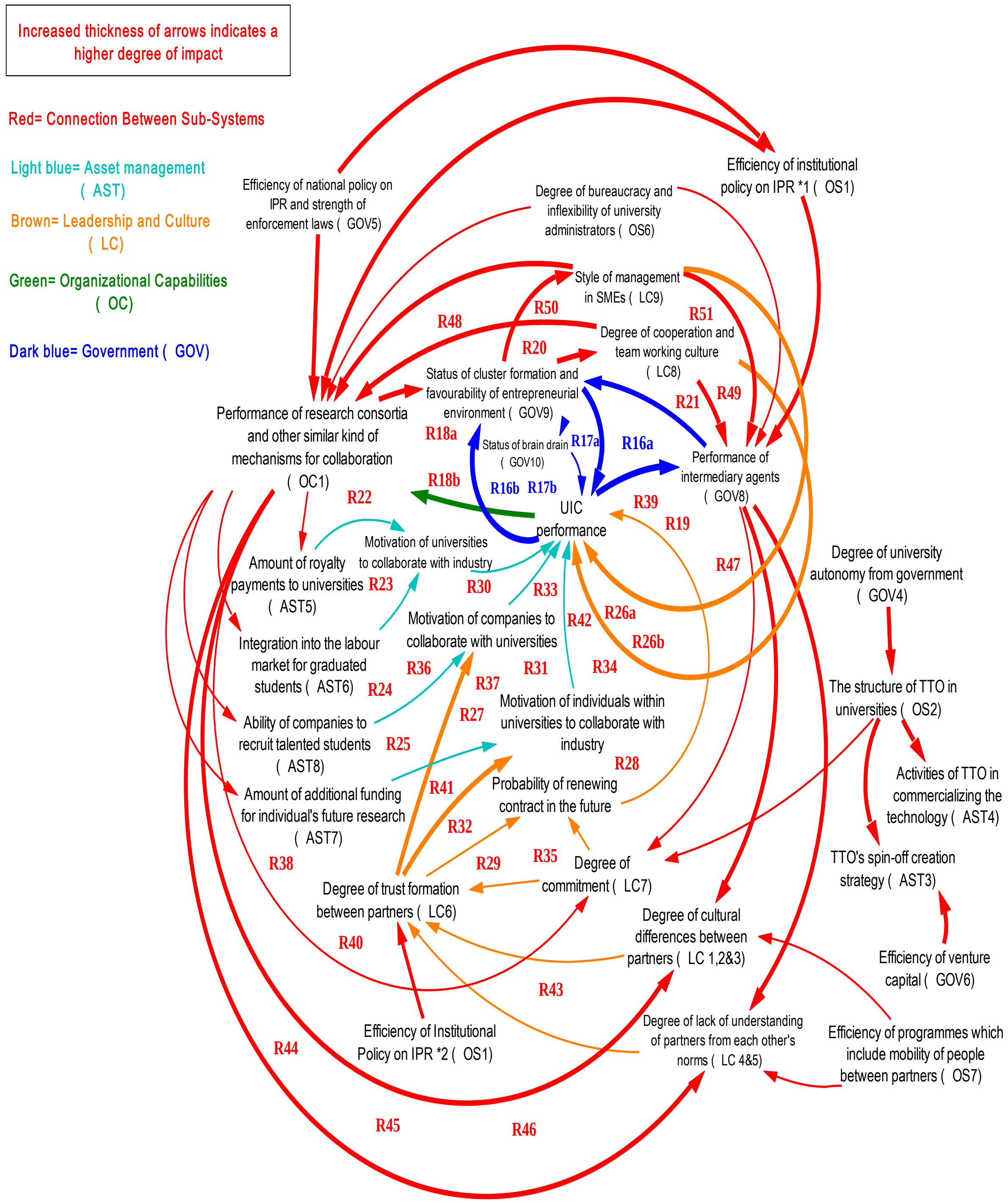


Figure 10.7: Relationship between elements of five sub-systems: Constructed from the results in Tables 10.9-13

Based on Figure 10.7 it is clear that, there is a high level of connection between elements of different sub-systems. The new model (DSM) which is a refinement version of the previous model (see Section 9.8) is a complete picture of UIC activities. This new model is shown in Figure 10.8.

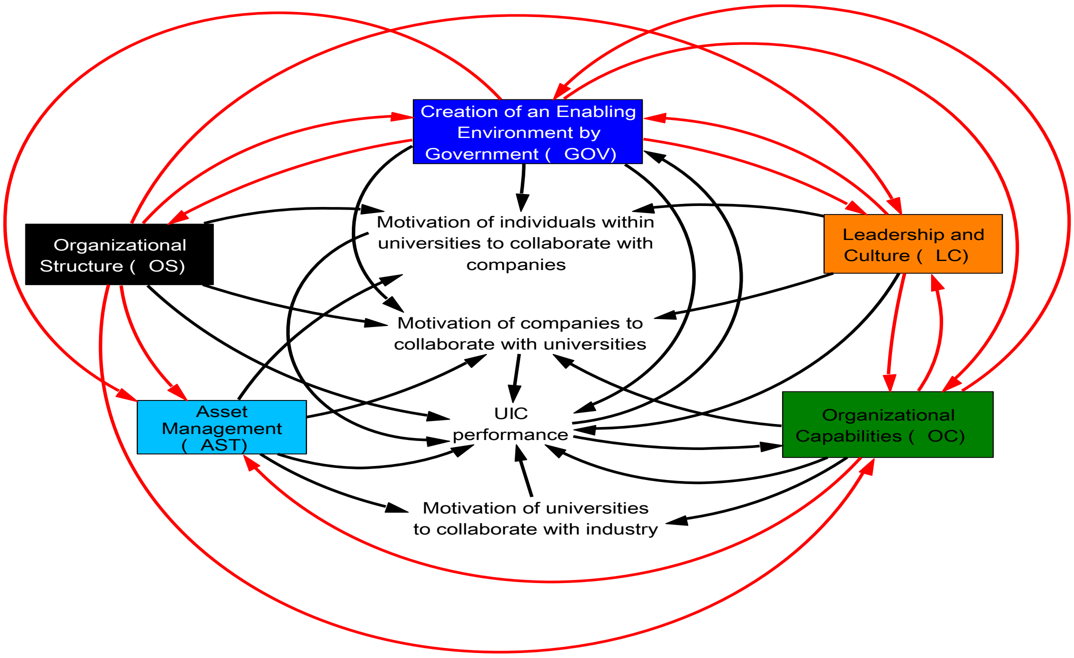


Figure 10.8: Dynamic Systems Model showing interaction between five sub-systems

10.3.7 Overall picture and calibrated version of the DSM (detailed version)

The present approach includes five sub-systems which are operating in parallel and influencing each other. Figure 10.9 which is called final version of the DSM, represents all of previous five sub-systems and internal interaction of different factors within each of these sub-systems and also shows the detailed possible connections between these sub-systems. It also includes all potential loops which are identified by the respondents. This is the useful dynamic model to depict the findings systematically. This system illustrates the predominant elements of cultural influences.

DSM not only tested all of the connections identified as a result of survey analysis (figure 9.2), but also those connections in a conceptual model (Figure 7.2) shown with black arrows (second and third order impact forces). Additionally, DSM also includes critical forces that emerged as a result of interviews. These forces are highlighted by asterix (*) in Tables 10.4 to 10.8.

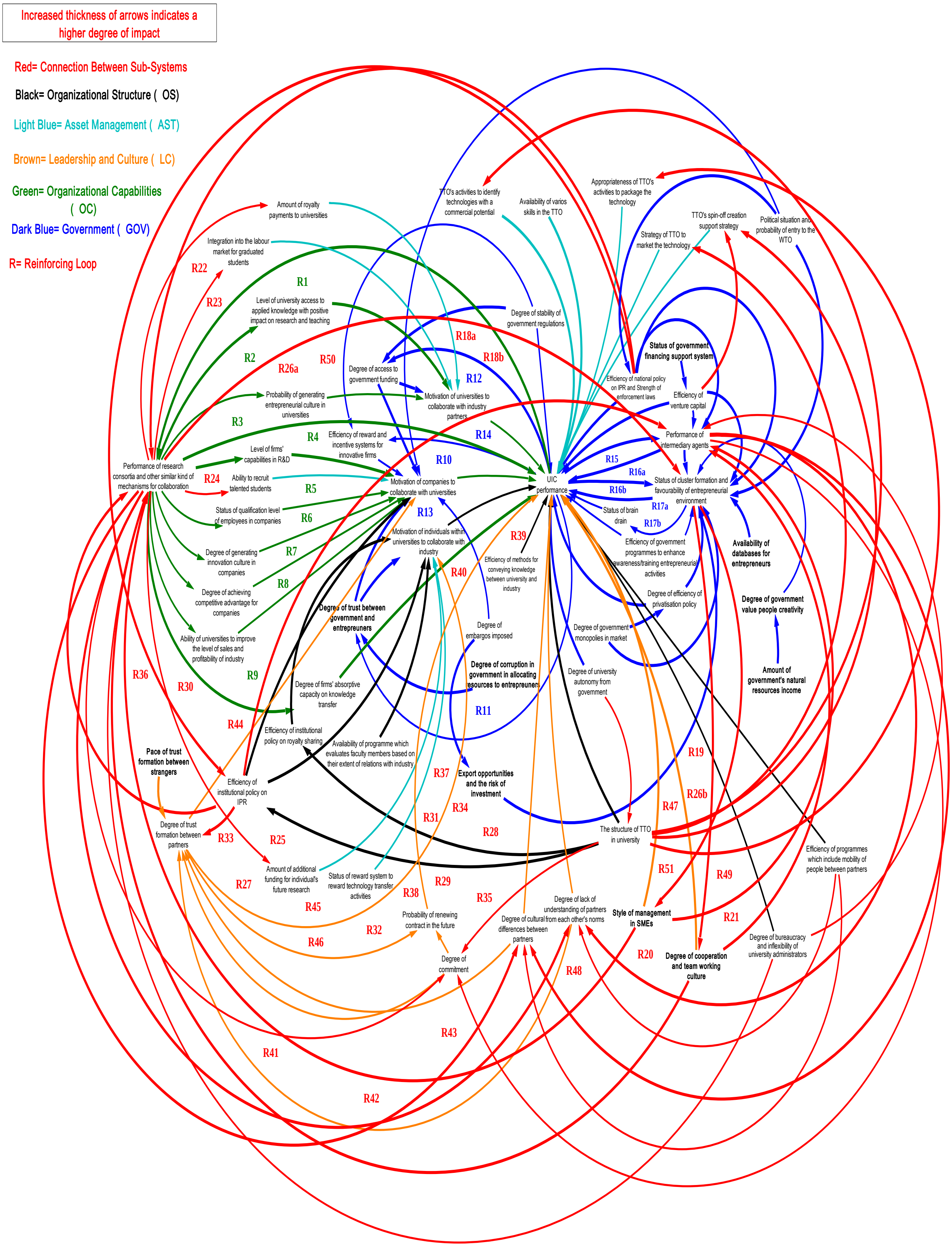


Figure 10.9: Detailed (calibrated) version of the DSM: Constructed from the results in Tables 10.9-13

CHAPTER 11

ANALYSIS OF INTERVIEWS: CONSTRUCTING SCENARIOS

11.1 INTRODUCTION

The analysis of the interview data is structured as follows:

1- Writing Scenario Scripts: Introduction

2- Scenario Script 1 (Stagnation: current policy framework + 15 years)

3- Scenario Script 2 (Efficiency-Driven: current to new policy framework + 15 years)

4- Scenario Script 3 (Innovation-Driven: Scenario 2+ enhanced policy framework + 15 years)

The first step explains the logic for developing different scenario scripts. The second, third and fourth steps are using the systems model to produce the first, second and third scenarios for the future of UIC in Iran.

11.2 WRITING SCENARIO SCRIPTS: INTRODUCTION

Following the construction of the DSM, a series of future scenarios were generated. The first scenario was developed using the respondent's knowledge of the current situation of the UIC in country based on every single element in the Dynamic Systems Model (DSM), and also by asking what is likely to happen if the policy pathways of Iran remain unchanged in the future (for 15 years).

To generate the second and third scenarios, what-if questions steered the discussion to the required key policy change issues. It should be noted that for the second and third scenarios; a new political/societal manifesto was developed in order to change the direction of several levers (forces) of the DSM simultaneously in each scenario to understand the system response. These changes in direction were based on literature on the experience of countries in different stages of transition. The majority of "What-if?" questions were aligned with the policy experience of countries in two specific stages of development i.e. efficiency-driven economy and innovation-driven economy.

In this stage; scripts for different scenarios are written by changing a direction of principal forces in the model (DSM). Because the change in the direction of one important force cause change in many other forces direction, a set of consistent responses start to happen. The set of stories which are created due to these changes are the final scenarios. It should be noted that questions for the 'second' and 'third' scenarios were designed based on the critical elements obtained from the survey analysis (see Section 9.7). Their direction and suitability for a specific scenario were determined by theories of innovation systems; especially those which consider the role of university, industry and government in transition e.g. Competitiveness Index Report (World Economic Forum, 2008) and other supporting literature e.g. Triple Helix, NIS and Porter's diamond that focus on the necessity of existence of specific elements for each stage of evolution. The direction and suitability of some "what if" questions for the second and third scenario related to Iranian context (e.g. questions regarding political situation and embargoes or joining the WTO) were defined based on views from pilot testing the interview instrument regarding the suitability and direction of these questions for a specific scenario.

Since elements were also added by respondents during the development of the DSM and scenarios (see Sections 10.3.5 and 11.3), it was necessary to design "what if question" to cover these elements.

In developing the second and third scenarios, respondents were asked to assume that in scenario 2, apart from the new direction of forces, the systems model will have all features of the current state. Furthermore they were asked to assume that in scenario 3, apart from its new direction of forces, this scenario includes all other changes in direction of forces proposed for scenario 2.

11.3 SCENARIO SCRIPT 1 (STAGNATION: CURRENT POLICY FRAMEWORK + 15 YEARS)

Respondents were asked to describe what will happen if the current situation (related to each elements of the DSM) remains unchanged over the next 15 years.

11.3.1 Five sub-systems of the first scenario

The following sections provide results related to each of the five sub-systems from the first scenario and the way that sub-systems interact.

11.3.1.1 Organizational Structure sub-system (OS)

Table 11.2 includes results related to each element of the Organizational Structure sub-system in the first scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

Organizational Structure sub-system in the first scenario includes all of the elements of the DSM for related sub-system plus another which emerged as a result of discussion on the first scenario. The added element in this stage is shown in Table 11.1.

Elements of Sub-System 1: Organizational Structure to Coordinate and Support Partnerships (OS)
• **OS8:** University education system misaligned to industry needs (university, industry, government)

Table 11.1: Element of sub-system 1 (added in first scenario): Organizational Structure to Coordinate and Support Partnerships (OS)

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td rowspan="3">OS1</td><td rowspan="3">“Very weak institutional policy on IP rights which do not consider issues relating to IP ownership with collaborative research programmes and/or other contractual agreements with various partners ”</td><td colspan="2">LC6 (11U, 9I, 12G) (Figure 11.8)
OC1 (11U, 9I, 12G) (Figure 11.8)
GOV8 (11U, 9I, 12G) (Figure 11.8)</td></tr>
<tr><td>Decrease motivation of companies to collaborate with universities (7I, 9G)</td><td>Decrease UIC performance (7I, 9G)
(Figure 11.1)</td></tr>
<tr><td>Decrease motivation of individuals within universities to collaborate with companies (11U, 4G)</td><td>Decrease UIC performance (11U, 4G)
(Figure 11.1)</td></tr>
<tr><td colspan="4">*Additional comments:

Majority of respondents in the pool mentioned that if this situation remains unchanged in the future, there will be no opportunity for trust formation between partners and the probability of motivating universities and industry to collaborate with each other will be decreased. This situation confirms that even the first stage of trust formation which is defined by Sako (1991) as “contractual trust” is very hard to achieve in the first scenario and if this situation continues there will be less opportunity to achieve higher level of trust in UIC.
(5U, 4I, 6G): Currently, most UIC activities which are arranged through formal university procedures are limited to simpler mechanisms for collaboration (e.g. consultation, conferences) due to the perceived barriers and risks for deeper collaboration e.g. inefficiency of IPR. Consequently, informal collaborations i.e. not arranged with institutions, take place through personal networks between academics and companies including friendship, reputation and expertise. The extent of such collaboration is therefore limited to trusted partners</td></tr>
<tr><td>OS2</td><td>“Weak structure of technology transfer offices in universities: inappropriate policy and process for legal, financial and human resource management in TTOs ”</td><td colspan="2">Decrease UIC performance (11U, 4G) (Figure 11.1)
OS1 (8U, 2G) (Figure 11.1)
OS3 (8U, 2G) (Figure 11.1)
AST3 (6U) (Figure 11.8)
AST4 (6U) (Figure 11.8)
LC7 (3U, 1G) (Figure 11.8)</td></tr>
<tr><td colspan="4">*Additional comments:
(3U): The structure of TTOs is currently under vice presidency of research in universities and there is lack of autonomy and very low amount of budget allocated to these offices; as a result, these offices cannot invest on recruiting staff from multidisciplinary fields and they should rely on their current staff. They proposed that, the best way is restructuring this office and put it under direct supervision of university presidency. They declared that without this change there will be no chance of success in the future.</td></tr>
<tr><td>OS3</td><td>“Very weak institutional policy on royalty sharing”</td><td>Decrease motivation of individuals within universities (11U, 4G)</td><td>Decrease UIC performance (11U, 4G) (Figure 11.1)</td></tr>
<tr><td>OS4</td><td>“Absence of programme which evaluate faculty members based on their extent of relations with industry”</td><td>Decrease motivation of individuals within universities (11U, 4G)</td><td>Decrease UIC performance (11U, 4G) (Figure 11.1)</td></tr>
<tr><td colspan="4">*Additional comments:
(11U, 4G): A current criterion to evaluate faculty members is traditionally based on numbers of publications and journal articles. For example no efficient programme is available in universities to evaluate faculty members based on their extent of relations with industry. If this situation continues in the future, universities will not have one of the efficient instruments which is necessary to motivate individuals within universities to collaborate with industry and as a results, UIC activities will be decreased.
(5U, 2G): There has been no consideration until recently in universities to incorporate patents or other intellectual property assets as criteria to evaluate faculty members and researchers’ career. However, there is a high degree of uncertainty to execute this criterion in the near future. One of the respondents in MSRT declared that the Ministry is recently trying to approve a regulation to consider the extent of relations with industry as a criterion for evaluation of faculty members.
(1U): “I had collaborative activities with industry; however there is no criterion available to consider it as a promotion factor to my current status and if this situation continues my motivation for continuing collaboration will be decreased because universities just consider publications to evaluate faculty members and not practical experiences”.</td></tr>
<tr><td>OS5</td><td>“Deficiency of methods for conveying knowledge between universities and industry e.g. frequency of site visits by industry and plant visits by researchers”</td><td colspan="2">Decrease UIC performance (8U, 8I) (Figure 11.1)</td></tr>
<tr><td colspan="4">*Additional comments:
(3U, 1I): They were satisfied with the current methods for conveying knowledge in their institution and they mentioned that if this situation continues, the user of the technology could use it completely.</td></tr>
</table>

Table 11.2: Organizational Structure sub-system and its related elements and connections in the first scenario

<table>
<tr><th>Coding</th><th>Description</th><th>Connections and weights</th></tr>
<tr><td>OS6</td><td>“High bureaucracy and inflexibility of university administrators”</td><td>Decrease UIC performance (11U, 9I) (Figure 11.1)
OC1 (5U, 7I) (Figure 11.8)
GOV8 (5U, 7I) (Figure 11.8)</td></tr>
<tr><td colspan="3">*Additional comments:

(9I): If this situation continues in the future, companies will search for an alternative source of innovation rather than relying on universities.

(8U): If this situation continues in the future, the willingness of the researcher to collaborate through formal contract will be decreased and they prefer to make a linkage with industry informally; although this kind of activity is not allowed currently. A bureaucracy procedure in TTOs is the other major issue which decreases the willingness of researchers within universities to collaborate with these offices. Therefore, the level of trust between individual researchers and TTOs is also decreased and as a result most of researchers follow the process of commercialization and knowledge transfer informally.</td></tr>
<tr><td>OS7</td><td>“Inefficiency of programmes which includes mobility of people between partners”</td><td>Decrease UIC performance (9U, 6I, 7G) (Figure 11.1)
LC1 (5U, 3I, 5G) (Figure 11.8)
LC2 (5U, 3I, 5G) (Figure 11.8)
LC3 (5U, 3I, 5G) (Figure 11.8)
LC4 (5U, 3I, 5G) (Figure 11.8)
LC5 (5U, 3I, 5G) (Figure 11.8)</td></tr>
<tr><td colspan="3">*Additional comments:

(1U): “After spending sometime in industry, all situations were changed and my previous position was gone”.

(1I): “After working six months in university as a lecturer the low level of payment de-motivated me to continue this job and make me reluctant to do it again”.</td></tr>
<tr><td>OS8</td><td>“University education system is misaligned to industry needs”</td><td>Decrease UIC performance (2U, 4I, 1G) (Figure 11.1)</td></tr>
</table>

Table 11.2 (continued): Organizational Structure sub-system and its related elements and connections in the first scenario.

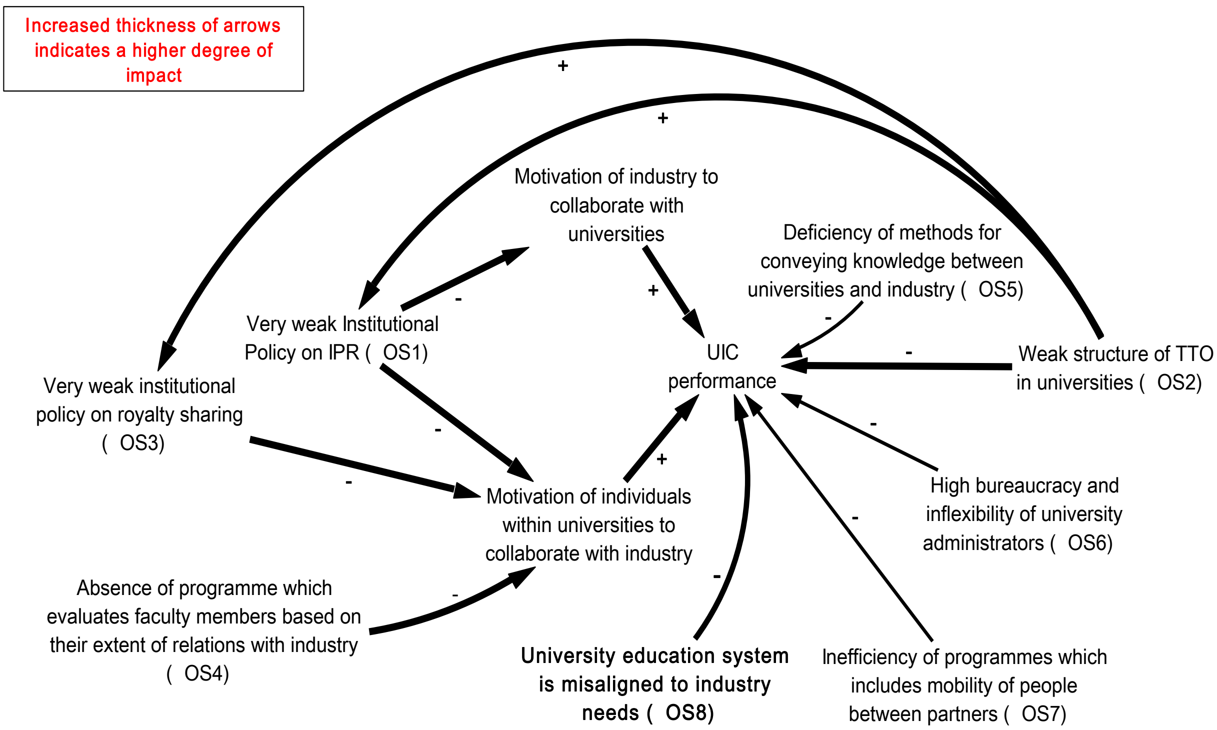


Figure 11.1: Organizational Structure sub-system in the first scenario: constructed from the results in Table 11.2

11.3.1.2 Asset Management sub-system (AST)

Table 11.3 includes results related to each element of the Asset Management sub-system in the first scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

Asset Management sub-system in the first scenario includes all of the elements of the DSM for related sub-system.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>AST1</td><td>“Lack of comprehensive reward system to reward technology transfer activities of researchers e.g. when it shifts based on academic favour in royalty and equity distribution formula”</td><td>Decrease motivation of individuals within universities (9U)</td><td>Decrease UIC performance (9U)
(Figure 11.2)</td></tr>
<tr><td colspan="4">*Additional comments:

(2U): Their institution is trying to design specific reward system to reward technology transfer activities in order to motivate researchers to collaborate with industry.</td></tr>
<tr><td>AST2</td><td>“Insufficient skills in technology transfer offices”</td><td colspan="2">Decrease UIC performance (11U, 9I, 12G) (Figure 11.2)</td></tr>
<tr><td colspan="4">*Additional comments:

(8U, 4I, 6G): Because of very poor marketing and negotiation skills in the TTOs, there is no potential for making connection between researchers with new idea and companies who are interested in these ideas. If this situation continues, there would be less chance for partners to be familiar with each other’s capabilities and needs. Because of the poor negotiation skills of the people in these offices there is no potential for trust formation between partners. If this situation continues there would be less chance for UIC activities because there is no potential for trust formation.</td></tr>
<tr><td>AST3</td><td>“Weak TTOs spin-off creation support strategy”</td><td colspan="2">Decrease UIC performance (11U) (Figure 11.2)</td></tr>
<tr><td colspan="4">*Additional comments:

(4U): Because of the very weak activities of these offices to support researchers during development phase of their innovations and also the network weakness of these offices to connect entrepreneurs to potential venture capital, their potential to facilitate spin-off company formation is at risk. One respondent who was part of the TTO in university commented that, “spin-offs do not officially exist in the country because of many reasons. Very weak presence of venture capital, weak institutional policy regarding IP and very reactive posture of TTO towards support of spin-offs are the main reasons which impede spin-off formation from academia”.

(8U): If this situation continues in the future the UIC performance will be decreased because it would be less effort for entrepreneurial activities and most of entrepreneurs will be de-motivated; also the country will leave behind the “future outlook of the country in 1404=2025” which considers universities to become entrepreneurial.</td></tr>
</table>

Table 11.3: Asset Management sub-system and its related elements and connections in the first scenario

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>AST4</td><td>“Weak activities of TTOs to commercialize the technology including: Weakness in strategy of TTOs to market the technology, Weakness in TTOs activities to identify technology with commercial potential, Weakness of TTOs activities to package the technology appropriately”</td><td colspan="2">Decrease UIC performance (11U) (Figure 11.2)</td></tr>
<tr><td colspan="4">*Additional comments:
(9U): TTOs are not properly equipped with expertise to give consultation about probability of commercialization success of specific technology. If this situation continues in the future, the probability of overestimation or underestimation of the commercialization success of specific technology will be very high.
(7U): Because of lack of information about the real needs of industry, there is no appropriate package to design based on their needs as to attract industry. If this situation continues in the future, it would be less chance for companies to get familiar with the real capabilities of universities.</td></tr>
<tr><td>AST5</td><td>“Low amount of royalty payments to universities”</td><td>Decrease motivation of universities (11U, 4G)</td><td>Decrease UIC performance (11U, 4G)
(Figure 11.2)</td></tr>
<tr><td>AST6</td><td>“Low chance of integration into the labour market for graduated students”</td><td>Decrease motivation of universities (10U, 4G)</td><td>Decrease UIC performance (10U, 4G) (Figure 11.2)</td></tr>
<tr><td>AST7</td><td>“Low amount of additional funding for individual future research”</td><td>Decrease motivation of individuals within universities (11U, 1G)</td><td>Decrease UIC performance (11U, 1G) (Figure 11.2)</td></tr>
<tr><td>AST8</td><td>“Weak opportunity to recruit talented students”</td><td>Decrease motivation of companies (6I, 9G)</td><td>Decrease UIC performance (6I, 9G)
(Figure 11.2)</td></tr>
<tr><td colspan="4">*Additional comments:
Majority of respondents within the pool had general consensuses that, because UIC performance is weak in this scenario, there are weak opportunities for both partners to get benefits for their organizations even in the simpler types of interactions such as consultation, seminars and conferences (low chance for universities to increase their royalty share from collaboration (AST5), low chance for students to integrate into the labour market (AST6), the amount of additional funding for researchers when collaborating with companies is very low (AST7), and there is low chance for companies to recruit talented students from universities (AST8).</td></tr>
</table>

Table 11.3 (continued): Asset Management sub-system and its related elements and connections in the first scenario

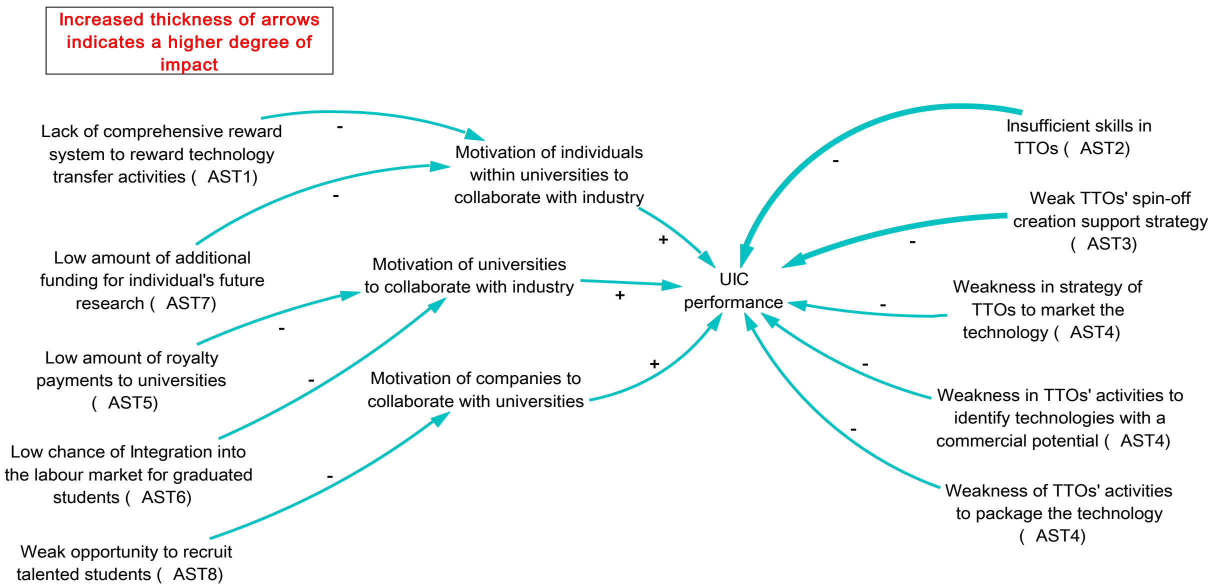


Figure 11.2: Asset Management sub-system in the first scenario: constructed from the results in Table 11.3

11.3.1.3 Leadership and Culture sub-system (LC)

Table 11.5 includes results related to each element of the Leadership and Culture sub-system in the first scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

Leadership and Culture sub-system in the first scenario includes all of the elements of the DSM for related sub-system plus these four elements which emerged as a result of discussion on the first scenario. The added elements in this stage are shown in Table 11.4.

Elements of Sub-System 3: Leadership and Culture (LC)
• **LC11:** Negative view among university people to earn money from research (university) • **LC12:** Volatile university management (university, industry) • **LC13**: SMEs in Iran do not have a long-term plans for research activities (university, industry, government) • **LC14**: Risk-averse culture in universities (university, government)

Table 11.4: Elements of sub-system 3 (added in the first scenario): Leadership and Culture (LC)

Coding	Description	Connections and weights
LC1	"High level of cultural differences in university-industry collaboration (secrecy vs. dissemination)"	LC6 (11U, 9I, 12G) (Figure 11.3) Decrease UIC performance (11U, 9I, 12G) (Figure 11.3)
LC2	"High level of cultural differences in university-industry collaboration (time orientation differences)"	LC6 (11U, 7I, 12G) (Figure 11.3) Decrease UIC performance (11U, 7I, 12G) (Figure 11.3)
***Additional comments:** (1U): "*If industry starts a project today with university; they need results yesterday!*" This probably shows how they are in a rush.		
LC3	"High level of cultural differences in university-industry collaboration (profit maximization)"	LC6 (11U, 12G) (Figure 11.3) Decrease UIC performance (11U, 12G) (Figure 11.3)
***Additional comments:** According to majority of respondents, willingness of companies to maximize their profit without taking other important issues into consideration is another cultural barrier to UIC. (1U): "*Industry always expects positive results from us; they are not familiar with the obstacles during innovation process*". (2U): Sometimes companies because of this culture do not stay committed to their current contract and this situation is worse in the absence of comprehensive national policy for IPR protection and enforcement laws which exist in the first scenario.		

Table 11.5: Leadership and Culture sub-system and its related elements and connections in the first scenario

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>LC4</td><td>“Lack of understanding of industry norms by university people”</td><td colspan="2">LC6 (8U, 9I, 12G) (Figure 11.3)

Decrease UIC performance (8U, 9I, 12G) (Figure 11.3)</td></tr>
<tr><td>LC5</td><td>“Lack of understanding of university norms by industrial people”</td><td colspan="2">LC6 (11U, 12G) (Figure 11.3)
Decrease UIC performance (11U, 12G) (Figure 11.3)</td></tr>
<tr><td rowspan="3">LC6</td><td rowspan="3">“Decreasing opportunities for trust formation between partners”</td><td>Decrease motivation of companies (9I, 9G)</td><td>Decrease UIC performance (9I, 9G) (Figure 11.3)</td></tr>
<tr><td>Decrease motivation of individuals within universities (11U, 4G)</td><td>Decrease UIC performance (11U, 4G) (Figure 11.3)</td></tr>
<tr><td>Decrease probability of renewing contract in the future (11U, 9I)</td><td>Decrease UIC performance (11U, 9I) (Figure 11.3)</td></tr>
<tr><td colspan="4">*Additional comments:

(3U, 1G): If this situation continues in the future there would be less opportunity for more complex level of interaction between partners like R&D contract or joint venture activities.

(1G): “The lack of trust is not the only problem of universities and industry; trust does not exist between universities and industry, between government and industry, and government and entrepreneurs, and this situation creates culture of distrust in the country. If the culture of distrust continues to exist in the future, it can have a negative effect on the motivation of entrepreneurs within or outside the universities to be active in UIC. Actually it creates an inertia culture for entrepreneurship activities”.

(3I): Based on our previous experience of collaboration, the initial trust was formed mostly based on reputation and expertise of the person in universities; but unfortunately it did not lead to proper continued relationship, because sometimes trust was abused during relationship. One of them commented that, this happened because of the lack of efficient policy for IPR. If this situation remains unchanged, the initial trust would be shaped based on either by intermediate person who knows the potential researchers, researcher’s reputation and expertise, or through organization; which in most of the time because of lack of mechanism to guarantee the contract, trust that will be shaped based on these processes would be vulnerable.</td></tr>
<tr><td rowspan="2">LC7</td><td rowspan="2">“Lack of commitment between partners”</td><td colspan="2">LC6 (3U, 5I, 1G) (Figure 11.3)</td></tr>
<tr><td>Decrease probability of renewing contract in the future (9U, 9I)</td><td>Decrease UIC performance (9U, 9I) (Figure 11.3)</td></tr>
<tr><td>LC8</td><td>“Lack of Team working and cooperation culture”</td><td colspan="2">OC1 (2U, 3I, 2G) (Figure 11.8)
GOV8 (2U, 4I, 2G) (Figure 11.8)
Decrease UIC performance (2U, 7I, 5G) (Figure 11.3)</td></tr>
<tr><td colspan="4">*Additional comments:

Majority of industry people declared that the low amount of cooperation with other companies in the region and with research institutions and universities is part of the culture of Iranian society.

(2U): Researchers within universities are more interested in individual research rather than focusing on team working research and it is one of the cultural problems which decrease the quality of research.

(1G): Although government has established a Ministry for this purpose by the name of Ministry of Cooperation to encourage cooperation culture in the society, however we still have a problem to encourage cooperation culture in the country.

(1U): Self-reliance is a part of Iranian culture and from the childhood it is supposed to rely only on your own rather that getting help from others.

One respondent from industry side commented that “from the childhood most of the people in their family or even in the school are thought not to take a partner especially for business activities”. Two people from government and one from industry also commented that unless the culture of the people does not change, there would be less opportunity for UIC. And they all agreed that it would be a very long process.</td></tr>
</table>

Table 11.5 (continued) Leadership and Culture sub-system and its related elements and connections in the first scenario

Coding	Description	Connections and weights
LC9	"Traditional style of management in SMEs "	OC1 (4U, 2I, 3G) (Figure 11.8) GOV8 (4U, 2I, 3G) (Figure 11.8) Decrease UIC performance (6U, 2I, 3G) (Figure 11.3)
***Additional comments:** (6U, 2I, 3G): Traditional style of management in SMEs has a cultural root. Some of the SMEs in Iran have been evolved from very old trading system called "bazaar" in which they followed a very traditional style of management rather than applying scientific approach. (6U, 2I, 3G): Low SME management quality which is more based on traditional management practices makes a barrier which impedes UIC. Most of SMEs in the country especially commodity based enterprise just follow traditional style of management in their companies. Most of them are less familiar with the concept of innovation and are not utilizing open innovation strategy in order to either collaborate with other companies or universities. If this situation continues in the future there is no opportunity for UIC, because companies are not willing to use universities as a source of innovation.		
LC10	"Very slow process of trust formation between strangers"	LC6 (3U, 5I) (Figure 11.3)
***Additional comments:** (3U, 5I): People in Iran do prefer to trust someone whom they know before, or at least know them through a person whom they trust. Iranian people trust strangers only after long term process. Based on their comments, if this situation continues in the future very long process will be anticipated for the effective participation of companies and universities in government collaborative programmes. (1I): There is a proverb in Iranian culture which says, "*trust someone only after you test them in three different situations*". (2I): This is a problem which has a strong cultural root in Iran. There is a belief that do not trust other person unless otherwise is proved. This makes a trust formation a very long process.		
LC11	"Negative view among university people to earn money from research"	Decrease UIC performance (3U) (Figure 11.3)
***Additional comments:** (3U): There is a general view in universities and among researchers that researchers should be dedicated to his/her job and develop science, and this is not proper to earn money from their research output. There is a kind of negative view for example for those researchers who want to start a business e.g. spin-off companies formation, or who wants to earn money from their research work or even as a result of work in industry as a part-time job. They agreed that if this negative environment does not change in the future, it will have a negative impact on UIC performance and particularly on entrepreneurial activities.		
LC12	"Volatile university management-characterized by individuals rather than institutes"	Decrease UIC performance (3U, 2I) (Figure 11.3)
LC13	"SMEs in Iran do not have long-term plans for research activities"	Decrease UIC performance (4U, 4I, 3G) (Figure 11.3) GOV9 (4U, 4I, 3G) (Figure 11.3)
LC14	"Risk-averse culture in universities"	Decrease UIC performance (3U, 1G) (Figure 11.3)
***Additional comments:** (3U, 1G): Academic environment in Iran is basically designed based on risk-averse culture rather than encouraging risk taking culture. This is part of the national culture which does not support entrepreneurial activities due to the belief that it may incorporate risks. Students are taught to enter the market in which they can have high revenue with minimum level of risk e.g. construction industry. Based on their views if this situation continues in the future, the country will have problem to encourage entrepreneurship.		

Table 11.5 (continued): Leadership and Culture sub-system and its related elements and connections in the first scenario

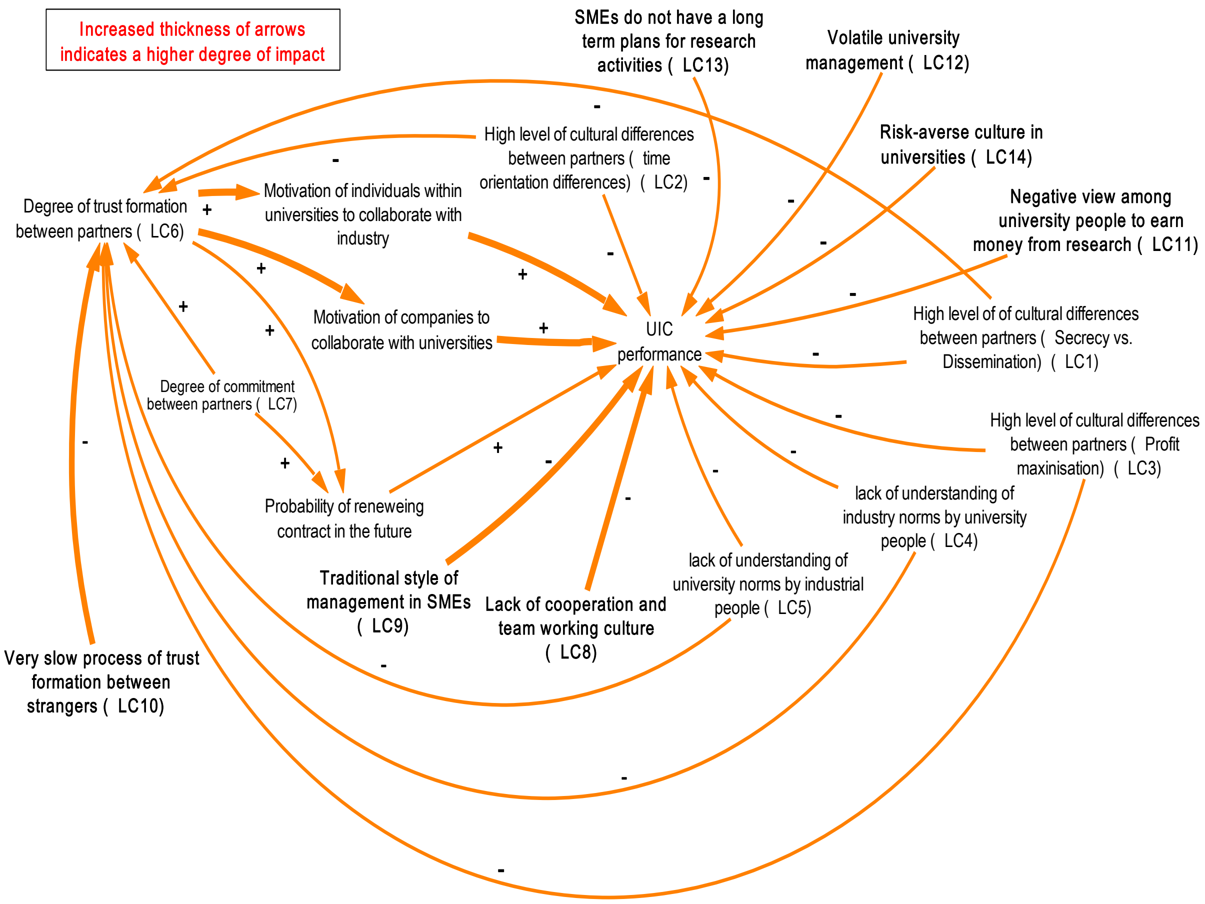


Figure 11.3: Leadership and Culture sub-system in the first scenario: constructed from the results of Table 11.5

11.3.1.4 Organizational Capabilities sub-system (OC)

Table 11.7 includes results related to each element of the Organizational Capabilities sub-system in the first scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

Organizational Capabilities sub-system in the first scenario includes all of the elements of the DSM for related sub-system plus these two elements which emerged as a result of discussion on the first scenario. The added elements in this stage are shown in Table 11.6.

Elements of Sub-System 4: Organizational Capabilities (OC)	
• **OC10:** Weakness of management in collaboration in research consortia (university, industry, government)	• **OC11**: Lack of government support (university, industry, government)

Table 11.6: Elements of sub-system 4 (added in the first scenario): Organizational Capabilities (OC)

Coding	Description	Connections and weights
OC1	"Weak performance of research consortia and other similar kind of mechanisms for collaboration (e.g. R&D contract or joint activities)"	AST5 (11U, 4G) (Figure 11.8) AST6 (11U, 4G) (Figure 11.8) AST7 (11U, 1G) (Figure 11.8) AST8 (9I, 9G) (Figure 11.8) LC1 (11U, 9I, 12G) (Figure 11.8) LC2 (11U, 7I, 12G) (Figure 11.8) LC3 (11U, 12G) (Figure 11.8) LC4 (8U, 9I, 12G) (Figure 11.8) LC5 (11U, 12G) (Figure 11.8) LC7 (3U, 5I, 1G) (Figure 11.8) OC2 (11U, 9I, 12G) (Figure 11.4) OC3 (11U) (Figure 11.4) OC4 (8U) (Figure 11.4) OC5 (9I) (Figure 11.4) OC6 (8I) (Figure 11.4) OC7 (8I) (Figure 11.4) OC8 (7I) (Figure 11.4) OC9 (7I) (Figure 11.4) GOV9 (5U, 3I, 3G) (Figure 11.8) Decrease UIC performance (11U, 9I, 12G) (Figure 11.4)

***Additional comments:**

(1I): "*Our company was a member of research consortia, however, we faced many problems during our participation and we decided to cancel our membership. Only we had one experience of joint R&D with universities where a number of students were there, however because it was only for short period of time we did not get an opportunity to know students' capabilities for future recruitment (AST8)*".

One of the people from MSRT declared that although research consortium which are related to biotechnology and automobile related industry is not efficient; however, evidence shows that where government increase its support to these consortia e.g., Saffron Research Consortia, or military-based consortia, the degree of success is increased.

(1U): If this situation continues in the future the huge expenditure and investment of companies and universities will be useless and wasted and huge amount of money will be spent without any use in the future. He declared that "*if university put this investment in the bank it will be better because the interest of the bank which is currently 18% (by assuming the same amount in 15 years time) is much better than collaborating with companies without financial benefit*".

(1I): Although our company pays a membership to research consortia, however because of low level of qualities, we might decide not to participate for a long time.

(1G): "*Iranian system of innovation is not mature. Almost weak and fragmented scientific capabilities in academia in one hand and technological immaturity in companies on the other hand, and also absence of efficient instrument to link these two bodies made a fewer opportunities for UIC compared to other developed countries. Therefore, unless universities do not invest on increasing their scientific capabilities and identify their major strengths and align it with industry needs and also firms do not invest more on their R&D budget in order to increase their absorptive capacity, it will be very few opportunities for UIC and the current gap will become more and more*". It should be noted that this problem is common in many developing countries. In Malaysia for example as noted by Abd Razak and Saad (2009), in the absence of specific mechanism to make universities aware of real industry's needs and also motivate industry to invest more on their R&D, there will be few opportunities for UIC.

Table 11.7: Organizational Capabilities sub-system and its related elements

Coding	Description	Connections and weights	
OC2	"Low level of firms' absorptive capacity on knowledge transfer"	Decrease UIC performance (11U, 9I, 12G) (Figure 11.4)	
***Additional comments:** (11U, 9I, 12G): Very low investment of companies in their R&D which decrease their absorptive capacity in UIC activities.			
LOOPS	"Decreasing UIC performance"	OC1 (23 people in the pool) (See Loops R3, R9) (Figure 11.4)	
OC3	"Low opportunity for universities to access applied knowledge with positive impact on research and teaching when collaborating with companies"	Decrease motivation of universities (11U)	Decrease UIC performance (11U) (Figure 11.4)
OC4	"Low probability of generating entrepreneurial culture in universities when collaborating with companies"	Decrease motivation of universities (8U)	Decrease UIC performance (8U) (Figure 11.4)
LOOPS	"Decreasing UIC performance"	OC1 (7U) (See Loops R1, R2) (Figure 11.4)	
OC5	"Low level of impact on firms' capabilities in R&D when collaborating with universities"	Decrease motivation of companies (9I)	Decrease UIC performance (9I) (Figure 11.4)
OC6	"Low probability of generating innovation culture in companies when collaborating with universities"	Decrease motivation of companies (8I)	Decrease UIC performance (8I) (Figure 11.4)
OC7	"Low chance of achieving competitive advantage for companies when cooperating with universities"	Decrease motivation of companies (8I)	Decrease UIC performance (8I) (Figure 11.4)
OC8	"Low probability of increasing qualification level of employees in companies when collaborating with universities"	Decrease motivation of companies (7I)	Decrease UIC performance (7I) (Figure 11.4)
OC9	"Low probability to improve sales and profitability of industry when collaborating with universities"	Decrease motivation of companies (7I)	Decrease UIC performance (7I) (Figure 11.4)
LOOPS	"Decreasing UIC performance"	OC1 (6I) (See Loops R4, R5, R6, R7, and R8) (Figure 11.4)	
LOOPS	"Decreasing UIC performance"	OC1 (7U) (See Loops R22, R23, R25) (Figure 11.8) OC1 (4I, 8G) (See Loop R24) (Figure 11.8)	
LOPS	"Decreasing UIC performance"	OC1 (23 people in the pool) (See Loops R30, R31, R32, R44, R45, R46) (Figure 11.8) OC1 (19 people in the pool) (See Loops R36, R37, R38, R40) (Figure 11.8)	
OC10	"Weakness of management in collaboration in research consortia"	OC1 (8U, 7I, 3G) (Figure 11.4)	
OC11	"Lack of government support from research consortia"	(OC1) (7U, 6I, 2G) (Figure 11.4)	

Table 11.7 (continued): Organizational Capabilities sub-system and its related elements and connections in the first scenario

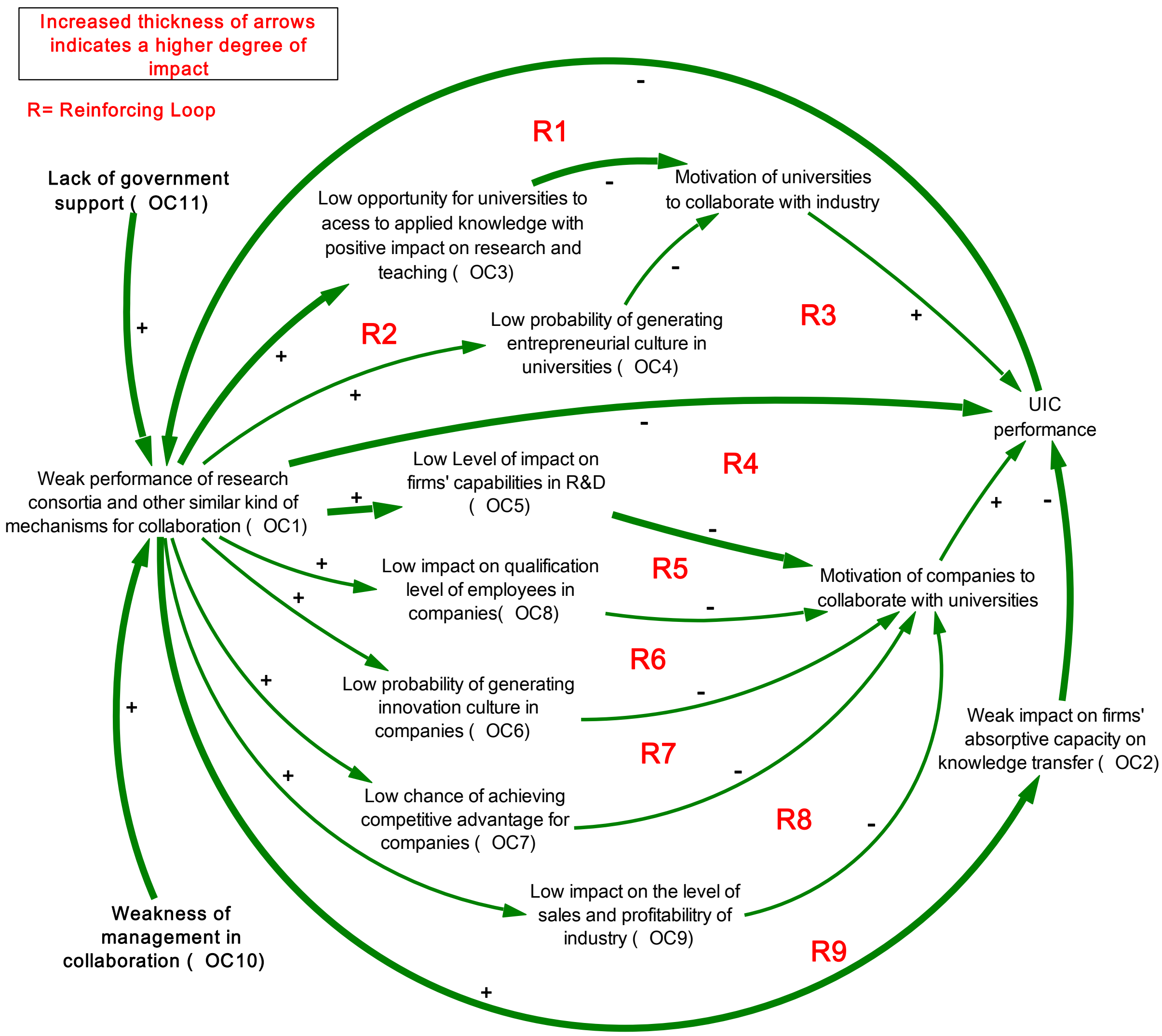


Figure 11.4: Organizational Capabilities sub-system in the first scenario: constructed from the results in Table 11.7

11.3.1.5 Government sub-system (GOV)

Table 11.9 includes results related to each element of the Government sub-system in the first scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

Government sub-system in the first scenario includes all of the elements of the DSM for related sub-system plus these three elements which emerged as a result of discussion on the first scenario. The added elements in this stage are shown in Table 11.8.

Elements of Sub-System 5: Creation of Enabling Environment by Government (GOV)	
• **GOV22:** Government negative view about property ownership and capitalism of individual (university, industry, government) • **GOV23:** Bureaucratic procedures to form start-ups (industry, government)	• **GOV24**: Weakness of management in collaboration in intermediary agents (university, industry, government)

Table 11.8: Elements of sub-system 5 (added in the first scenario): Creation of Enabling Environment by Government (GOV)

<table>
<tr><th>Coding</th><th>Description</th><th colspan="3">Connections and weights</th></tr>
<tr><td>GOV1*</td><td>“Low level of access to government funding by universities (no differences in university’s allocated budget) when collaborating with companies”</td><td>Decrease motivation of universities (11U, 4G)</td><td>Decrease UIC performance (11U, 4G)</td><td>GOV1* (7U, 3G); See Loop R12* (Figure 11.7)</td></tr>
<tr><td rowspan="2">GOV1</td><td rowspan="2">“Low level of access to government funding when collaborating with other partner”</td><td>Decrease motivation of universities (11U, 4G)</td><td>Decrease UIC performance (11U, 4G)</td><td rowspan="2">GOV1 (7U, 5I, 9G); See Loops R12, R14 (Figure 11.7)</td></tr>
<tr><td>Decrease motivation of companies (9I, 9G)</td><td>Decrease UIC performance (9I, 9G)</td></tr>
<tr><td>GOV2</td><td>“Inefficiency of reward and incentive systems for innovative firms when collaborating with universities”</td><td>Decrease motivation of companies (8I, 9G)</td><td>Decrease UIC performance (8I, 9G)</td><td>GOV2 (5I, 6G); See Loop R10 (Figure 11.7)</td></tr>
<tr><td>GOV3</td><td>“Instability of government regulations regarding UIC”</td><td colspan="3">GOV1* (11U, 9I, 12G) (Figure 11.7)
GOV2 (9I, 9G) (Figure 11.7)
Decrease UIC performance (11U, 9I, 12G) (Figure 11.7)</td></tr>
<tr><td colspan="5">*Additional comments:

(1I): “Stable regulations with weaknesses are better than efficient regulation which is unstable”.</td></tr>
<tr><td>GOV4</td><td>“Lack of university autonomy from the government”</td><td colspan="3">OS2 (6U, 2G) (Figure 11.8)
Decrease UIC performance (11U, 4G) (Figure 11.7)</td></tr>
<tr><td colspan="5">*Additional comments:

(6U, 2G): Low degree of university autonomy from government has a negative impact on structure of TTOs in universities (OS2), because their hierarchical structure is defined directly by MSRT and there is no autonomy for university’s top management to change this. If this situation remains unchanged and there is no autonomy for universities regarding these issues, other efforts will be meaningless; because all activities of these offices and the availability of right mixture of the people depends heavily on the budget of these offices and when there is no autonomy for universities to allocate budget properly, there will be no hope to improve the structure of these offices.</td></tr>
</table>

Table 11.9: Government sub-system and its related elements and connections in the first scenario

<table>
<tr><th>Coding</th><th>Description</th><th>Connections and weights</th></tr>
<tr><td>GOV5</td><td>“Inefficiency of national policy on IP rights and enforcement of laws”</td><td>Decrease UIC performance (11U, 9I, 12G) (Figure 11.7)
OS1 (11U, 9I, 12G) (Figure 11.8)
OC1 (11U, 9I, 12G) (Figure 11.8)
GOV8 (11U, 9I, 12G) (Figure 11.7)
GOV9 (11U, 9I, 12G) (Figure 11.7)</td></tr>
<tr><td colspan="3">*Additional comments:
(1I): If this situation continues in the future and there is no IPR policy in national level, the willingness towards buying technology rather than focusing on domestic capabilities for production will be increased.

(1G): The organization responsible for IPR is under juridical system, but it is designed in a very low level of the chart of this ministry which reflects the low degree of importance of IPR in the country.

(1G): “Strengthening national IPR policy and protection especially based on TRIPP agreement might be considered as a disadvantage for the country especially in a short term; because if government increases protection of IPR, then huge amount of money will be out from the country which is not desirable. Therefore, weakness of this factor is also influenced by low level of willingness of the government to support it. But if this situation continues in the long-term it would be less opportunity to join WTO for the country, which is a threat”.</td></tr>
<tr><td>GOV6</td><td>“Inefficiency of activities of venture capital”</td><td>Decrease UIC performance (11U, 9I, 12G) (Figure 11.7)
AST3 (6U) (Figure 11.8)
GOV8 (11U, 9I, 12G) (Figure 11.7)
GOV9 (11U, 9I, 12G) (Figure 11.7)</td></tr>
<tr><td colspan="3">*Additional comments:
(6U): Inefficiency of venture capital in the country has a negative impact on TTO’s effort to support spin-off creation form academia (AST3).</td></tr>
<tr><td>GOV7</td><td>“Weak government financing support system”</td><td>GOV6 (4U, 6I, 9G) (Figure 11.7)</td></tr>
<tr><td colspan="3">*Additional comments:
(1I): There is a deficiency in public venture capital. Government’s lack of constant financial support is a problem; which always make a problem in receiving the agreed budget. He had a complaint that they rarely receive the budget on time and often it leads to fail the projects which are already in operation.

(4U, 6I, 9G): If this situation continues in the future, there will be less opportunity to create entrepreneurial environment in the country.

(1I): “It is not clear in the current situation that who actually support VC investors in Iran.

(1I): “One of the strengths of the first scenario is the availability of second market for investments in order to sell or buy shares e.g. effective mechanism in stock exchange, which can motivate investors”.

(1U, 4I, 2G): Deficiency of government financing support policy for start-ups and lack of monitoring control system, have allowed large-scale redirection of direct government investment to companies to be directed into areas which have more short-term profitability (e.g. construction industry), and if this continues in the future it will decrease level of government trust with companies which is not desirable.

(1G): Most of the ministries under government like MSRT and MIM have allocated VC budget to support start-ups, however, this budget are not allocated fairly and properly to the applicants which de-motivate entrepreneurship in the country. He commented that there is no organization available to monitor and organize public VC industry properly.</td></tr>
<tr><td>GOV8</td><td>“Weak performance of intermediary agents e.g. science and technology parks and incubators”</td><td>Decrease UIC performance (9U, 7I, 12G) (Figure 11.7)
LC1 (9U, 7I, 12G) (Figure 11.8)
LC2 (9U, 7I, 12G) (Figure 11.8)
LC3 (9U, 7I, 12G) (Figure 11.8)
LC4 (8U, 7I, 12G) (Figure 11.8)
LC5 (9U, 12G) (Figure 11.8)
LC7 (3U, 5I, 1G) (Figure 11.8)
GOV9 (9U, 7I, 12G) (Figure 11.7)</td></tr>
<tr><td colspan="3">*Additional comments:
Majority of respondents believed that because companies put a huge amount of investment in this kind of intermediary agents for collaboration and also university did the same and invest huge amount of money (e.g. incubator facilities) but they did not get any proper return for their investment, UIC performance will be decreased in the long term. It will also have a negative impact in long term on the process of cluster formation.</td></tr>
</table>

Table 11.9 (continued): Government sub-system and its related elements and connections in the first scenario

<table>
<tr><th>Coding</th><th>Description</th><th>Connections and weights</th></tr>
<tr><td>LOOPS</td><td>“Decreasing UIC performance”</td><td>GOV8 (19 people in the pool) (See Loops R27, R28, R29, R41, R42, R43, R33, R34, R35, R39) (Figure 11.8)</td></tr>
<tr><td>GOV9</td><td>“Weak status of cluster formation and un-favourability of entrepreneurial environment”</td><td>Decrease UIC performance (11U, 9I, 12G) (Figure 11.7)
LC9 (4U, 2I, 3G) (Figure 11.8)
LC8 (2U, 4I, 2G) (Figure 11.8)
GOV10 (6U, 7I, 11G) (Figure 11.7)</td></tr>
<tr><td colspan="3">*Additional comments:

(3G): If this situation continues in the future it will make a threat for “future outlook of the country in 1404=2025” which considers country as a first economic power in the region. One of them also commented that “it will be a strong competition in the near future in the region. Even our neighbour countries which are far behind us will be an economic power in the near future”.

(5U, 2I, 1G): Apart from availability of entrepreneurial environment, other factors like political issues, low standard of living and experiencing different standard of living abroad are considered as other major factors to have an impact on decision of entrepreneurs to leave the country; therefore, brain drain (GOV10) is increased in the first scenario.</td></tr>
<tr><td>LOOPS</td><td>“Decreasing UIC performance”</td><td>GOV8 (7U, 4I, 6G) (See Loops R15, R16a) (Figure 11.7)
GOV9 (7U, 4I, 6G) (See Loop R16b) (Figure 11.7)
OC1 (5U, 3I, 3G) (See Loop R18a) (Figure 11.8)</td></tr>
<tr><td>GOV10</td><td>“Increasing brain drain”</td><td>Decrease UIC performance (11U, 9I, 12G) (Figure 11.7)</td></tr>
<tr><td>LOOPS</td><td>“Decreasing UIC performance”</td><td>GOV8 (2U, 3I, 5G) (See Loop R17a) (see Figure 11.7)
GOV9 (2U, 3I, 5G) (See Loop R17b) (see Figure 11.7)
OC1 (5U, 3I, 3G) (See Loop R18b) (see Figure 11.8)</td></tr>
<tr><td>GOV11</td><td>“Inefficiency of privatisation policy”</td><td>Decrease UIC performance (9I, 9G) (Figure 11.7)
GOV9 (7I, 6G) (Figure 11.7)</td></tr>
<tr><td colspan="3">*Additional comments:

(1G): “Although government is trying to privatise the economy; however, still the golden shares of privatised companies are related to government which is not efficient”.</td></tr>
<tr><td>GOV12</td><td>“High level of government monopolies in market”</td><td>GOV9 (7I, 6G) (Figure 11.7)
GOV11 (9I, 9G) (Figure 11.7)</td></tr>
<tr><td colspan="3">*Additional comments:

(1G): “Currently government is trying to establish national competitiveness group in order to promote competitiveness in the country; however, without decreasing monopolies it will be no success in the first scenario”.</td></tr>
<tr><td>GOV13</td><td>“Inefficiency of databases for entrepreneurs”</td><td>GOV9 (2U, 7I, 5G) (Figure 11.7)</td></tr>
<tr><td colspan="3">*Additional comments:

(2U, 7I, 5G): Incomplete databases about the current situation of specific cluster, number of companies currently active, potential opportunities for investment and potential financing support policies are major issues which were raised by these respondents and they declared that if this situation continues in the future, it will de-motivate entrepreneurs for investment.</td></tr>
<tr><td>GOV14</td><td>“High government natural resources income”</td><td>GOV15 (1U, 3I, 4G) (Figure 11.7)</td></tr>
<tr><td>GOV15</td><td>“Decreasing government value people creativity”</td><td>GOV9 (1U, 3I, 4G) (Figure 11.7)</td></tr>
<tr><td colspan="3">*Additional comments:

(1U, 3I, 4G): If this situation continues in the future and government do not value people creativity, it will decrease the level of trust to government in terms of supporting entrepreneurs; which will have negative impact on cluster formation and development.</td></tr>
</table>

Table 11.9 (continued): Government sub-system and its related elements and connections in the first scenario

<table>
<tr><th>Coding</th><th>Description</th><th colspan="4">Connections and weights</th></tr>
<tr><td rowspan="2">GOV16</td><td rowspan="2">“Weakness in political relation and less probability of Iranian entry to the WTO”</td><td colspan="4">GOV5 (2G) (Figure 11.7)
GOV9 (3I, 5G) (Figure 11.7)</td></tr>
<tr><td colspan="2">Decrease motivation of companies (5I, 9G)</td><td colspan="2">Decrease UIC performance (5I, 9G) (Figure 11.7)</td></tr>
<tr><td rowspan="2">GOV17</td><td rowspan="2">“Increasing embargos imposed by the West”</td><td colspan="2">Increase motivation of companies (7I, 9G)</td><td colspan="2">Increase UIC performance (7I, 9G) (Figure 11.7)</td></tr>
<tr><td colspan="4">GOV18 (6I, 5G) (Figure 11.7)</td></tr>
<tr><td colspan="6">*Additional comments:

(7I, 9G): By increasing embargoes in the future and increasing limitation for joint activities with foreign partners, companies’ motivation to collaborate with university partners to survive in the market will be increased. Increasing embargoes and greater limitations for joint activities with foreign partners, causes a short-term motivation to collaborate with universities to survive in the market. However, many other problems such as IPR issues, bureaucracy of universities limit the degree of success.

(1I): “Increasing embargo can increase motivation of companies to collaborate with local university partners for their every day needs; however, because of low probability to join the WTO, there is no strong force to compete with international market. Therefore, there would be no strong force for innovation”.</td></tr>
<tr><td>GOV18</td><td>“Decreasing export opportunities and increasing the risk of investment “</td><td colspan="4">GOV9 (6I, 5G) (Figure 11.7)</td></tr>
<tr><td colspan="6">*Additional comments:

(6I, 5G): By increasing embargoes the risk of investment will be increased and also export opportunities are decreased and there is no attraction to invite more FDI or Joint Ventures especially in biotechnology and car manufacturing industry.</td></tr>
<tr><td>GOV19</td><td>“Inefficiency of government programmes to enhance awareness/training for entrepreneurial activities”</td><td colspan="4">Decrease UIC performance (8U, 6I, 12G) (Figure 11.7)
GOV9 (8U, 6I, 12G) (Figure 11.7)</td></tr>
<tr><td colspan="6">*Additional comments:

Rest of the respondents in the pool had different views. They mentioned that this factor does not have an impact on willingness of the people to act entrepreneurially and it does neither have an impact on UIC performance nor on cluster formation.</td></tr>
<tr><td>GOV20</td><td>“High level of corruption in government for allocating resources to entrepreneurs”</td><td colspan="4">GOV21 (2U, 2G) (Figure 11.7)
GOV21* (3I, 2G) (Figure 11.7)</td></tr>
<tr><td>GOV21</td><td>“Decreasing trust between entrepreneurs within universities and government”</td><td>Decrease motivation of individuals within universities (2U, 2G)</td><td>Decrease UIC performance (2U, 2G)</td><td colspan="2">GOV21 (2U, 2G); See Loop R11 (Figure 11.7)</td></tr>
<tr><td>GOV21*</td><td>“Decreasing trust between entrepreneurs and government”</td><td>Decrease motivation of companies (3I, 2G)</td><td>Decrease UIC performance (3I, 2G)</td><td colspan="2">GOV21* (3I, 2G); See Loop R13 (Figure 11.7)</td></tr>
<tr><td rowspan="3">LC8</td><td rowspan="3">“Lack of team working and cooperation culture”</td><td>Decrease UIC performance (2U, 4I, 2G)</td><td>GOV9
(2U, 4I, 2G)</td><td></td><td>LC8
(2U, 4I, 2G)
See Loop R26b (Figure 11.8)</td></tr>
<tr><td>Decrease UIC performance (2U, 4I, 2G)</td><td>GOV8(2U, 4I, 2G)</td><td>GOV9(2U , 4I, 2G)</td><td>LC8 (2U, 4I, 2G); See Loops R19, R21 (Figure 11.8)</td></tr>
<tr><td>Decrease UIC performance (2U, 3I, 2G)</td><td>OC1
(2U, 3I, 2G)</td><td>GOV9
(2U, 3I, 2G)</td><td>LC8 (2U, 3I, 2G); See Loops R20, R26a (Figure 11.8)</td></tr>
</table>

Table 11.9 (continued): Government sub-system and its related elements and connections in the first scenario

Coding	Description	Connections and weights			
LC9	"Traditional style of management in SMEs"	Decrease UIC performance (4U, 2I, 3G)	GOV9 (4U, 2I, 3G)		LC9 (4U, 2I, 3G); See Loop R51(Figure 11.8)
		Decrease UIC performance (4U, 2I, 3G)	GOV8(4U, 2I, 3G)	GOV9 (4U, 2I, 3G)	LC9 (4U, 2I, 3G); See Loops R47, R49 (Figure 11.8)
		Decrease UIC performance (4U, 2I, 3G)	OC1 (4U, 2I, 3G)	GOV9 (4U, 2I, 3G)	LC9 (4U, 2I, 3G); See Loops R48, R50 (Figure 11.8)
GOV22	"Government negative view about property ownership and capitalism of individual"	GOV5 (1U, 3I, 2G) (Figure 11.7)			
***Additional comments:** (1I): "*Prevailing negative view by the government on individual capitalism is a major factor which makes a barrier for strengthening IPR policy in Iran and if this situation remains unchanged in the future it would be a threat for promoting IPR protection policy*". (1U, 3I, 2G): If this situation continues in the future, it will make a threat for growing private-owned businesses and it will have a detrimental impact on cluster development. However, one of the respondents commented that this view is relatively moderated recently compared to 20 years ago.					
GOV23	"Bureaucratic procedure to form start-ups"	GOV9 (5I, 4G) (Figure 11.7)			
GOV24	"Weakness of management in collaboration in intermediary agents"	GOV8 (9U, 7I, 12G) (Figure 11.7)			

Table 11.9 (continued): Government sub-system and its related elements and connections in the first scenario

The following section describes in detail the impact of three forces related to government sub-system. These forces include: "instability of government regulations regarding UIC" (GOV3), "inefficiency of reward and incentive systems for innovative firms when collaborating with universities" (GOV2), and "High government monopolies in market" (GOV12).

GOV3 (3U, 5I, 2G): The regulations for supporting universities and industry are instable; even when there is a sign of success for these regulations, because of the short life of these mechanisms for collaboration, people in universities and industry are confused and do not trust these programmes as permanent schemes. By changing Minister or even manager of a specific section, these programmes are changed radically. One of these people from MIM commented that, previously a popular programme was available by the name of 60/40. Basically it was designed to help companies; especially SMEs to collaborate with university partners and also helps universities to increase their funding. Government paid 60% of project cost and the rest were paid by industry. Based on his view, this programme achieved an acceptable level of success and companies were motivated to participate in this kind of initiative; but unfortunately because of government instability and changing the related Minister in 2006, new Minister changed the structure of this programme and introduce quite different mechanisms which are not efficient and as a result motivation of companies to collaborate in this kind of programmes decreased. This view aligned with one of the Archetypes introduced by Peter Senge in 1990 by the name of Limits to Growth (see Figure 11.5). His recommendation to achieve leverage is that the limiting factors should be identified and changed as soon as possible (Senge, 1990, p 95, see Section 6.3.1.3). In this case, the instability of government regulations is considered as limiting conditions which should be removed from this system to enable it to work properly. If this situation remains unchanged in the future, there will be little opportunity for successful UIC.

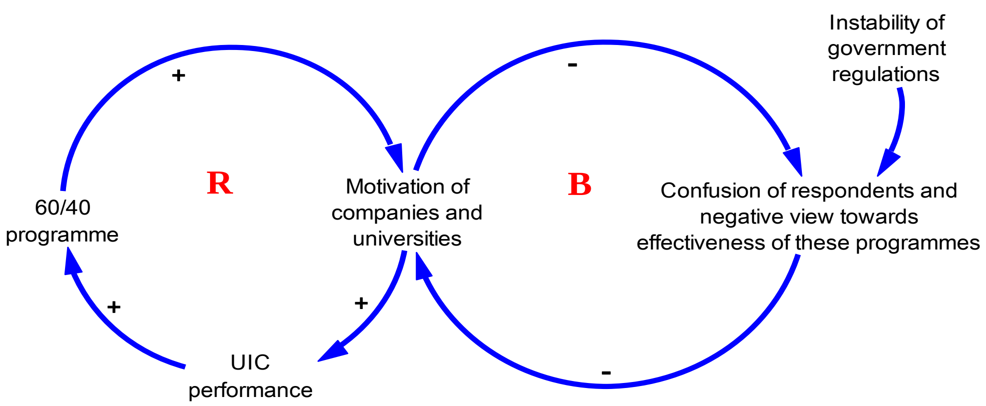


Figure 11.5: Limits to Growth (instability of government regulations and its impacts on UIC performance)

One of the respondents from MIM commented that "*although 60/40 programme was successful to some extent, however many companies requested government to decrease their shares to 20% in this programme; which was not accepted by government. Also weakness in IPR was one of the issues that the relation of many partners was not leading to long-term relationships and only focused on simple kind of mechanisms for collaboration*". According to his view and based on Senge's Archetype (Section 6.3.1.3), the weakness of IPR can be also considered as a limiting factor to growth of successful schemes like 60/40. After a short period of success, the weakness of IPR protection policy creates limiting conditions which impedes the success of these kind of programmes.

GOV2 (1G): One of the respondents from government who had a key position also commented that, tax incentives (until 2007) were introduced based on percentage of R&D that companies spent in their collaborative activities with universities. It was to some degree successful, because effective mechanisms were in place to monitor the performance of companies on a regular basis and a team dedicated to monitor the activities of companies. Companies were obliged to pay 0.2% of their income to government; thus based on their expenditure on their R&D related to university collaborations, this amount was decreased and by increasing the number of collaborations this amount was decreased again. However, recently the regulation has changed and a new scheme was introduced (2007). Currently this scheme is not effective at all to motivate companies. This scheme was designed based on a very low amount of loan provided by MIM and it is increased based on the number of collaborative activities. However, very bureaucratic procedure of this mechanism limited success. The new regulations are vague and likely to change again. There is no effective mechanism to monitor the activities of companies and amount of money they spend on their collaboration activities.

Four respondents from the industry side and two from MIM, however, commented that, although some government funding programmes e.g. 60/40 and also tax incentive systems were successful to some extent, because of a lack of efficient IPR protection and enforcement laws, participation of companies was not high and most of their involvement ended up with just simple forms of interaction e.g. consultation.

GOV12 (3I, 1G): Government currently is trying to encourage investment especially for cluster development and one of the main objectives is to increase competition in the country and to enhance entrepreneurial activities e.g. by giving loan to start-ups. However, because of government monopolies in market (GOV12), these programmes have a little chance for success. This activity of government is very similar to Shifting the Burden Archetype of Senge (1990). Senge (1990) declared that the underlying problem occurs and generates symptoms that need attention. But people searching for other solution to the problem rather than focusing on fundamental one. This seems very efficient temporarily, but leads to fundamental problem left unaltered and then leads to worse the underlying problem. Because the symptoms apparently removed, and the system have no abilities to solve the underlying problem (Senge, 1990, see Section 6.3.1.3). This issue is very similar to the current situation of Iran (and in the first scenario if the situation remains unchanged) where government is trying to temporarily motivate actors e.g. giving loans to participate in entrepreneurial activities and encourage competition; however, because of major problem (monopolies) is not solved fundamentally and the focus is more on temporary solutions, these programmes may achieve low degree of success in the future; but they will not be successful at the end because the major problem e.g. monopolies has remained in the system. Based on

Senge (1990) the way to achieve leverage is that the fundamental response should be strengthened and the symptomatic response should be weakened at the same time. Figure 11.6 shows this Archetype and explains what will happen if the situation remains unchanged in the future (first scenario).

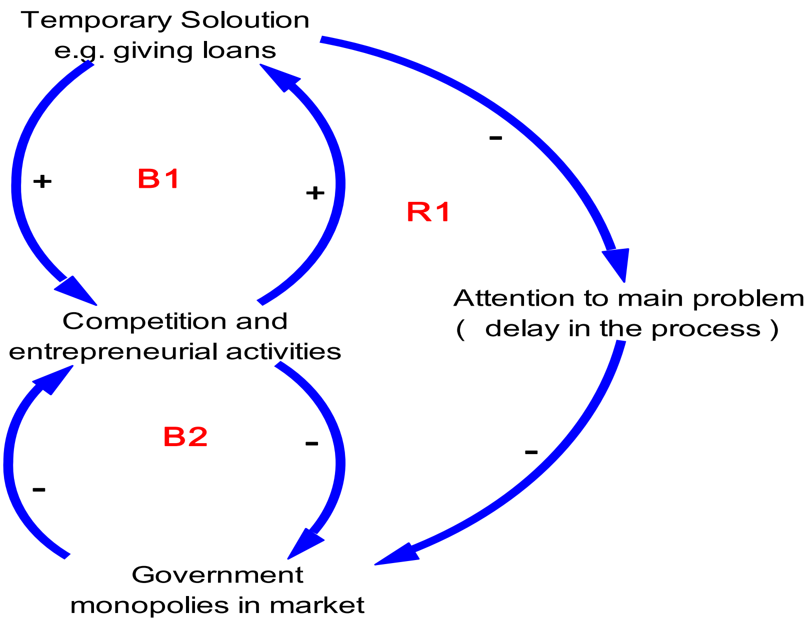


Figure 11.6: Shifting the Burden (Government monopolies in market and its consequences)

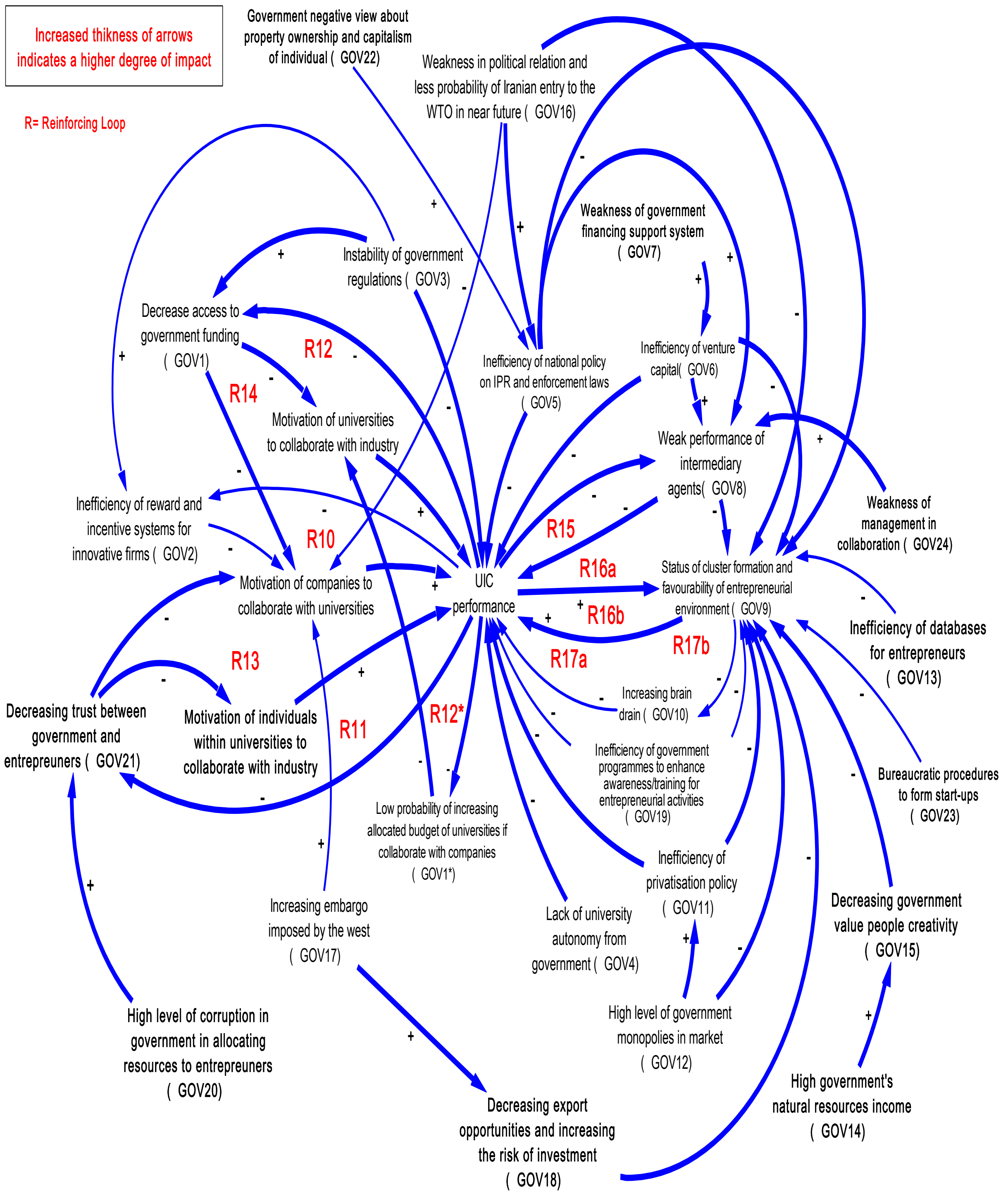


Figure 11.7: Government sub-system in the first scenario: constructed from the results of Table 11.9

11.3.1.6 Connection between sub-systems

The complete picture of connection between elements of different sub-systems and also all other reinforcing loops in the first scenario are presented in Figure 11.8.

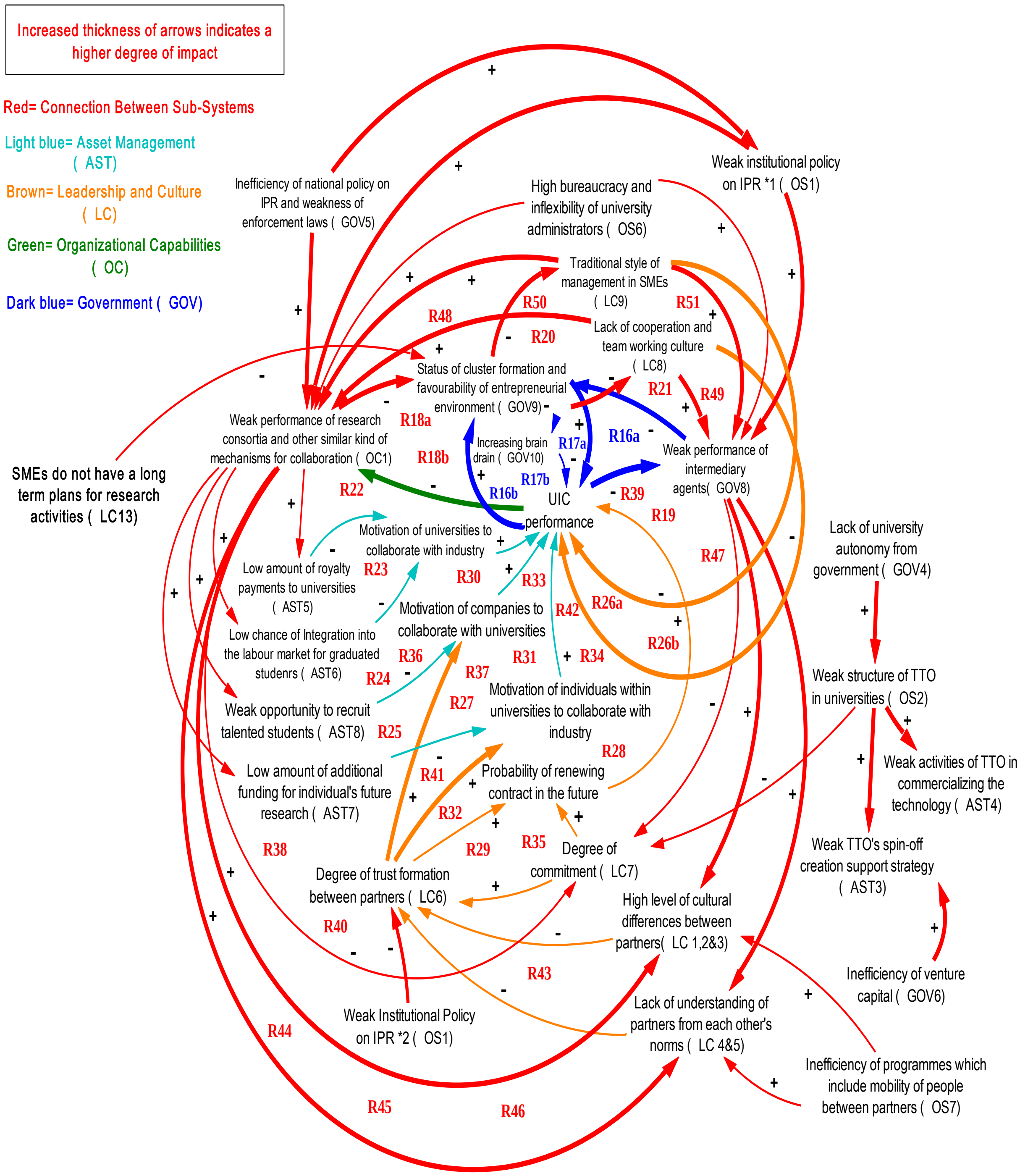


Figure 11.8: Relationship between elements of five sub-systems in the first scenario: constructed from the results in Tables 11.2, 11.3, 11.5, 11.7, and 11.9

11.4 SCENARIO SCRIPT 2 (EFFICIENCY-DRIVEN ECONOMY: CURRENT STATE + NEW POLICY FRAMEWORK + 15 YEARS)

The main activities here were to ask questions of respondents to find out their views on the impact of changing the direction of some forces in the system and how the system as a whole would respond. In other words, to depict the interactions between positive and negative forces in the system. Negative forces are those which still exist from the current state and positive forces are those which are entered to the system as a result of policy changes. The objective here is to enact a political, societal manifesto in order to observe the status of the UIC system of the country if a series of changes happen simultaneously. The list of these forces and proposed changes in direction are presented in Table 11.10. Table 11.10 provides a summary of literature, pilot testing of interview questions and also respondents' points of view which indicate the direction of specific forces in this stage of development. Table 11.10 provides literature support to changing direction of specific forces based on empirical experiences of countries at the same stage of development. Furthermore, Table 11.10 provides details regarding the direction of all forces in this scenario as a result of interactions with other forces. According to Table 11.10, based on the respondents points of view, as the result of changing some of these forces (cause) some other forces will be affected (effect). For example according to the respondents, because of the deficiency of research consortia, the cultural misunderstanding between partners exists. This view is also supported by Worasinchai et al., (2008) who found that cultural misunderstanding of the partners environment still exists in some other countries e.g. Thailand at the same stage of development as Iran in this scenario (Table 11.10).

Scenario 2: Efficiency -driven	**Main Features**	**Direction**	**Related Sub-System**	**References**
1.	Designing efficient rules regarding IPR in institutions	+ +	**OS**	(Inzelt, 2004; World Economic Forum, 2008)
2.	Clear royalty sharing formulas in universities and other intermediary agents	+ +	**OS**	(Inzelt, 2004; World Economic Forum, 2008)
3.	Weak IPR policy in terms of compatibility with international obligation	_ _	**GOV**	(Jayakar, 1997; Robert and Ostergard, 2000; Rooks and Oerlemans, 2005)

OS=Organizational Structure, AST= Asset Management, LC= Leadership and Culture, OC= Organizational Capabilities, GOV= Government

Table 11.10: Main features of the second scenario and direction of forces

Scenario 2: Efficiency -driven	Main Features	Direction	Related Sub-System	References
1.	Efficient national policy on IPR, but still weak enforcement law	_ +	**GOV**	(Jayakar, 1997; Robert and Ostergard, 2000)
2.	Government do not have negative view about property ownership and capitalism of individual	+ +	**GOV**	Respondnets
3.	Cultural misunderstanding environment among partners: • Unfamiliarity with norms of other partner • Time orientation differences • Secrecy vs. dissemination • Profit maximisation by companies	_ _	**LC**	(Respondents; Worasinchai et al., 2008)
4.	Lack of cooperation and team working culture among individual	_ _	**LC**	Respondents
5.	Traditional Style of management in SMEs	_ _	**LC**	Respondents
6.	SMEs still do not have a long-term plans for their research activities	_ _	**LC**	Respondents
7.	Less volatile university management	+ +	**LC**	Respondents
8.	Degree of commitment	_ +	**LC**	Respondents
9.	Weak potential for trust formation, but the situation is better compared to first scenario	_ +	**LC**	(Respondents; Worasinchai et al., 2008; Bouhamed et al., 2009; Singer and Peterka, 2009; Yokakul and Zawdie, 2009)
10.	Slow process of trust formation to strangers	_ _	**LC**	Respondents
11.	Changing negative view among university people to be more positive about earn money from research	+ +	**LC**	Respondents
12.	Still university have risk averse culture	_ _	**LC**	Respondents
13.	Efficient structure of Technology Transfer Office in university	+ +	**OS**	(Siegel and Phan, in Libercap, 2005)
14.	Strong TTO support from commercialization activities	+ +	**AST**	(Siegel and Phan, in Libercap, 2005)
15.	TTO support from Spin-off creation from university	_ +	**AST**	Respondents
16.	Inefficiency of universities promotion rules to evaluate faculty members based on their extent of relations with industry	_ _	**OS**	(Siegel et al., 2004)
17.	Inefficiency of methods for conveying knowledge between producer (university) and receiver (industry)	_ _	**OS**	
18.	High degree of bureaucracy and inflexibility of university administrators	_ _	**OS**	(Dzisah and Etzkowitz, 2008; Bouhamed et al., 2009; Singer and Peterka, 2009)
19.	University education system still is not aligned to industry needs	_ _	**OS**	Respondents
20.	Inefficiency of programmes which include mobility of people	_ _	**OS**	(Marques and Neto, 2007)
21.	Designing comprehensive reward system to reward technology transfer activities for researchers within university	+ +	**AST**	(Liu and Jiang, 2001)

Table 11.10 (continued): Main features of the second scenario and direction of forces

Scenario 2: Efficiency -driven	Main Features	Direction	Related Sub-System	References
1.	Weak performance of mechanisms for collaboration e.g. research consortia • Lack of government support • Weakness of management in collaboration	_ +	**OC**	(Respondents; Lima and Filho, 2009)
2.	Existence of corruption in government side, especially for allocating resources to entrepreneurs	_ _	**GOV**	(Respondents; Everhart et al., 2003; Veracierto, 2008)
3.	Government monopolies in market is decreased (still exist)	_ +	**GOV**	(Porter, 1990; Bitzenis, 2003; Wignaraja, 2003; World Economic Forum, 2008)
4.	Inefficiency of government in privatisation process is decreased, but still delay exist in the process	_ +	**GOV**	(Bitzenis, 2003; Pitelis in Wignaraja, 2003; Wignaraja, 2003)
5.	Decreasing embargo imposed by Western Government	+ +	**GOV**	Pilot testing of interview questions
6.	High probability to join the WTO	+ +	**GOV**	Pilot testing of interview questions
7.	Designing efficient programme for training entrepreneurs	+ +	**GOV**	(Krueger, 1993; Siegel and Phan, in Libercap, 2005)
8.	Still weak government financial support policy: • More stability of financial supporting schemes • Medium level support of public and private VC	_ +	**GOV**	(Porter, 1990; Knight in Bulumac and Bendis, 2001; Marques and Neto, 2007; World Economic Forum, 2008; Singer and Peterka, 2009)
9.	Huge natural resource income	_ _	**GOV**	Respondents
10.	Availability of efficient databases for entrepreneurs	+ +	**GOV**	(Respondents; Porter, 1990)
11.	Decreasing bureaucratic procedures to form start-ups	+ +	**GOV**	(Respondents; World Economic Forum, 2008)
12.	Increasing stability of government regulations	+ +	**GOV**	(World Economic Forum, 2008)
13.	Higher level of access to government funding if collaborate with partner	_ +	**GOV**	Respondents
14.	No mechanism available to increase university budget if cooperating more with industry	_ _	**GOV**	
15.	Efficiency of reward and incentive systems for innovative firms when collaborate with universities	_ +	**GOV**	(Respondents; Singer and Peterka, 2009)
16.	Increasing university autonomy from government	+ +	**GOV**	(Etzkowitz et al., 2000; Abd Razak and Saad, 2009; Saad and Abdelkader, 2009)
17.	Efficiency of government programmes to control brain drain	+ _	**GOV**	(Respondents; Davenport, 2004; World Economic Forum, 2008)
18.	Weak performance of intermediary agents • Weakness of management in collaboration	+ _	**GOV**	(Respondents; Lima and Filho, 2009)
19.	Increasing firms' R&D budget	+ _	**OC**	(World Economic Forum, 2008; Yokakul and Zawdie, 2009)

Table 11.10 (continued): Main features of the second scenario and direction of forces

The main questions which were asked of respondents for this scenario consisted of the following items (see Appendix D). It should be noted that all of these questions were provided to the respondents in advance of the interview and they were asked to develop the scenario script based on their considered opinion.

1- What will happen if universities change the structure of institutional IPR?
    - Develop guidelines for the management and exploitation of IPR in universities that consider issues relating to IP ownership with collaborative research programmes and/or contractual agreement with various partners.
    - Design clear institutional policy on royalty-sharing and the inclusion of benefits for researcher/inventor or his/her department.
2- What if technology transfer offices change their structure and recruit multidisciplinary teams including legal, IP, business development and financial experts in order to promote UIC?
3- What will happen if technology transfer offices gather all the necessary skills including marketing, technical and negotiation and operate on an appropriate scale?
4- What if TTOs proactively do the following activities:
    - Develop a strategy to market the technology
    - Identifying technologies with a commercial potential
    - Packaging the technology appropriately to attract industrial interest
5- What if universities change their financial reward system to reward technology transfer activities e.g. it is shifted based on academic favour in royalty and equity distribution formula?
6- If the political situation improves and firms in Iran increase the proportion of foreign strategic technology alliances and/or attract FDI, what will happen to?

- Competitiveness in the region?
- UIC performance?

7- What will happen if companies increase their R&D compared to the current state? (Medium-level expenditure on R&D).

8- If the Government introduces policies and actions to stem the flow of human capital (a control phase which force and regulate return and stay of human capital) particularly expensive trained scientific and technical human capital what will happen to level of UIC activities?

9- What will happen if the Government takes the following actions towards IPR protection?

   - Designing an efficient policy framework for IP at the national level
   - Still retains ineffectiveness in enforcement of IPR
   - Still retains weakness in IPR policy due to inconsistency with international obligations

10- What will happen if the Government introduces an efficient programme to enhance awareness/training for entrepreneurial activities?

11- What will happen if the Government shifts its policy for supporting technology-based companies (with risky nature of their activities) from traditional financing mechanism (that need real assets to secure loans) to risk capital (that do not require security and implies that return for investors depend on the growth and profitability of the company) (VC is still not widely available in this scenario).

12- What will happen if the Government legislates to grant the national universities autonomy from Government supervision in order to freely develop their research policy and relations with companies?

13- What will happen if international relations with other countries improve, paving the way for Iran to join the WTO?

14- What will happen if embargoes are decreased by Western Governments?

15- What if the Government reduces the state monopolies compared to the current situation (still monopolies exist)?

16- What if the Government privatisation process of industries is made more efficient compared to the current situation; but some delays still exist in the process?

17- What if the Government regulations regarding UIC become more stable?

11.4.1 Five sub-systems of the second scenario

The following sections provide results related to each of the five sub-systems from the second scenario and the way that sub-systems interact.

It should be noted that unlike the first scenario where most of the forces were negative, at this stage of development (15 years from the current state), there may be a confrontation between positive and negative forces; and the success of UIC and cluster activities depends on how strong the positive forces are to overcome the negative ones.

11.4.1.1 Organizational Structure sub-system (OS)

Table 11.11 includes the results related to each element of the Organizational Structure sub-system in the second scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td rowspan="3">OS1</td><td rowspan="3">"Increasing efficiency of institutional policy on IP rights"</td><td colspan="2">LC6 (11U, 9I, 12G) (Figure 11.14)
OC1 (11U, 9I, 12G) (Figure 11.14)
GOV8 (11U, 9I, 12G) (Figure 11.14)</td></tr>
<tr><td>Increase motivation of companies to collaborate with universities (7I, 9G)</td><td>Increase UIC performance (7I, 9G)
(Figure 11.9)</td></tr>
<tr><td>Increase motivation of individuals within universities to collaborate with companies (11U, 4G)</td><td>Increase UIC performance (11U, 4G)
(Figure 11.9)</td></tr>
<tr><td colspan="4">*Additional comments:

(11U, 9I, 12G): Although all respondents acknowledged the positive impact of increasing efficiency of institutional IPR; however, all agreed that because of the weakness of enforcement laws (GOV5); there will be no potential that the collaboration, particularly more sophisticated forms achieve high level of success in the future in this scenario

1(U): "Although positive signals for collaboration exists, however most of the actors on both sides still feel insecure because of the absence of strong enforcement laws and therefore a high level of collaboration will not be expected".

(1G): "There will be radical improvements compared to the first scenario because researchers are at least aware of the ownership of invention and possible share for commercialization; however the situation still is not desirable".</td></tr>
<tr><td>OS2</td><td>"Efficient structure of technology transfer offices in universities (recruiting multidisciplinary teams)"</td><td colspan="2">Increase UIC performance (11U, 4G) (Figure 11.9)
OS1 (8U, 2G) (Figure 11.9)
OS3 (8U, 2G) (Figure 11.9)
AST3 (6U) (Figure 11.14)
AST4 (6U) (Figure 11.14)
LC7 (3U, 1G) (Figure 11.14)</td></tr>
<tr><td colspan="4">*Additional comments:

(1G): "Availability of IP experts in TTOs in this scenario is the main prerequisite of success in implementing efficient IPR policy in universities (OS1)".

(2U, 1G): Because of the efficient structure of TTOs in universities, the level of contractual commitment between partners (LC7) will be increased; especially commitment of universities to industry.

(6U): Some of the prerequisites of supporting spin-off company formation (AST3) from universities exist in this scenario. These include the efficient structure of TTOs and availability of experts in various disciplines which can help researchers and entrepreneurs to identify the degree of market success of their invention.</td></tr>
</table>

Table 11.11: Organizational Structure sub-system and its related elements and connections in the second scenario

Coding	Description	Connections and weights	
OS3	"Increasing efficiency of institutional policy on royalty sharing"	Increase motivation of individuals within universities (11U, 4G)	Increase UIC performance (11U, 4G) (Figure 11.9)
***Additional comments:** (1U): "*Availability of efficient royalty-sharing formulas encourages researchers to collaborate with companies especially through formal mechanisms of collaboration. In this case researchers/inventors will be assured that their royalty share will be paid with fairness and no individual decision maker in institution can change it*".			
OS4	"Absence of programme which evaluate faculty members based on their extent of relations with industry"	Decrease motivation of individuals within universities (11U, 4G)	Decrease UIC performance (11U, 4G) (Figure 11.9)
OS5	"Deficiency of methods for conveying knowledge between universities and industry e.g. frequency of site visits by industry and plant visits by researchers"	Decrease UIC performance (8U, 8I) (Figure 11.9)	
OS6	"Still high bureaucracy and inflexibility of university administrators (internal bureaucracy)"	Decrease UIC performance (11U, 9I) (Figure 11.9) OC1 (5U, 7I) (Figure 11.14) GOV8 (5U, 7I) (Figure 11.14)	
OS7	"Inefficiency of programmes which includes mobility of people between partners"	Decrease UIC performance (9U, 6I, 7G) (Figure 11.9) LC1 (5U, 3I, 5G) (Figure 11.14) LC2 (5U, 3I, 5G) (Figure 11.14) LC3 (5U, 3I, 5G) (Figure 11.14) LC4 (5U, 3I, 5G) (Figure 11.14) LC5 (5U, 3I, 5G) (Figure 11.14)	
OS8	"Still Low opportunities for UIC in this scenario (more complex form); therefore, Still University education system is misaligned to industry needs (OS8)"	Decrease UIC performance (2U, 4I, 1G) (See loop R52) (Figure 11.9)	
***Additional comments:** (2U, 4I, 1G): Although they are major improvements in UIC especially in simpler forms of collaboration; however, still it is not strong enough to force universities align their education systems according to industry needs. Therefore UIC performance is decreased (see Loop R52).			

Table 11.11 (continued): Organizational Structure sub-system and its related elements and connections in the second scenario

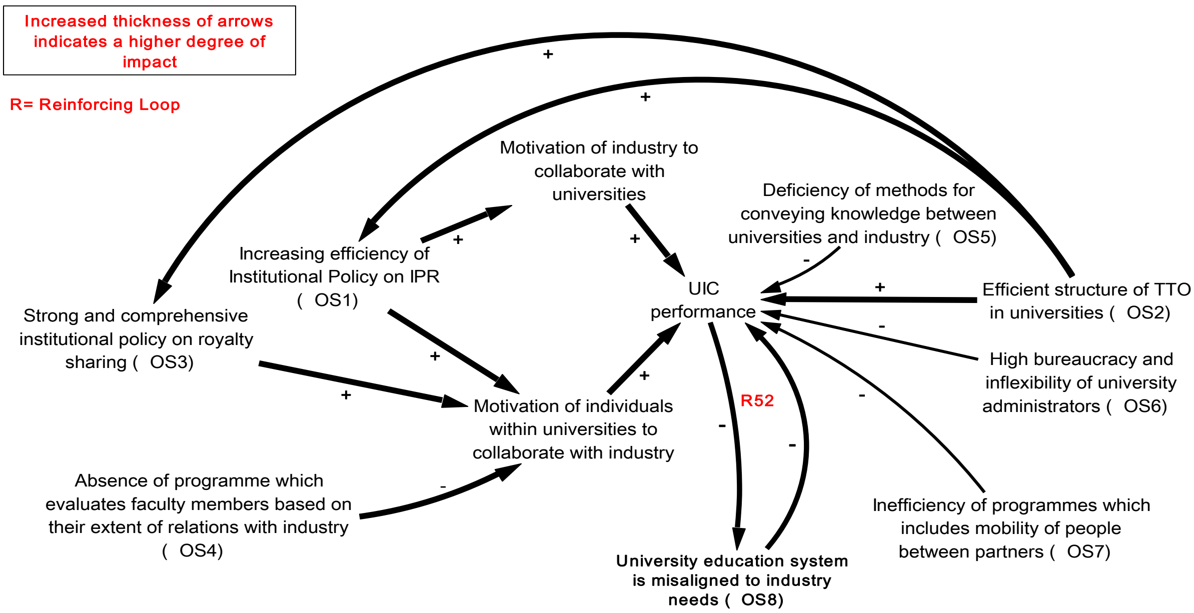


Figure 11.9: Organizational Structure sub-system in the second scenario: constructed from the results in Table 11.11

11.4.1.2 Asset Management sub-system (AST)

Table 11.12 includes results related to each element of the Asset Management sub-system in the second scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>AST1</td><td>“Efficient and comprehensive reward system to reward technology transfer activities of researchers e.g. when it shifts based on academic favour in royalty and equity distribution formula”</td><td>Increase motivation of individuals within universities (11U)</td><td>Increase UIC performance (11U)
(Figure 11.10)</td></tr>
<tr><td>AST2</td><td>“Availability of various skills in technology transfer offices e.g. Marketing, technical and negotiation skills”</td><td colspan="2">Increase UIC performance (11U, 9I, 12G) (Figure 11.10)</td></tr>
<tr><td colspan="4">*Additional comments:

(8U, 4I, 6G): Availability of negotiation skills in TTOs in this scenario was considered as an advantage which can facilitate trust formation between partners in collaboration.

(1I): “High level of trust in collaboration depends on the negotiation skills of the people in TTOs to ensure companies that every single process will be supervised by this office. Availability of such a skill can also decrease every kind of conflict that might happen in the collaboration”.</td></tr>
<tr><td>AST3</td><td>“Still Weak TTOs Spin-off creation support strategy- the situation is improved compared to the first scenario”</td><td colspan="2">Decrease UIC performance (11U) (Figure 11.10)</td></tr>
<tr><td colspan="4">*Additional comments:

(11U): Although some advantages exist to support spin-off formation e.g. increasing efficiency of institutional IPR; however, in this scenario like previous scenario, weak policy exists for spin-off company formation and support in TTOs. The critical success factor for formation of spin-off companies which is strong enforcement laws for IPR is not in place yet.

(1U): “Although some of the basic requirements for spin-off formation exist, however, there is still lack of entrepreneurial orientation in TTOs to support these activities”.</td></tr>
<tr><td>AST4</td><td>“Improving activities of TTOs to commercialize the technology including: Improving strategy of TTOs to market the technology, Improving TTOs activities to identify technology with commercial potential, Improving TTOs activities to package the technology appropriately”</td><td colspan="2">Increase UIC performance (11U) (Figure 11.10)</td></tr>
<tr><td colspan="4">*Additional comments:

(11U): Because of the ability of these offices to identify the technology with a commercial potential; the probability of commercialization success will be increased. As a result, the probability of overestimation or underestimation of the technology will be decreased.

(9U): Despite the huge improvement compared to the first scenario, for those connections with industry which requires strong protection of IPR e.g. enforcement laws (GOV5); still this scenario is not successful in the later stage of commercialization process.</td></tr>
</table>

Table 11.12: Asset Management sub-system and its related elements and connections in the second scenario

Coding	Description	Connections and weights	
AST5	"Increasing amount of royalty payments to university through simpler kind of mechanisms for collaboration not complex one e.g. research consortia"	Increase motivation of universities to some extent (11U, 4G)	Increase UIC performance to some extent (11U, 4G) (Figure 11.10)
AST6	"High chance of integration into the labour market for graduated students through simpler kind of mechanisms for collaboration not complex one e.g. research consortia"	Increase motivation of universities to some extent (10U, 4G)	Increase UIC performance to some extent (10U, 4G) (Figure 11.10)
AST7	"Increasing amount of additional funding for individual future research through simpler kind of mechanisms for collaboration not complex one e.g. research consortia"	Increase motivation of individuals within universities to some extent (11U, 1G)	Increase UIC performance to some extent (11U, 1G) (Figure 11.10)
AST8	"Increasing opportunity to recruit talented students through simpler kind of mechanisms for collaboration not complex one e.g. research consortia"	Increase motivation of companies to some extent (6I, 9G)	Increase UIC performance to some extent (6I, 9G) (Figure 11.10)
***Additional comments:** Majority of the respondents within the pool had general consensuses that although as a result of improving UIC performance, there are lots of chances for both partners to get benefits for their organizations compared to the first scenario (more chance for universities to increase their royalty share from collaboration (AST5), more chance for students to integrate into the labour market (AST6), the amount of additional funding for researchers when collaborating with companies will be increased (AST7), and there would be more chance for companies to recruit talented students from universities (AST8); however, majority of them stressed that in this scenario only these benefits are available for more simpler kinds of interaction because still more complex forms of interactions are either absent or weak in this stage of development e.g. research consortia.			

Table 11.12 (continued): Asset Management sub-system and its related elements and connections in the second scenario

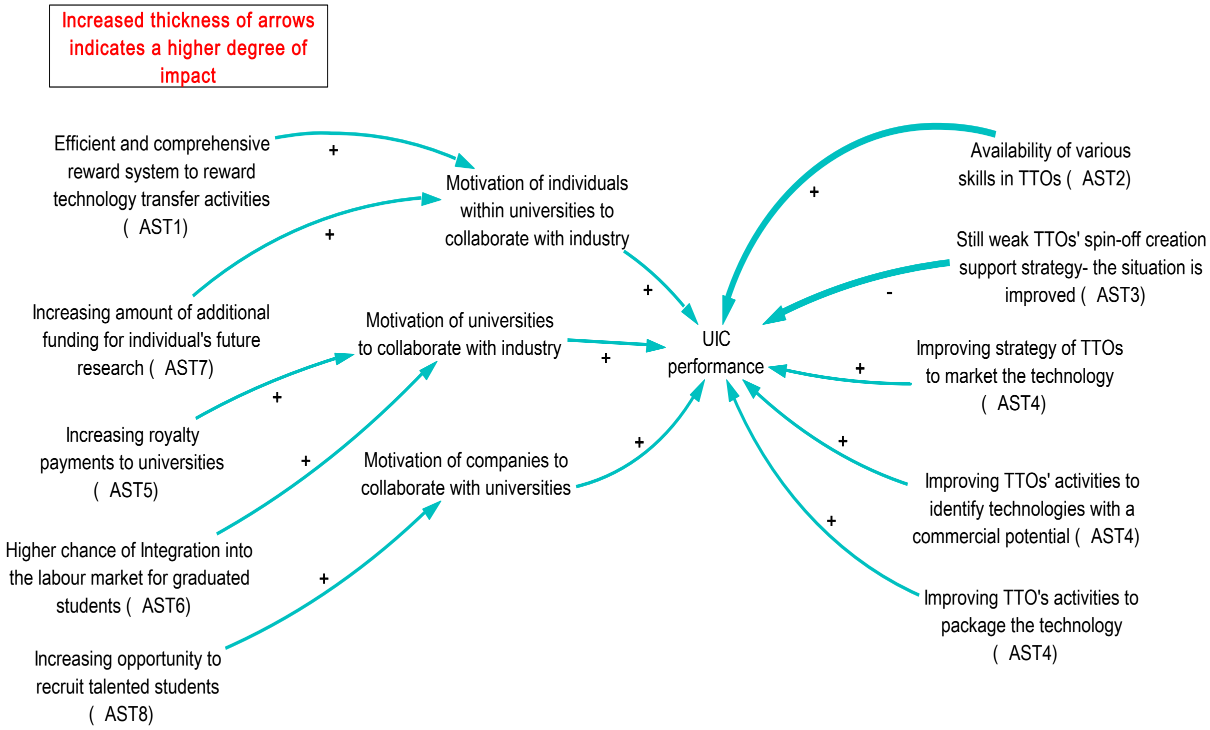


Figure 11.10: Asset Management sub-system in the second scenario: constructed from the results in Table 11.12

11.4.1.3 Leadership and Culture sub-system (LC)

Table 11.13 includes results related to each element of the Leadership and Culture sub-system in the second scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>LC1</td><td>“Still high level of cultural differences in university-industry collaboration (secrecy vs. dissemination)”</td><td colspan="2">LC6 (11U, 9I, 12G) (Figure11.11)

Decrease UIC performance (11U, 9I, 12G) (Figure 11.11)</td></tr>
<tr><td colspan="4">*Additional comments:

Although respondents had a general consensus that UIC performance is improved in this scenario compared to the first one, however, majority of them declared that there are not enough interactions available to promote cultural aspects of collaboration; which means that the collaboration is not strong enough to decrease the cultural differences between partners.

Another respondent from industry commented that “to decrease the cultural misunderstanding environment; the interaction should be repeated and it requires more complex forms of interaction; which is the weakness of second scenario”.</td></tr>
<tr><td>LC2</td><td>“Still high level of cultural differences in university-industry collaboration (time orientation differences)”</td><td colspan="2">LC6 (11U, 7I, 12G) (Figure 11.11)

Decrease UIC performance (11U, 7I, 12G) (Figure 11.11)</td></tr>
<tr><td>LC3</td><td>“Still high level of cultural differences in university-industry collaboration (profit maximization)”</td><td colspan="2">LC6 (11U, 12G) (Figure 11.11)

Decrease UIC performance (11U, 12G) (Figure 11.11)</td></tr>
<tr><td>LC4</td><td>“Still Lack of understanding of industry norms by university people”</td><td colspan="2">LC6 (8U, 9I, 12G) (Figure 11.11)
Decrease UIC performance (8U, 9I, 12G) (Figure 11.11)</td></tr>
<tr><td>LC5</td><td>“Still Lack of understanding of university norms by industrial people”</td><td colspan="2">LC6 (11U, 12G) (Figure 11.11)

Decrease UIC performance (11U, 12G) (Figure 11.11)</td></tr>
<tr><td rowspan="3">LC6</td><td rowspan="3">“Decreasing opportunities for trust formation between partners through more complex forms of collaboration; opportunities available for trust in simpler mechanisms for collaboration ”</td><td>Decrease motivation of companies (9I, 9G)</td><td>Decrease UIC performance (9I, 9G) (Figure 11.11)</td></tr>
<tr><td>Decrease motivation of individuals within universities (11U, 4G)</td><td>Decrease UIC performance (11U, 4G) (Figure 11.11)</td></tr>
<tr><td>Decrease probability of renewing contract in the future (11U, 9I)</td><td>Decrease UIC performance (11U, 9I) (Figure 11.11)</td></tr>
<tr><td rowspan="2">LC7</td><td rowspan="2">“Still low degree of commitment between partners; however the situation is improved compared to the first scenario (not strong enough)”</td><td colspan="2">LC6 (3U, 5I, 1G) (Figure 11.11)</td></tr>
<tr><td>Decrease probability of renewing contract in the future (9U, 9I)</td><td>Decrease UIC performance (9U, 9I) (Figure 11.11)</td></tr>
<tr><td colspan="4">*Additional comments:

(3U, 1G): The major differences between second and first scenario is that, in the first scenario there was no opportunity for increasing commitment among partners in collaboration and it leads to many negative consequences. According to them, the strength of the second scenario is that it can create an opportunities for increasing commitment between partners in other ways e.g. through TTO support of the collaboration. Therefore, opportunities –although it’s not too many- exist for trust formation.</td></tr>
</table>

Table 11.13: Leadership and Culture sub-system and its related elements and connections in the second scenario

Coding	Description	Connections and weights
LC8	"Lack of Team working and cooperation culture"	OC1 (2U, 3I, 2G) (Figure 11.14) GOV8 (2U, 4I, 2G) (Figure 11.14) Decrease UIC performance (2U, 7I, 5G) (Figure 11.11)
LC9	"Traditional style of management in SMEs "	OC1 (4U, 2I, 3G) (Figure 11.14) GOV8 (4U, 2I, 3G) (Figure 11.14) Decrease UIC performance (6U, 2I, 3G) (Figure 11.11)
LC10	"Very slow process of trust formation between strangers"	LC6 (3U, 5I) (Figure 11.11)
LC11	"Higher opportunities for UIC in this scenario (in simpler forms); therefore, no negative view among university people to earn money from research (LC11)"	Increase UIC performance (3U) (See loop R53) (Figure 11.11)
***Additional comments:** (3U): Due to the advantage of this scenario which provides more opportunities for UIC; negative view towards researchers who wants to earn money as a product of their research will be moderated compared to the first scenario; and because the collaboration between partners especially in simpler forms is more prevalent; therefore the negative environment towards entrepreneurial activities and making profit from research will be lower than the first scenario. This situation makes a ground for universities to pursue easily their entrepreneurial objectives and this will enhance UIC performance.		
LC12	"Less volatile university management"	Increase UIC performance (3U, 2I) (Figure 11.11)
LC13	"Still Low opportunities for UIC in this scenario (more complex form), and still weak cluster activities; therefore, SMEs in Iran still do not have a long-term plans for research activities (LC13)"	Decrease UIC performance (See Loop R54) (4U, 4I, 3G) (Figure 11.11) GOV9 (4U, 4I, 3G) (See Loop R55) (Figure 11.14)
LC14	"Because of lack of entrepreneurial orientation in universities; still universities have risk-averse culture (LC14)"	Decrease UIC performance (See loop R56) (3U, 1G) (Figure 11.11)

Table 11.13 (continued): Leadership and Culture sub-system and its related elements and connections in the second scenario

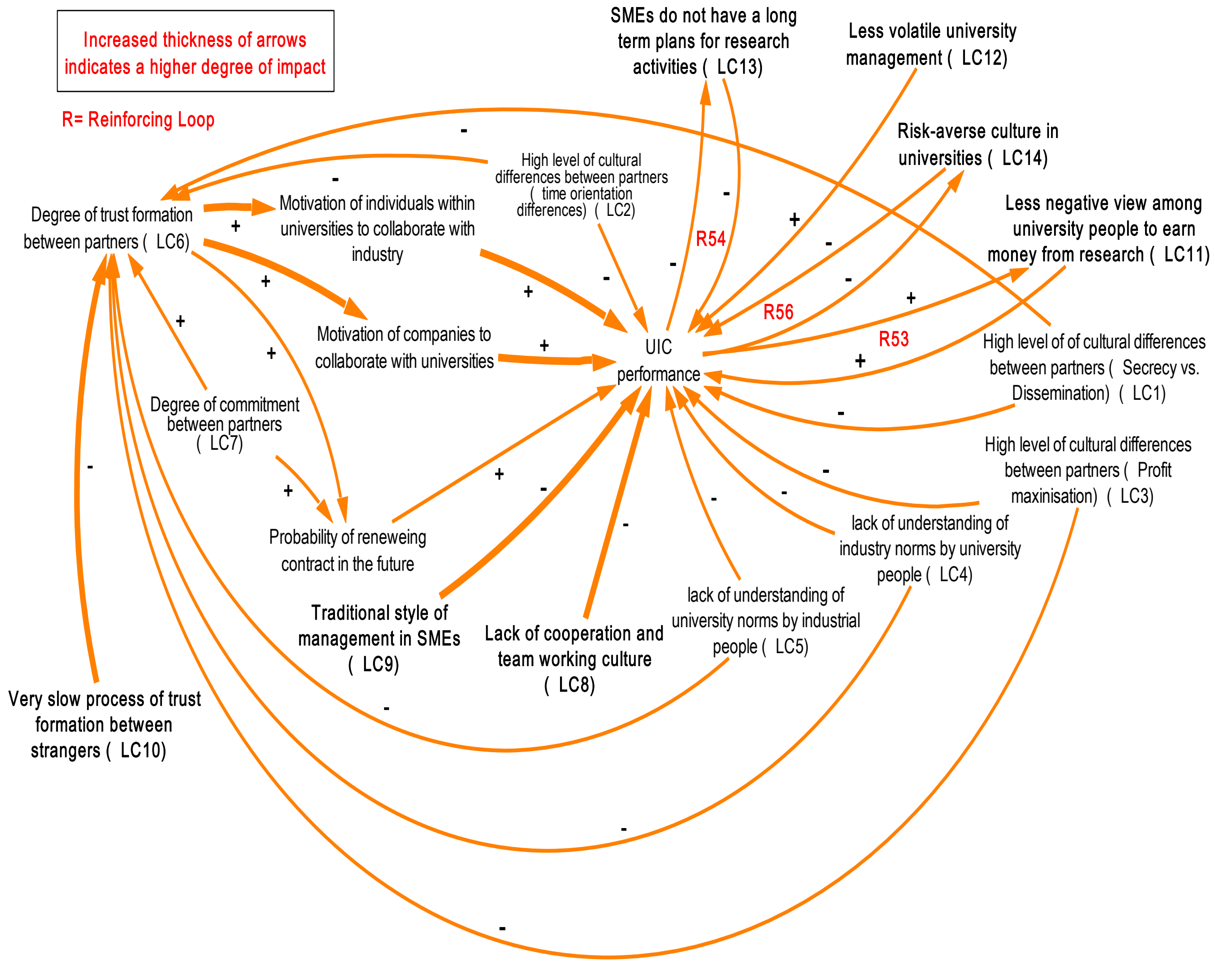


Figure 11.11: Leadership and Culture sub-system in the second scenario: constructed from the results in Table 11.13

11.4.1.4 Organizational Capabilities sub-system (OC)

Table 11.14 includes results related to each element of the Organizational Capabilities sub-system in the second scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>OC1</td><td>“Still weak performance of research consortia and other similar kind of mechanisms for collaboration (e.g. R&D contract or joint activities)”</td><td colspan="2">AST5 (11U, 4G) (Figure 11.14)
AST6 (11U, 4G) (Figure 11.14)
AST7 (11U, 1G) (Figure 11.14)
AST8 (9I, 9G) (Figure 11.14)
LC1 (11U, 9I, 12G) (Figure 11.14)
LC2 (11U, 7I, 12G) (Figure 11.14)
LC3 (11U, 12G) (Figure 11.14)
LC4 (8U, 9I, 12G) (Figure 11.14)
LC5 (11U, 12G) (Figure 11.14)
LC7 (3U, 5I, 1G) (Figure 11.14)
OC2 (11U, 9I, 12G) (Figure 11.12)
OC3 (11U) (Figure. 11.12)
OC4 (8U) (Figure 11.12)
OC5 (9I) (Figure 11.12)
OC6 (8I) (Figure 11.12)
OC7 (8I) (Figure 11.12)
OC8 (7I) (Figure 11.12)
OC9 (7I) (Figure 11.12)
GOV9 (5U, 3I, 3G) (Figure 11.14)
Decrease UIC performance (11U, 9I, 12G) (Figure 11.12)</td></tr>
<tr><td colspan="4">*Additional comments:

It was a common agreement among respondents that although the situation is improved compared to the first scenario; however, still there are no effective programmes available in this scenario to motivate partners for high level of interaction in order to decrease cultural gap between partners in collaboration (LC1-LC5).

(1U): “In this scenario still complex mechanisms for collaborations e.g. research consortia are suffered from lack of supporting infrastructure in order to motivate partners for higher level of interaction e.g. lack of IPR enforcement laws and also lack of entrepreneurial orientation of universities”.

According to majority of respondents in the pool, the advantage of this scenario compared to the first one is that there is comprehensive national policy for IPR (GOV5) and there is more efficient institutional policy on IPR (OS1) which can act as positive levers to enhance the performance of research consortia; however, all agreed that because still enforcement laws is not in place, there would be weak possibility that these kind of mechanisms for collaboration leads to increase the performance of UIC and there would be no strong motivation for universities and industry to participate; because this mechanisms most of the time leads to commercialization of product.</td></tr>
<tr><td>OC2</td><td>“Still low level of firms’ absorptive capacity on knowledge transfer because of weakness of more complex mechanisms for collaboration”</td><td colspan="2">Increase UIC performance to some extent (11U, 9I, 12G) (Figure 11.12)</td></tr>
<tr><td colspan="4">*Additional comments:

(11U, 9I, 12G): Investment in R&D is increased by companies to some extent in this scenario which has a positive impact on absorptive capacity of firms in collaboration with universities.</td></tr>
<tr><td>LOOPS</td><td>“Decreasing UIC performance”</td><td colspan="2">OC1 (23 people in the pool) (See Loops R3, R9) (Figure 11.12)</td></tr>
<tr><td>OC3</td><td>“Low opportunity for universities to access to applied knowledge with positive impact on research and teaching when collaborating with companies”</td><td>Decrease motivation of universities (11U)</td><td>Decrease UIC performance (11U) (Figure 11.12)</td></tr>
<tr><td>OC4</td><td>“Low probability of generating entrepreneurial culture in universities when collaborating with companies”</td><td>Decrease motivation of universities (8U)</td><td>Decrease UIC performance (8U) (Figure 11.12)</td></tr>
<tr><td>LOOPS</td><td>“Decreasing UIC performance”</td><td colspan="2">OC1 (7U) (See Loops R1, R2) (Figure 11.12)</td></tr>
<tr><td>OC5</td><td>“Low level of impact on firms’ capabilities in R&D when collaborating with universities”</td><td>Decrease motivation of companies (9I)</td><td>Decrease UIC performance (9I) (Figure 11.12)</td></tr>
</table>

Table 11.14: Organizational Capabilities sub-system and its related elements and connections in the second scenario

Coding	Description	Connections and weights	
OC6	"Low probability of generating innovation culture in companies when collaborating with universities"	Decrease motivation of companies (8I)	Decrease UIC performance (8I) (Figure 11.12)
OC7	"Low chance of achieving competitive advantage for companies when cooperating with universities"	Decrease motivation of companies (8I)	Decrease UIC performance (8I) (Figure 11.12)
OC8	"Low probability of increasing qualification level of employees in companies when collaborating with universities"	Decrease motivation of companies (7I)	Decrease UIC performance (7I) (Figure 11.12)
OC9	"Low probability to improve sales and profitability of industry when collaborating with universities"	Decrease motivation of companies (7I)	Decrease UIC performance (7I) (Figure 11.12)
LOOPS	"Decreasing UIC performance"	OC1 (6I) (See Loops R4, R5, R6, R7, and R8) (Figure 11.12)	
LOOPS	"Decreasing UIC performance"	OC1 (7U) (See Loops R22, R23, R25) (Figure 11.14) OC1 (4I, 8G) (See Loop R24) (Figure 11.14)	
LOPS	"Decreasing UIC performance"	OC1 (23 people in the pool) (See Loops R30, R31, R32, R44, R45, R46) (Figure 11.14) OC1 (19 people in the pool) (See Loops R36, R37, R38, R40) (Figure 11.14)	
OC10	"Weakness of management in collaboration in research consortia"	OC1 (8U, 7I, 3G) (Figure 11.12)	
OC11	"Lack of government support from research consortia"	(OC1) (7U, 6I, 2G) (Figure 11.12)	

Table 11.14 (continued): Organizational Capabilities sub-system and its related elements and connections in the second scenario

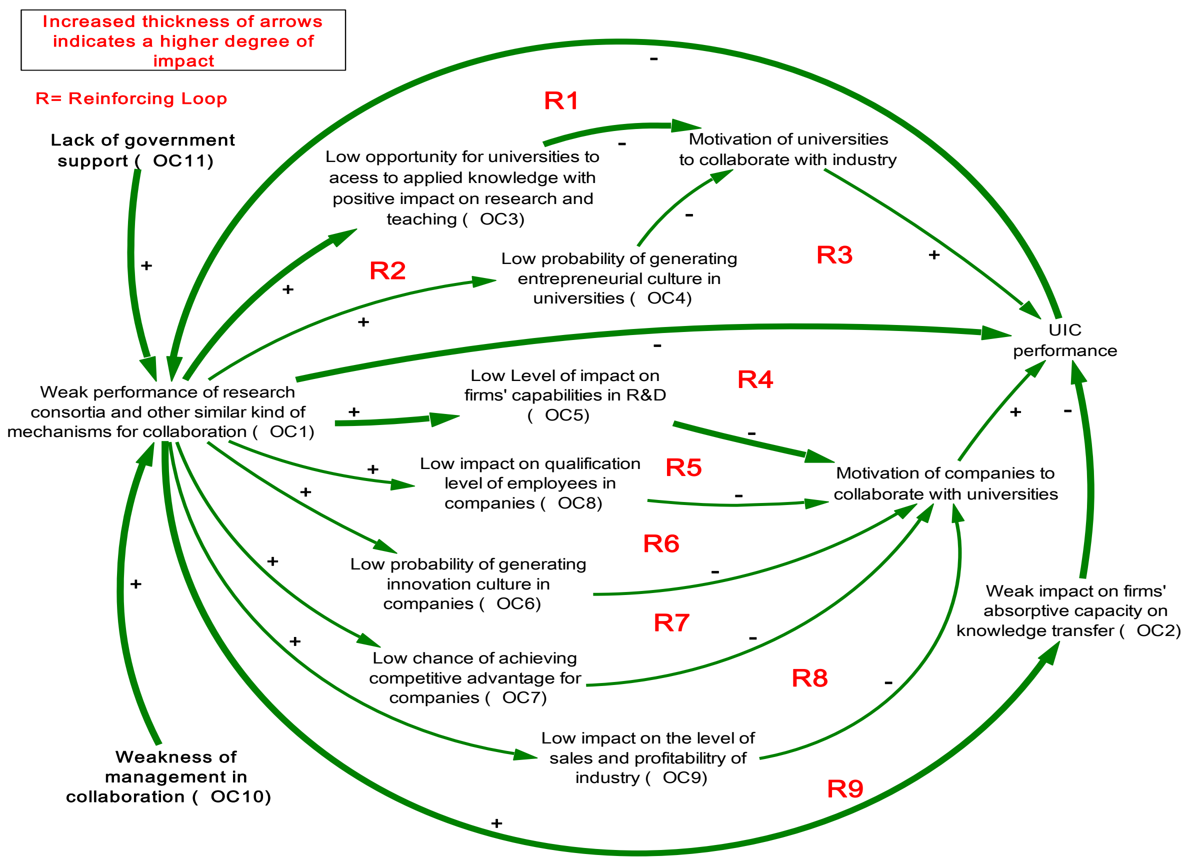


Figure 11.12: Organizational Capabilities sub-system in the second scenario: constructed from the results in Table 11.14

11.4.1.5 Government sub-system (GOV)

Table 11.15 includes results related to each element of the Government sub-system in the second scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

Coding	Description	Connections and weights		
GOV1*	"Low level of access to government funding by universities (still no differences in university's allocated budget) when collaborating with companies"	Decrease motivation of universities (11U, 4G)	Decrease UIC performance (11U, 4G)	**GOV1*** (7U, 3G); See Loop R12* (Figure 11.13)
GOV1	"Increasing access to government funding when collaborating with other partner"	Increase motivation of universities (11U, 4G)	Increase UIC performance (11U, 4G)	**GOV1** (7U, 5I, 9G); See Loops R12, R14 (Figure 11.13)
		Increase motivation of companies (9I, 9G)	Increase UIC performance (9I, 9G)	

Table 11.15: Government sub-system and its related elements and connections in the second scenario

<table>
<tr><th>Coding</th><th>Description</th><th colspan="3">Connections and weights</th></tr>
<tr><td>GOV2</td><td>“Increasing efficiency of reward and incentive systems for innovative firms when collaborating with universities”</td><td>Increase motivation of companies (8I, 9G)</td><td>Increase UIC performance (8I, 9G)</td><td>GOV2 (5I, 6G); See Loop R10 (Figure 11.13)</td></tr>
<tr><td>GOV3</td><td>“Increasing stability of government regulations regarding UIC”</td><td colspan="3">GOV1* (11U, 9I, 12G) (Figure 11.13)
GOV2 (9I, 9G) (Figure 11.13)
Increase UIC performance (11U, 9I, 12G) (Figure 11.13)</td></tr>
<tr><td colspan="5">*Additional comments:

Although majority of respondents agreed that still there are few mechanisms available for companies and universities to access to government funding (GOV1); however they all agreed that because of the stability of government regulation in this regards; these programmes to some degree can enhance motivation of universities and companies to collaborate together.

(8I, 9G): Because of the stability of government regulations, the government schemes to give reward and incentive system for innovative firms (GOV2) would be more effective compared to the first scenario.</td></tr>
<tr><td>GOV4</td><td>“Increasing university autonomy from government supervision in order to develop their research policy and relations with companies ”</td><td colspan="3">OS2 (6U, 2G) (Figure 11.14)
Increase UIC performance (11U, 4G) (Figure 11.13)</td></tr>
<tr><td colspan="5">*Additional comments:

(1G): “In this situation universities can also change the structure of TTOs (OS2) in their organizational chart and give higher rank and allocate more budgets which can make these offices more proactive in the process of technology transfer from universities to industry”.

(6U, 2G): By giving more autonomy to universities, the external bureaucratic procedures are decreased (e.g. universities do not arrange everything with MSRT in this scenario).

(6U, 2G): Because in this scenario government grant all of the national universities autonomy from the government supervision in order to develop their research policy and relations with companies, there would be more opportunities for them to arrange the structure of these offices based on their needs in specific periods of time. Only with acceptable level of autonomy from government, universities can change the structure of TTOs to make it parallel with the real needs of the society. Only in this situation university can allocate more budgets for these offices’ activities; which previously were allocated by MSRT and it was very low.</td></tr>
<tr><td>GOV5</td><td>“Increasing efficiency of national policy on IP rights but still deficiency in enforcement of laws and also no consistency with international obligations”</td><td colspan="3">Few opportunities to increase UIC performance (11U, 9I, 12G) (Figure 11.13)
OS1 (11U, 9I, 12G) (Figure 11.14)
OC1 (11U, 9I, 12G) (Figure 11.14)
GOV8 (11U, 9I, 12G) (Figure 11.13)
GOV9 (11U, 9I, 12G) (Figure 11.13)</td></tr>
<tr><td colspan="5">*Additional comments:

Although all respondents in the pool acknowledged the positive impact of increasing efficiency of national IPR; however, all agreed that because of deficiency of enforcement laws, there are still less opportunities for more complex forms of collaboration (e.g. OC1). Also they mentioned that inefficiency in enforcement laws still have a negative impact on UIC performance, performance of intermediary agents (GOV8), and also it has a negative impact on the process of cluster formation (GOV9). They all agreed that although the situation is improved, however, the negative impact is still stronger than the positive one.</td></tr>
</table>

Table 11.15 (continued): Government sub-system and its related elements and connections in the second scenario

<table>
<tr><th>Coding</th><th>Description</th><th>Connections and weights</th></tr>
<tr><td>GOV6</td><td>“Increasing efficiency of venture capital- but still it is not available in a broad scope”</td><td>Still few opportunities to increase UIC performance (11U, 9I, 12G) (Figure 11.13)
AST3 (6U) (Figure 11.14)
GOV8 (11U, 9I, 12G) (Figure 11.13)
GOV9 (11U, 9I, 12G) (Figure 11.13)</td></tr>
<tr><td colspan="3">*Additional comments:

(6U): In this scenario government has shifted its strategy to more support of VC rather than just focusing on traditional financing support; which can enhance the probability of spin-off company formation from academia. However, they stressed that because VC is still not available in a broad scope; TTOs may face difficulties to link potential entrepreneurs with VC investors. Therefore, it may decrease the probability of success of spin-off formation from academia.

(11U, 9I, 12G): Because government has shifted its policy to more support technology-based companies through changing its policy from traditional financing mechanism to risk capital; therefore there would be more opportunities for UIC compared to the first scenario. Also it enhances the performance of intermediary agents (GOV8) because companies and universities are more interested to collaborate through these agents. Moreover, there would be more opportunities to enhance the status of cluster in the region (GOV9) and improve entrepreneurial environment because many SMEs can enter for competition in clusters. However, all the respondents agreed that because the accessibility to VC is limited and it is not available in a broad range in this scenario, the effect will not be very high.</td></tr>
<tr><td>GOV7</td><td>“Increasing efficiency of government financing support system”</td><td>GOV6 (4U, 6I, 9G) (Figure 11.13)</td></tr>
<tr><td>GOV8</td><td>“Still weak performance of intermediary agents e.g. science and technology parks and incubators”</td><td>Decrease UIC performance (9U, 7I, 12G) (Figure 11.13)
LC1 (9U, 7I, 12G) (Figure 11.14)
LC2 (9U, 7I, 12G) (Figure 11.14)
LC3 (9U, 7I, 12G) (Figure 11.14)
LC4 (8U, 7I, 12G) (Figure 11.14)
LC5 (9U, 12G) (Figure 11.14)
LC7 (3U, 5I, 1G) (Figure 11.14)
GOV9 (9U, 7I, 12G) (Figure 11.13)</td></tr>
<tr><td colspan="3">*Additional comments:

(9U, 7I, 12G): Although there are many advantages compared to the first scenario for improving performance of intermediary agents; however, the overall performance of intermediary agents was considered weak in this scenario. The weakness in performance of these intermediary agents is still considered as a main reason which will not be very successful to enhance UIC. These people also declared that because of weakness of these intermediary agents, they also do not have very positive influence on the status of cluster formation and favourability of entrepreneurial environment. Although some of the supporting infrastructures are improved compared to the first scenario e.g. national IPR or availability of VC to some degree; However because of other obstacles like lack of enforcement laws, weakness of management in collaboration (GOV24) and still absence of VC in a broad scope, barriers continue to exist for the success of these intermediary agents. Majority of respondents believed that because companies put a huge amount of investment in these kind of intermediary agents for collaboration and also universities did the same and invest huge amount of money (e.g. incubator facilities) but in this scenario the positive impact is still only limited to some simpler forms of collaboration and they did not get any proper return for their investment; in the long term, UIC performance will be decreased. It will also have a negative impact in the long term on the process of cluster formation as well.

(1U): “Although the status of intermediary agents’ involvement is not desirable in this scenario; however, some improvements are obvious especially to improve the linkage between university and industry in some cases which do not lead to commercialization activities e.g. consultation and marketing advice”.</td></tr>
<tr><td>LOOPS</td><td>“Decreasing UIC performance”</td><td>GOV8 (19 people in the pool) (See Loops R27, R28, R29, R41, R42, R43, R33, R34, R35, R39) (Figure 11.14)</td></tr>
</table>

Table 11.15 (continued): Government sub-system and its related elements and connections in the second scenario

Coding	Description	Connections and weights	
GOV9	"Status of cluster activities is enhanced compared to the first scenario (still many barriers exist and not strong enough) but still the environment for entrepreneurial activities is not satisfactory"	Few opportunities to increase UIC performance, and in the long-term UIC performance will be decreased (huge amount of investment; but few opportunities for collaboration) (11U, 9I, 12G) (Figure 11.13) LC9 (4U, 2I, 3G) (Figure 11.14) LC8 (2U, 4I, 2G) (Figure 11.14) GOV10 (6U, 7I, 11G) (Figure 11.13)	
		LC13 (4U, 4I, 3G)	GOV9 (4U, 4I, 3G) (See Loop R55) (Figure 11.14)
***Additional comments:** (6U, 7I, 11G): In this scenario government wants to force and regulate return and stay of human capital by designing policy and regulations. However several respondents were not in agreement with these kind of programmes and mentioned that there are many other motivational factors which do not exist in this scenario which makes a barrier for these government initiatives and they still consider brain drain as a barrier to UIC. Favourable entrepreneurial environment does not still exist to have a positive impact on decision of entrepreneurs and researchers to stay in the country. (1I): "*Based on the availability of amount of stimulations in this scenario, it seems that it is not strong enough to persuade entrepreneurs to stay in the country*". (5U, 2I, 1G): They had different views and mentioned that because of improvement in political relation in this scenario, there would be more chance to be a part of global economy; therefore, it will have a positive impact to reduce amount of brain drain. By comparing these different views it seems that still intention of entrepreneurs to leave the country has a negative effect on UIC performance.			
LOOPS	"Decreasing UIC performance"	GOV8 (7U, 4I, 6G) (See Loops R15, R16a) (Figure 11.13) GOV9 (7U, 4I, 6G) (See Loop R16b) (Figure 11.13) OC1 (5U, 3I, 3G) (See Loop R18a) (Figure 11.14)	
GOV10	"Still increasing brain drain"	Decrease UIC performance (6U, 7I, 11G) (Figure 11.13)	
LOOPS	"Decreasing UIC performance"	GOV8 (2U, 3I, 5G) (See Loop R17a) (see Figure 11.13) GOV9 (2U, 3I, 5G) (See Loop R17b) (see Figure 11.13) OC1 (5U, 3I, 3G) (See Loop R18b) (see Figure 11.14)	
GOV11	"Still inefficiency of privatisation policy; the situation is improved"	Few opportunities to increase UIC performance (9I, 9G) (Figure 11.13) GOV9 (7I, 6G) (Figure 11.13)	
***Additional comments:** (9I, 9G): There would be an improvement in the process of privatisation; however, the long process makes it less efficient in this scenario. Based on majority of respondent's point of views this situation is not strong enough to enhance the performance of UIC.			
GOV12	"Decreasing level of government monopolies in market (monopoly still exist)"	GOV9 (7I, 6G) (Figure 11.13) GOV11 (9I, 9G) (Figure 11.13)	
GOV13	"Providing comprehensive databases for entrepreneurs"	GOV9 (2U, 7I, 5G) (Figure 11.13)	
GOV14	"High government natural resources income"	GOV15 (1U, 3I, 4G) (Figure 11.13)	
GOV15	"Decreasing government value people creativity"	GOV9 (1U, 3I, 4G) (Figure 11.13)	

Table 11.15 (continued): Government sub-system and its related elements and connections in the second scenario

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td rowspan="2">GOV16</td><td rowspan="2">“Strengthening political relation and increasing probability of Iran entry to the WTO”</td><td colspan="2">GOV5 (2G) (Figure 11.13)
GOV9 (3I, 5G) (Figure 11.13)</td></tr>
<tr><td>Increase motivation of companies (5I, 9G)</td><td>Increase UIC performance (5I, 9G)
(Figure 11.13)</td></tr>
<tr><td colspan="4">*Additional comments:

(5I, 9G): In this scenario international relation with other countries is improved and there would be more probability to join the WTO. Also level of embargoes by western government is decreased. Therefore, it has a positive impact on motivation of companies to collaborate with university partner to increase their capacity for innovation to compete in an international market. Most of them agreed that in this situation there will be an extra international force to the country in order to be more competitive and innovative, because it will be more probability to integrate into the global market regulations e.g. joining the WTO.

(3I, 5G): This opportunity also has a positive impact on enhancing level of competition in the cluster. However, in this scenario there is still a deficiency in enforcement of IPR and also there are still many weaknesses in IPR policy which is not consistent with the international obligations. Therefore, entrepreneurial environment especially the environment which is satisfactory for international trade, still do not exist.

(2G): Although in this scenario still there is a delay in the process of strengthening IPR enforcement laws and there are some weaknesses in IPR policy which is not consistent with international obligations; however because of increasing the probability to join the WTO in this scenario there would be a force to make enforcement laws and IPR policy more consistent with international obligations e.g. TRIP agreement.</td></tr>
<tr><td rowspan="2">GOV17</td><td rowspan="2">“Decreasing embargos imposed by the West”</td><td>Increase motivation of companies (5I, 9G)</td><td>Increase UIC performance (5I, 9G) (Figure 11.13)</td></tr>
<tr><td colspan="2">GOV18 (6I, 5G) (Figure 11.13)</td></tr>
<tr><td colspan="4">*Additional comments:

(5I, 9G): Decreasing level of embargo increases the motivation of companies to collaborate with universities to compete in the international marketplace. However, the rest of the respondents in industry mentioned that although they will still use universities as a source of innovation; however, because other options like collaborating with foreign partners is also available, they will not be motivated very much.

(9I, 9G): By improving political situation and by increasing proportion of foreign strategic technology alliances and attracting more FDI; UIC performance will be increased and it has a positive impact on level of competition in the region. However, they all agreed that there are still many barriers which limit the ultimate success in terms of cluster formation (GOV9). Because of lack of efficient financing mechanisms e.g. VC is not available in a broad scope, deficiency of IPR in terms of enforcement laws, weakness in IPR policy which is not consistent with the international obligations and also availability of monopoly; the environment for foreign companies in these two fields is still not desirable and therefore; it will have a negative impact on cluster activities. Also majority of respondents declared that although the political situation is promoted; however, foreign companies are not still very interested to enter the country because of many obstacles e.g. weakness of enforcement laws.</td></tr>
<tr><td>GOV18</td><td>“Increasing export opportunities and decreasing the risk of investment “</td><td colspan="2">GOV9 (6I, 5G) (Figure 11.13)</td></tr>
<tr><td colspan="4">*Additional comments:

(6I, 5G): The risk of investment will be decreased and also export opportunities will be increased in this scenario and more attraction would exist to invite more FDI or Joint Ventures especially in biotechnology and car manufacturing industry. Therefore, it will have a positive impact on both competition in the country and status of cluster formation.</td></tr>
<tr><td>GOV19</td><td>“Increasing efficiency of government programmes to enhance awareness/training for entrepreneurial activities”</td><td colspan="2">Increase UIC performance (8U, 6I, 12G) (Figure 11.13)
GOV9 (8U, 6I, 12G) (Figure 11.13)</td></tr>
<tr><td>GOV20</td><td>“Still high level of corruption in government for allocating resources to entrepreneurs”</td><td colspan="2">GOV21 (2U, 2G) (Figure 11.13)
GOV21* (3I, 2G) (Figure 11.13)</td></tr>
</table>

Table 11.15 (continued): Government sub-system and its related elements and connections in the second scenario

Coding	Description	Connections and weights			
GOV21	"Decreasing trust between entrepreneurs within universities and government"	Decrease motivation of individuals within universities (2U, 2G)	Decrease UIC performance (2U, 2G)	**GOV21** (2U, 2G); See Loop R11 (Figure 11.13)	
GOV21*	"Decreasing trust between entrepreneurs and government"	Decrease motivation of companies (3I, 2G)	Decrease UIC performance (3I, 2G)	**GOV21*** (3I, 2G); See Loop R13 (Figure 11.13)	
LC8	"Lack of team working and cooperation culture"	Decrease UIC performance (2U, 4I, 2G)	GOV9 (2U, 4I, 2G)		LC8 (2U, 4I, 2G) See Loop R26b (Figure 11.14)
		Decrease UIC performance (2U, 4I, 2G)	GOV8(2U, 4I, 2G)	GOV9(2U , 4I, 2G)	LC8 (2U, 4I, 2G); See Loops R19, R21(Figure 11.14)
		Decrease UIC performance (2U, 3I, 2G)	OC1 (2U, 3I, 2G)	GOV9 (2U, 3I, 2G)	LC8 (2U, 3I, 2G); See Loops R20, R26a (Figure 11.14)
LC9	"Traditional style of management in SMEs"	Decrease UIC performance (4U, 2I, 3G)	GOV9 (4U, 2I, 3G)		LC9 (4U, 2I, 3G); See Loop R51(Figure 11.14)
		Decrease UIC performance (4U, 2I, 3G)	GOV8(4U, 2I, 3G)	GOV9 (4U, 2I, 3G)	LC9 (4U, 2I, 3G); See Loops R47, R49 (Figure 11.4)
		Decrease UIC performance (4U, 2I, 3G)	OC1 (4U, 2I, 3G)	GOV9 (4U, 2I, 3G)	LC9 (4U, 2I, 3G); See Loops R48, R50 (Figure 11.14)
GOV22	"Government do not have negative view about property ownership and capitalism of individual"	GOV5 (1U, 3I, 2G) (Figure 11.13)			
GOV23	"Decreasing bureaucratic procedure to form start-ups"	GOV9 (5I, 4G) (Figure 11.13)			
***Additional comments:** (5I, 4G): These activities increase the motivation of entrepreneurs to be more active in economic activities. These activities are parallel with World Economic Forum (2008) which suggests that countries in second stage of development "efficiency-driven" should decrease the number of procedures required to start a business.					
GOV24	"Weakness of management in collaboration in intermediary agents"	GOV8 (9U, 7I, 12G) (Figure 11.13)			

Table 11.15 (continued): Government sub-system and its related elements and connections in the second scenario

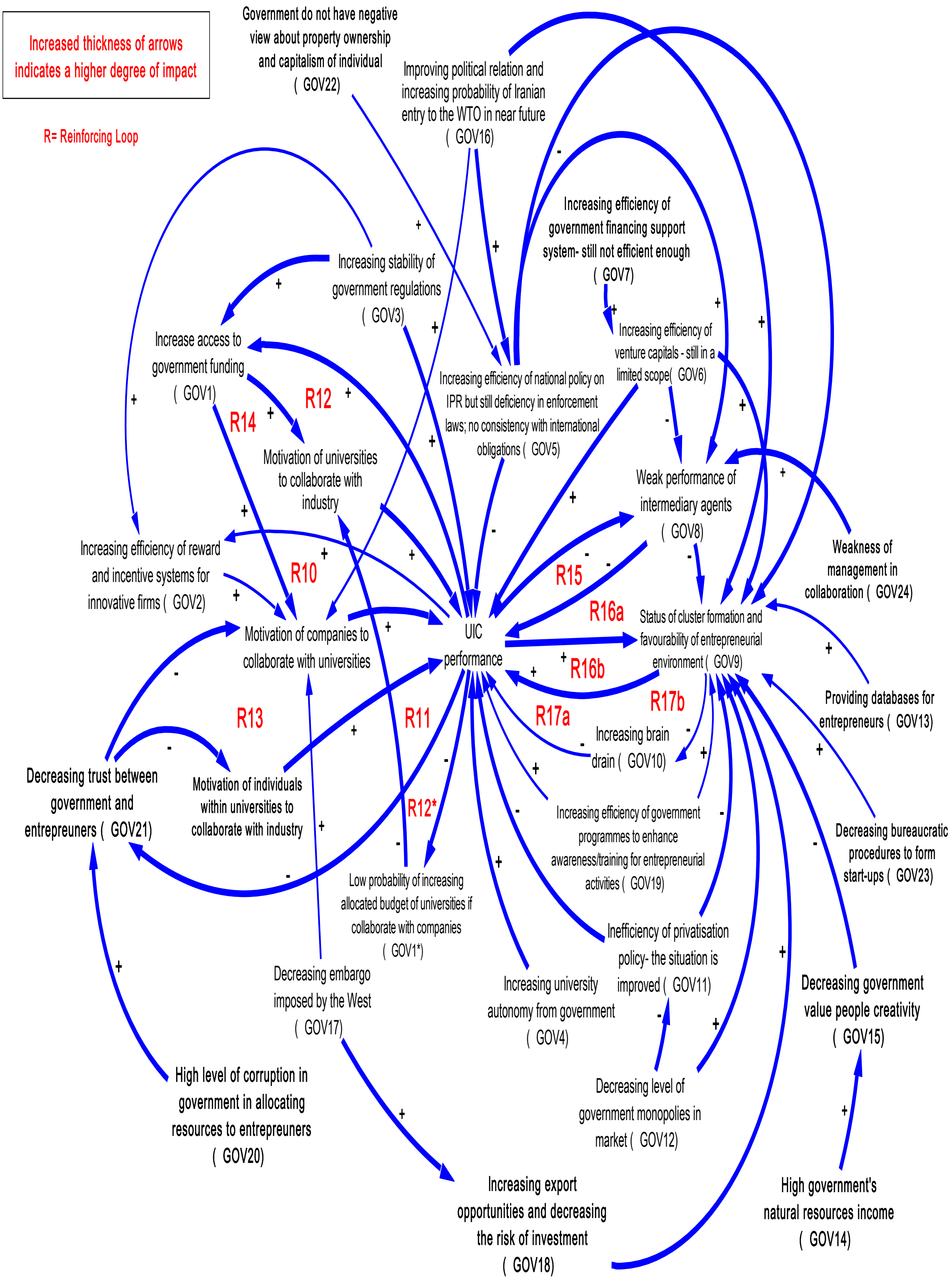


Figure 11.13: Government sub-system in the second scenario: constructed from the results in Table 11.15

11.4.1.6 *Connection between sub-systems*

The complete picture of connection between elements of different sub-systems and also all other reinforcing loops in the second scenario are presented in Figure 11.14.

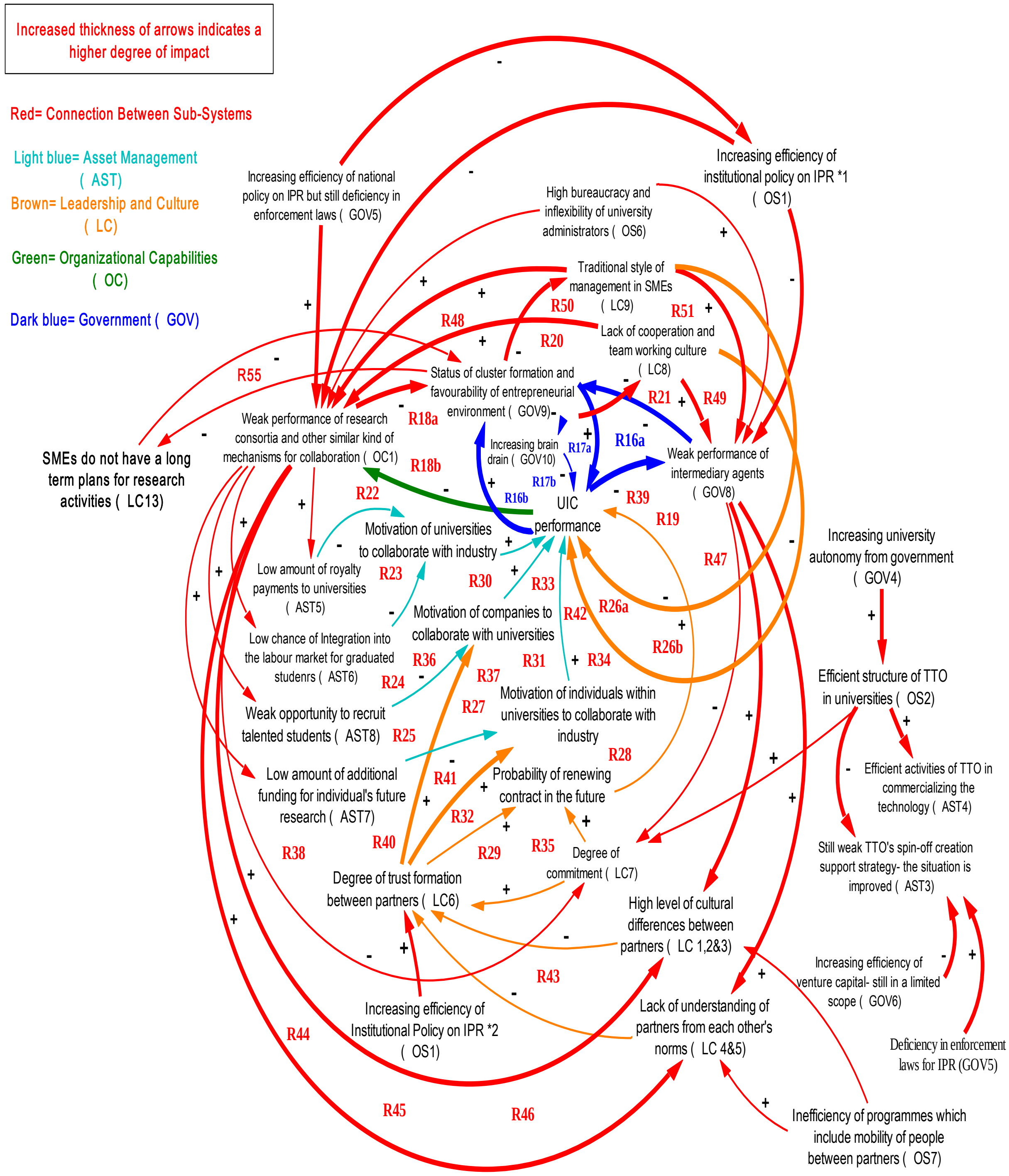


Figure 11.14: Relationships between elements of different sub-systems in the second scenario: constructed from the results in Tables 11.11-15

11.5 SCENARIO SCRIPT 3 (INNOVATION-DRIVEN ECONOMY: SCENARIO 2 + ENHANCED POLICY FRAMEWORK + 15 YEARS)

The main activities here were to ask questions of the respondents to find out their views on the impact of changing a direction of some forces in the system and how the system as a whole would respond. In other words, to depict the interactions between different forces (mostly positive) in the system and to explain how these positive interactions can enhance UIC. Negative forces are weakened in this scenario and positive forces become stronger compared to the scenario 2. Additional positive forces are also entered into the system. A list of these forces and proposed changes in directions are presented in Table 11.16. Table 11.16 provides a summary of literature, pilot testing of interview questions and also the respondents' point of views which suggest the direction of specific force in this stage of development. Table 11.16 provides some recent literature to support changing direction of specific forces based on the empirical experience of countries at this stage of development. Furthermore Table 11.16 provides details regarding the direction of all forces in this scenario as a result of interactions with other forces.

Scenario 3: Innovation -driven	Main Features	Direction	Related Sub-System	References
1.	Designing efficient rules regarding IPR in institutions	+ +	**OS**	
2.	Availability of clear royalty sharing formulas in universities and other intermediary agents	+ +	**OS**	
3.	Efficient IPR policy in terms of compatibility with international obligation	+ +	**GOV**	(Robert and Ostergard, 2000; World Economic Forum, 2008)
4.	Efficient national policy on IPR and also enforcement laws	+ +	**GOV**	(Robert and Ostergard, 2000; World Economic Forum, 2008)
5.	Government do not have negative view about property ownership and capitalism of individual	+ +	**GOV**	
6.	Cultural differences are decreased • Familiarity with norms of other partner is increased • Time orientation differences is decreased • Decreasing cultural issues in terms of Secrecy vs. dissemination • More respect to each other objective	+ +	**LC**	(Respondents; Davenport et al., 1999; Bstieler, 2006)

OS= Organizational Structure, AST= Asset Management, LC= Leadership and Culture, OC= Organizational Capabilities, GOV= Government

Table 11.16: Main features of the third scenario and direction of forces

Scenario 3: Innovation -driven	**Main Features**	**Direction**	**Related Sub-System**	**References**
1.	Encouraging cooperation and team working culture among individual	+ +	**LC**	Respondents
2.	Changing traditional style of management in SMEs	+ +	**LC**	Respondents
3.	SMEs have long-term plans for their research activities	+ +	**LC**	Respondents
4.	Less volatile university management	+ +	**LC**	
5.	Increasing degree of commitment	+ +	**LC**	(Respondents; Roth and Magee, 2002; Plewa and Quester, 2007)
6.	High potential for trust formation	+ +	**LC**	(Respondents; Fountain, in Branscomb and Keller 1998; Davenport et al., 1999; Bstieler, 2006; Hermans and Castiaux, 2007; Plewa and Quester, 2007)
7.	Slow process of trust formation to strangers	_ _	**LC**	Respondents
8.	Changing negative view among university people to be more positive about earn money from research	+ +	**LC**	Respondents
9.	Risk taking culture in universities	+ +	**LC**	Respondents
10.	Efficient structure of Technology Transfer Office in university	+ +	**OS**	
11.	Strong TTO support from commercialization activities	+ +	**AST**	
12.	Strong TTO support from Spin-off creation from university	+ +	**AST**	(Etzkowitz and Leydesdorff, 2000; Etzkowitz et al., 2000; Degroof and Roberts, 2004; Debackere and Veugelers, 2005; Macho-Stadler et al., 2008; Reeves et al., 2009)
13.	Effective universities' promotion rules to evaluate faculty members based on their extent of relations with industry	+ +	**OS**	(Gerwin et al., 1991)
14.	Efficiency of methods for conveying knowledge between producer (university) and receiver (industry)	+ +	**OS**	(Gerwin et al, 1991; Bergman and Feser, 1999; Santoro and Bierly, 2006; Hermans and Castiaux, 2007; Dzisah and Etzkowitz, 2008)
15.	Decreasing bureaucracy and inflexibility of university administrators	+ +	**OS**	(Gerwin et al, 1991)
16.	University education system is aligned to industry needs	+ +	**OS**	Respondents
17.	Effective programmes which include mobility of people between partners	+ +	**OS**	(Inzelt, 2004; Dzisah and Etzkowitz, 2008)
18.	Designing comprehensive reward system to reward technology transfer activities for researchers within university	+ +	**AST**	

Table 11.16 (continued): Main features of the third scenario and direction of forces

Scenario 3: Innovation -driven	Main Features	Direction	Related Sub-System	References
1.	Strong performance of mechanisms for collaboration e.g. research consortia • High government support • Strong management in collaboration	+ +	OC	(Respondents; Ceglie and Dini, 1999; Carayannis et al., 2000; Etzkowitz and Leydesdorff, 2000; Arbonies and Moso, 2002; Dwivedi and Varman, 2003; Inzelt, 2004; Etzkowitz et al., 2005; Rohrbeck and Arnold, 2006; Dooley and Kirk, 2007; White and Bruton, 2007)
2.	Decreasing level of corruption in government side, especially for allocating resources to entrepreneurs	+ +	GOV	(Treisman, 2000)
3.	Government monopolies in market is decreased Government design anti-monopoly policy	+ +	GOV	(Porter, 1990; Wignaraja, 2003; Marshal et al., 2005)
4.	Efficiency of government in privatisation process	+ +	GOV	(Porter, 1990; Marshal et al., 2005)
5.	• Decreasing embargo imposed by Western Government • Strengthening international relation	+ +	GOV	Pilot testing of interview questions
6.	Country joins the WTO	+ +	GOV	Pilot testing of interview questions
7.	Designing efficient programme for training entrepreneurs	+ +	GOV	
8.	Strong government financial support policy: • More stability of financial supporting schemes • Strong support of public and private VC	+ +	GOV	(Etzkowitz and Leydesdorff, 2000; Koh and Koh, 2002; Etzkowitz, 2005; Etzkowitz et al., 2005; Wonglimpiyarat, 2006)
9.	Decreasing natural resource income	+ +	GOV	Respondents
10.	Availability of efficient data bases for entrepreneurs	+ +	GOV	
11.	Decreasing bureaucratic procedures to form start-ups	+ +	GOV	
12.	Increasing stability of government regulations	+ +	GOV	
13.	higher level of access to government funding if collaborate with other partner	+ +	GOV	(Respondents; Porter, 1990; Davenport et al., 1999; Marshal et al., 2005; KTP programme: www.ktponline.org.uk;)
14.	Increase university allocated budget if cooperating with industry	+ +	GOV	(Dooley and Kirk, 2007)
15.	Efficiency of reward and incentive systems for innovative firms when collaborate with universities	+ +	GOV	(Respondents; Porter, 1990; Marshal et al., 2005; Sala et al., 2009)
16.	Increasing university autonomy from government	+ +	GOV	

Table 11.16 (continued): Main features of the third scenario and direction of forces

Scenario 3: Innovation -driven	Main Features	Direction	Related Sub-System	References
1.	Efficiency of government programmes to control brain drain	+ +	**GOV**	(Respondents; Mani, 2004)
2.	Strong performance of intermediary agents • High government support with low level of intervention • Strong management in collaboration	+ +	**GOV**	(Respondents; Porter, 1990; Ceglie and Dini, 1999; Davenport et al., 1999; Etzkowitz and Leydesdorff, 2000; Dwivedi and Varman, 2003; Etzkowitz et al., 2005; Smedlund, 2006; Kodama, 2008)
3.	Increasing firms' R&D budget	+ +	**OC**	(Inzelt, 2004; World Economic Forum, 2008)
4.	Government has a policy towards clusters which focuses on specialisation • Economies of specialisation • Geographical concentration	+ +	**GOV**	(Porter, 1990; Porter, 1998; World Economic Forum, 2008)

Table 11.16 (continued): Main features of the third scenario and direction of forces

The main questions which were asked from respondents for this scenario consist of the following items (see Appendix D). It should be noted that all of these questions were provided to the respondents in advance of the interview and they were asked to develop the scenario script based on their considered view.

1- What will happen if a programme which includes mobility of people for UIC is encouraged?

2- If universities and industry design efficient methods for conveying knowledge (tacit and explicit) between universities and industry, what will be the impact of this on the usage of technology by industry? (e.g. increasing joint research activities, availability of written reports, site visits by industry, plant visits by researchers).

3- If universities reduce the high degree of bureaucracy and inflexible procedures, what would be the potential outcomes?

4- What if universities change promotion and tenure decisions by considering the degree of academic involvement in UIC as a measure for promotion?

5- What if universities and especially technology transfer offices increase their support for the creation of spin-off companies?

6- What will be the effect of the following science and technology policies on trust formation (contractual trust- competence trust and good-will trust)?

    - If government employs instruments that involve an intermediary institution to bring together universities and firms? (government will provide financial and developmental assistance for firms to undertake R&D projects in collaboration with a university and encourage them for repeating relationships between the same partners) (CCG programme)

7- What will happen if universities and industry design specific programmes to enhance the level of their commitment when collaborating with other partner? e.g. increase senior management involvement in the corporate-university partnerships.

8- What if universities in Iran create active research consortia to help fund research? (companies pay membership fees to join these consortia and they expect benefits in terms of access to research)

9- What will happen if the Government promotes programme for transferring knowledge between universities and industry?

- Government programme (called KTP) which is funded by number of public sector agencies (the sponsors) with the policy and administrative arrangements led by the Department of Trade and Industry, which provides 75% of the total funding for partnerships. This programme is designed to help companies get access to universities' professionals and bring them into the business by working in partnership with academics or research teams.

10- What if intermediary organizations have a higher degree of involvement in UIC, and the Government increases its support and decrease the level of intervention? (see Appendix D for more details)

11- If government design a following policy and action to stem the flow of human capital; particularly expensive trained scientific and technical human capital what will happen?

- Stimulation phase which make a favourable environment for their activities

12- What will happen if government take following actions towards IPR protection?

- Designing an efficient policy framework for IP at the national level
- Strengthening the enforcement of IPR
- Formulating an IPR policy which compatible with Iranian production structure, consistent with international obligations

13- What if the Government establishes association for venture capitalists which can supervise and support private and public venture capital?

14- What if the Government develops policies for cluster enhancement which focuses on specialisation (economies of specialisation as well as geographic concentration)? This focus is on high concentrate of SMEs, both from the supply and demand side as well as cluster support institutions like universities.

15- What if the Government increase university access to government funding (increasing their allocated budget) based on the extent of collaborations with companies?

16- If R&D budgets for firms are increased e.g. by the companies themselves or by Government initiatives which give grants for those establishing research facilities, what will be the impact on the ability of firms to identify, absorb and exploit internally and externally generated knowledge?

17- If the Government introduce better reward and incentive systems and new forms of financial aids (e.g. increasing innovation funds and subsidies for firms or providing tax credit in case of cooperation more with universities) what do you think will happen?
18- What will happen if the Government design anti-monopoly policies to encourage competitiveness?
19- What will happen if the Government successfully achieves the privatisation of state industries?
20- What will happen if the country joins the WTO?

11.5.1 Five sub-systems of the third scenario

The following sections provide results related to each of the five sub-systems from the third scenario and the way that sub-systems interact.

11.5.1.1 Organizational Structure sub-system (OS)

Table 11.17 includes results related to each element of the Organizational Structure sub-system in the third scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td rowspan="3">OS1</td><td rowspan="3">“Strong institutional policy on IP rights”</td><td colspan="2">LC6 (11U, 9I, 12G) (Figure 11.20)
OC1 (11U, 9I, 12G) (Figure 11.20)
GOV8 (11U, 9I, 12G) (Figure 11.20)</td></tr>
<tr><td>Increase motivation of companies to collaborate with universities (7I, 9G)</td><td>Increase UIC performance (7I, 9G)
(Figure 11.15)</td></tr>
<tr><td>Increase motivation of individuals within universities to collaborate with companies (11U, 4G)</td><td>Increase UIC performance (11U, 4G)
(Figure 11.15)</td></tr>
<tr><td>OS2</td><td>“Efficient structure of technology transfer offices in universities: appropriate policy and process for legal, financial and human resource management in TTOs ”</td><td colspan="2">Increase UIC performance (11U, 4G) (Figure 11.15)
OS1 (8U, 2G) (Figure 11.15)
OS3 (8U, 2G) (Figure 11.15)
AST3 (6U) (Figure 11.20)
AST4 (6U) (Figure 11.20)
LC7 (3U, 1G) (Figure 11.20)</td></tr>
<tr><td>OS3</td><td>“Strong and comprehensive institutional policy on royalty sharing”</td><td>Increase motivation of individuals within universities (11U, 4G)</td><td>Increase UIC performance (11U, 4G) (Figure 11.15)</td></tr>
<tr><td>OS4</td><td>“Availability of programme which evaluate faculty members based on their extent of relations with industry”</td><td>Increase motivation of individuals within universities (11U, 4G)</td><td>Increase UIC performance (11U, 4G) (Figure 11.15)</td></tr>
<tr><td>OS5</td><td>“Increasing efficiency of methods for conveying knowledge between universities and industry e.g. frequency of site visits by industry and plant visits by researchers”</td><td colspan="2">Increase UIC performance (8U, 8I) (Figure 11.15)</td></tr>
<tr><td colspan="4">*Additional comments:
Majority of respondents declared that by increasing joint research activities which includes frequent site visits by industry and plant visits by researchers during technology transfer process, the conveying of tacit knowledge will be facilitated. Also they declared that availability of written reports will allow the user of technology to follow the process stage by stage and use it completely.
(1I): “By designing this programme the probability that firms encounter a problem in collaborative innovation projects will be decreased and also firms can use the technology completely”.</td></tr>
<tr><td>OS6</td><td>“Decreasing bureaucracy and inflexibility of university administrators”</td><td colspan="2">Increase UIC performance (11U, 9I) (Figure 11.15)
OC1 (5U, 7I) (Figure A)
GOV8 (5U, 7I) (Figure A)</td></tr>
<tr><td>OS7</td><td>“Increasing efficiency of programmes which includes mobility of people between partners”</td><td colspan="2">Increase UIC performance (9U, 6I, 7G) (Figure 11.15)
LC1 (5U, 3I, 5G) (Figure 11.20)
LC2 (5U, 3I, 5G) (Figure 11.20)
LC3 (5U, 3I, 5G) (Figure 11.20)
LC4 (5U, 3I, 5G) (Figure 11.20)
LC5 (5U, 3I, 5G) (Figure 11.20)</td></tr>
<tr><td colspan="4">*Additional comments:
(9U, 6I, 7G): Mobility of star scientists from university to industry; university researchers have part-time jobs in industry in order to learn, experience and observe; industry people work in universities as lecturers and joint research activities can be considered as an efficient mechanisms for mobility of people and have a positive influence on UIC performance.
(6I): Spin-off companies from universities can be considered as one of the efficient mechanism for mobility of people where university people come up with new ideas and they form their own business.
(1U): “The spin-off formation can be considered as the most successful form of mobility of people, because most of the time many faculty members and students are involved in the process and they become quite familiar with the business environment”.</td></tr>
<tr><td>OS8</td><td>“By Increasing UIC performance; university education system is aligned to industry needs”</td><td colspan="2">Increase UIC performance (2U, 4I, 1G) (See loop R52) (Figure 11.15)</td></tr>
<tr><td colspan="4">(1U): “Because of high degree of collaboration between partners in this scenario, they are two forces emerged which motivate universities to align their education system with industry. First one is more natural when lecturers, because of high level of interactions with industry, focus on more practical issues which are needed in real world rather than just focusing on theoretical subjects; secondly, MSRT will be under pressure to upgrade the university education system based on society needs in order to keep the university relationship with industry permanent”.</td></tr>
</table>

Table 11.17: Organizational Structure sub-system and its related elements and connections in the third scenario

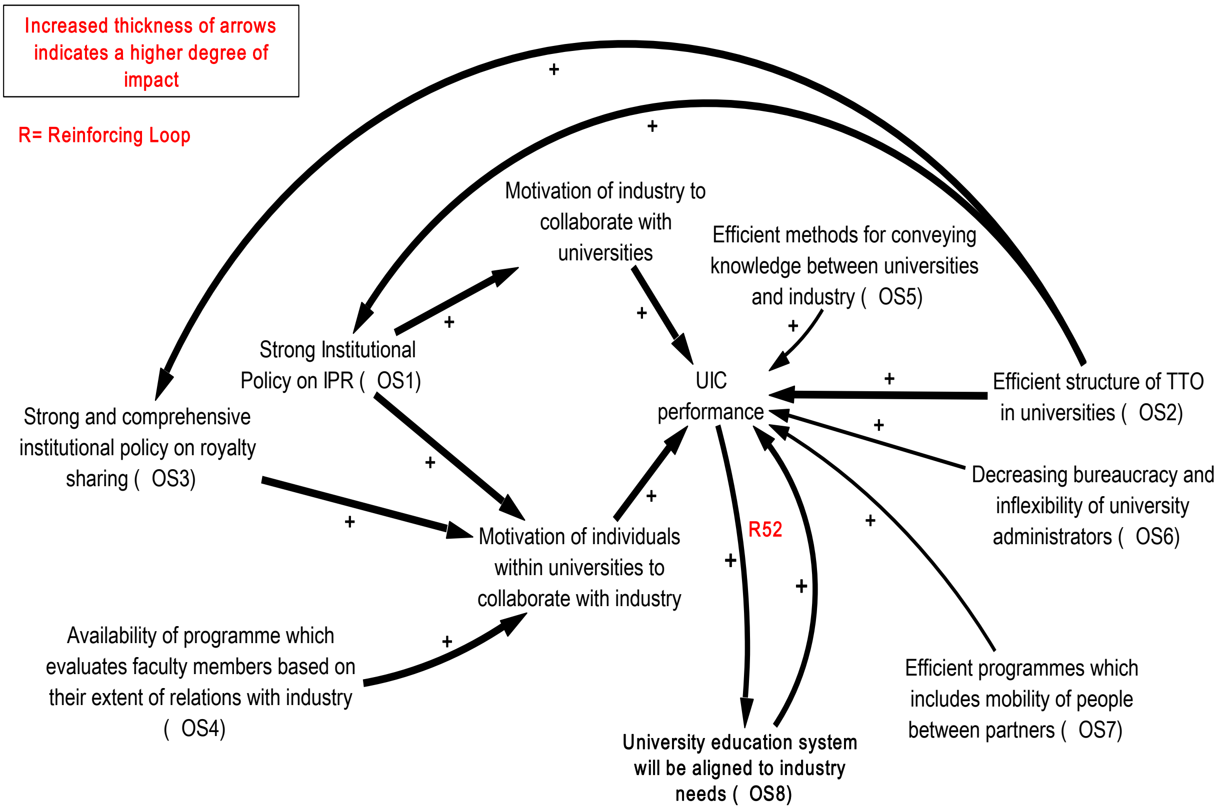


Figure 11.15: Organizational Structure sub-system in the third scenario: constructed from the results in Table 11.17

11.5.1.2 Asset Management sub-system (AST)

Table 11.18 includes results related to each element of the Asset Management sub-system in the third scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

Coding	Description	Connections and weights	
AST1	"Efficient and comprehensive reward system to reward technology transfer activities of researchers e.g. when it shifts based on academic favour in royalty and equity distribution formula"	Increase motivation of individuals within universities (9U)	Increase UIC performance (9U) (Figure 11.16)
AST2	"Availability of various skills in technology transfer offices"	Increase UIC performance (11U, 9I, 12G) (Figure 11.16)	

Table 11.18: Asset Management sub-system and its related elements and connections in the third scenario

Coding	Description	Connections and weights	
AST3	"Strong TTOs Spin-off creation support strategy"	Increase UIC performance (11U) (Figure 11.16)	
***Additional comments:** (11U): The critical success factor for formation of spin-off companies which is strong enforcement laws for IPR (GOV5) exists in this scenario.			
AST4	"Effective activities of TTOs to commercialize the technology including: effective strategy of TTOs to market the technology, effective TTOs' activities to identify technology with commercial potential, effective TTOs' activities to package the technology appropriately"	Increase UIC performance (11U) (Figure 11.16)	
AST5	"Increasing amount of royalty payments to universities"	Increase motivation of universities (11U, 4G)	Increase UIC performance (11U, 4G) (Figure 11.16)
AST6	"High chance of integration into the labour market for graduated students"	Increase motivation of universities (10U, 4G)	Increase UIC performance (10U, 4G) (Figure 11.16)
AST7	"Increasing amount of additional funding for individual future research"	Increase motivation of individual within universities (11U, 1G)	Increase UIC performance (11U, 1G) (Figure 11.16)
AST8	"Increasing opportunity to recruit talented students"	Increase motivation of companies (6I, 9G)	Increase UIC performance (6I, 9G) (Figure 11.16)

Table 11.18 (continued): Asset Management sub-system and its related elements and connections in the third scenario

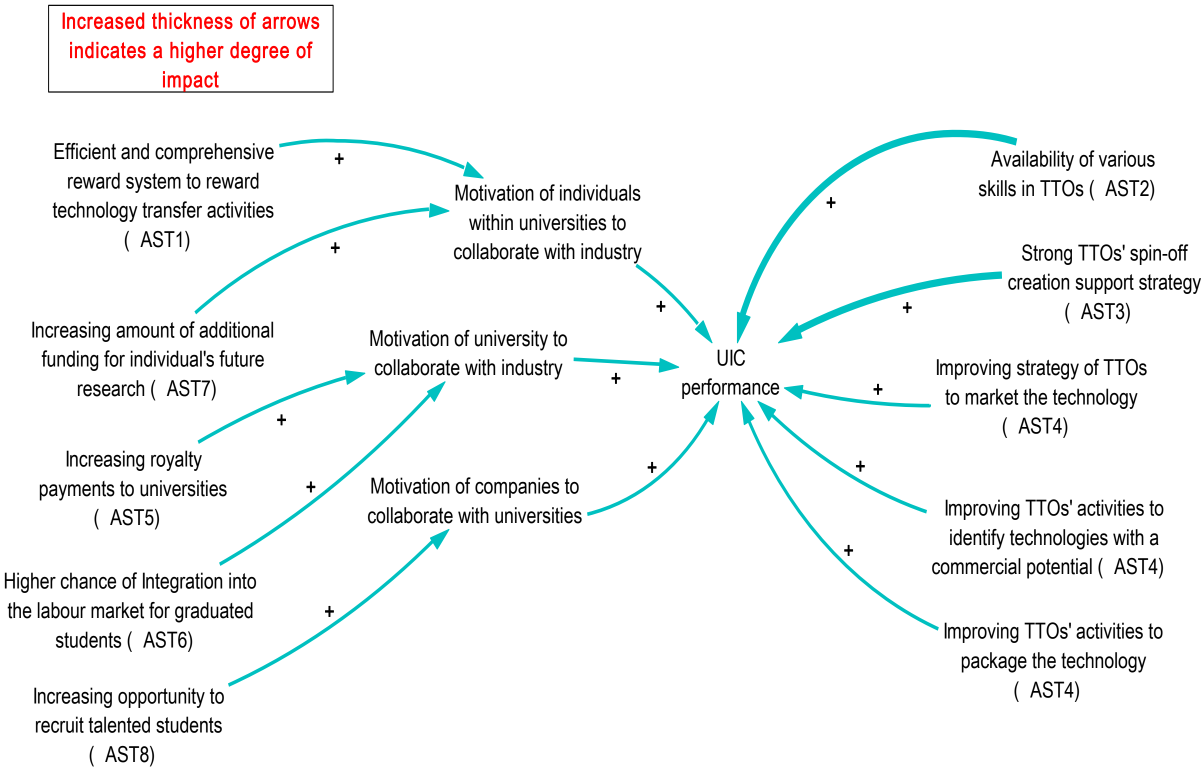


Figure 11.16: Asset Management sub-system in the third scenario: constructed form the results in Table 11.18

11.5.1.3 Leadership and Culture sub-system (LC)

Table 11.19 includes results related to each element of the Leadership and Culture sub-system in the third scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>LC1</td><td>“Decreasing cultural differences in university-industry collaboration (secrecy vs. dissemination)”</td><td colspan="2">LC6 (11U, 9I, 12G) (Figure 11.17)

Increase UIC performance (11U, 9I, 12G) (Figure 11.17)</td></tr>
<tr><td>LC2</td><td>“Decreasing cultural differences in university-industry collaboration (time orientation differences)”</td><td colspan="2">LC6 (11U, 7I, 12G) (Figure 11.17)

Increase UIC performance (11U, 7I, 12G) (Figure 11.17)</td></tr>
<tr><td>LC3</td><td>“Decreasing cultural differences in university-industry collaboration (profit maximization)”</td><td colspan="2">LC6 (11U, 12G) (Figure 11.17)

Increase UIC performance (11U, 12G) (Figure 11.17)</td></tr>
<tr><td>LC4</td><td>“Increasing understanding of industry norms by university people”</td><td colspan="2">LC6 (8U, 9I, 12G) (Figure 11.17)
Increase UIC performance (8U, 9I, 12G) (Figure 11.17)</td></tr>
<tr><td>LC5</td><td>“Increasing understanding of university norms by industrial people”</td><td colspan="2">LC6 (11U, 12G) (Figure 11.17)

Increase UIC performance (11U, 12G) (Figure 11.17)</td></tr>
<tr><td rowspan="3">LC6</td><td rowspan="3">“Increasing opportunities for trust formation between partners”</td><td>Increase motivation of companies (9I, 9G)</td><td>Increase UIC performance (9I, 9G) (Figure 11.17)</td></tr>
<tr><td>Increase motivation of individuals within universities (11U, 4G)</td><td>Increase UIC performance (11U, 4G) (Figure 11.17)</td></tr>
<tr><td>Increase probability of renewing contract in the future (11U, 9I)</td><td>Increase UIC performance (11U, 9I) (Figure 11.17)</td></tr>
<tr><td rowspan="2">LC7</td><td rowspan="2">“High degree of commitment between partners”</td><td colspan="2">LC6 (3U, 5I, 1G) (Figure 11.17)</td></tr>
<tr><td>Increasing probability of renewing contract in the future (9U, 9I)</td><td>Increase UIC performance (9U, 9I) (Figure 11.17)</td></tr>
<tr><td colspan="4">*Additional comments:

(9U, 9I): In this scenario universities and industry designed specific programmes to enhance level of their commitment when collaborating with other partner e.g. increase senior management involvement in corporate-university partnerships.</td></tr>
<tr><td>LC8</td><td>“Encouraging Team working and cooperation culture”</td><td colspan="2">OC1 (2U, 3I, 2G) (Figure 11.20)
GOV8 (2U, 4I, 2G) (Figure 11.20)
Increase UIC performance (2U, 7I, 5G) (Figure 11.17)</td></tr>
<tr><td colspan="4">*Additional comments:

(2U, 3I, 2G): Because of availability of strong cluster activities (GOV9), efficient intermediary agents (GOV8) and strong research consortia (OC1); team working and cooperation culture is encouraged. Therefore, UIC performance will be increased.

There is also another different view:
(3I, 3G): Cooperation and team working culture is a very long-term phenomenon and even in this scenario there is no possibility to improve it. Therefore, it still has a negative impact on UIC performance. One of the respondents in industry commented that “this problem has a long-term cultural root and it is not possible to change it even in this scenario”.</td></tr>
</table>

Table 11.19: Leadership and Culture sub-system and its related elements and connections in the third scenario

<table>
<tr><th>Coding</th><th>Description</th><th>Connections and weights</th></tr>
<tr><td>LC9</td><td>“Changing traditional style of management in SMEs ”</td><td>OC1 (4U, 2I, 3G) (Figure 11.20)
GOV8 (4U, 2I, 3G) (Figure 11.20)
Increase UIC performance (6U, 2I, 3G) (Figure 11.17)</td></tr>
<tr><td colspan="3">*Additional comments:

(4U, 2I, 3G): Because of the availability of strong cluster activities (GOV9), efficient intermediary agents (GOV8) and strong research consortia (OC1); traditional style of management is changed in this scenario and companies are interested in more rational approach e.g. open innovation strategy. Therefore, UIC performance will be increased.</td></tr>
<tr><td>LC10</td><td>“Very slow process of trust formation between strangers”</td><td>LC6 (3U, 5I) (Figure 11.17)</td></tr>
<tr><td colspan="3">*Additional comments:

(3U, 5I): In this scenario because the pace of trust to strangers is still low, shaping of goodwill trust will be very slow and it requires a very long term relationships rather than just two or three times collaboration experience.

(1I): “In Iran, even in the third scenario which would be equivalent to the situation of many western nations; the slow pace of trust formation still makes a barrier to successful UIC”.</td></tr>
<tr><td>LC11</td><td>“High opportunities for UIC; therefore, no negative view among university people to earn money from research (LC11)”</td><td>Increase UIC performance (3U) (See loop R53) (Figure 11.17)</td></tr>
<tr><td>LC12</td><td>“Less Volatile university management”</td><td>Increase UIC performance (3U, 2I) (Figure 11.17)</td></tr>
<tr><td>LC13</td><td>“Increasing opportunities for UIC in this scenario and strong cluster activities; therefore SMEs in Iran are motivated to have a long-term plans for research activities (LC13)”</td><td>Increase UIC performance (See Loop R54) (4U, 4I, 3G) (Figure 11.17)

GOV9 (4U, 4I, 3G) (See Loop R55) (Figure 11.20)</td></tr>
<tr><td>LC14</td><td>“Because of more entrepreneurial orientation in universities; risk-taking culture in universities is encouraged (LC14)”</td><td>Increase UIC performance (See loop R56) (3U, 1G) (Figure 11.17)</td></tr>
</table>

Table 11.19 (continued): Leadership and Culture sub-system and its related elements and connections in the third scenario.

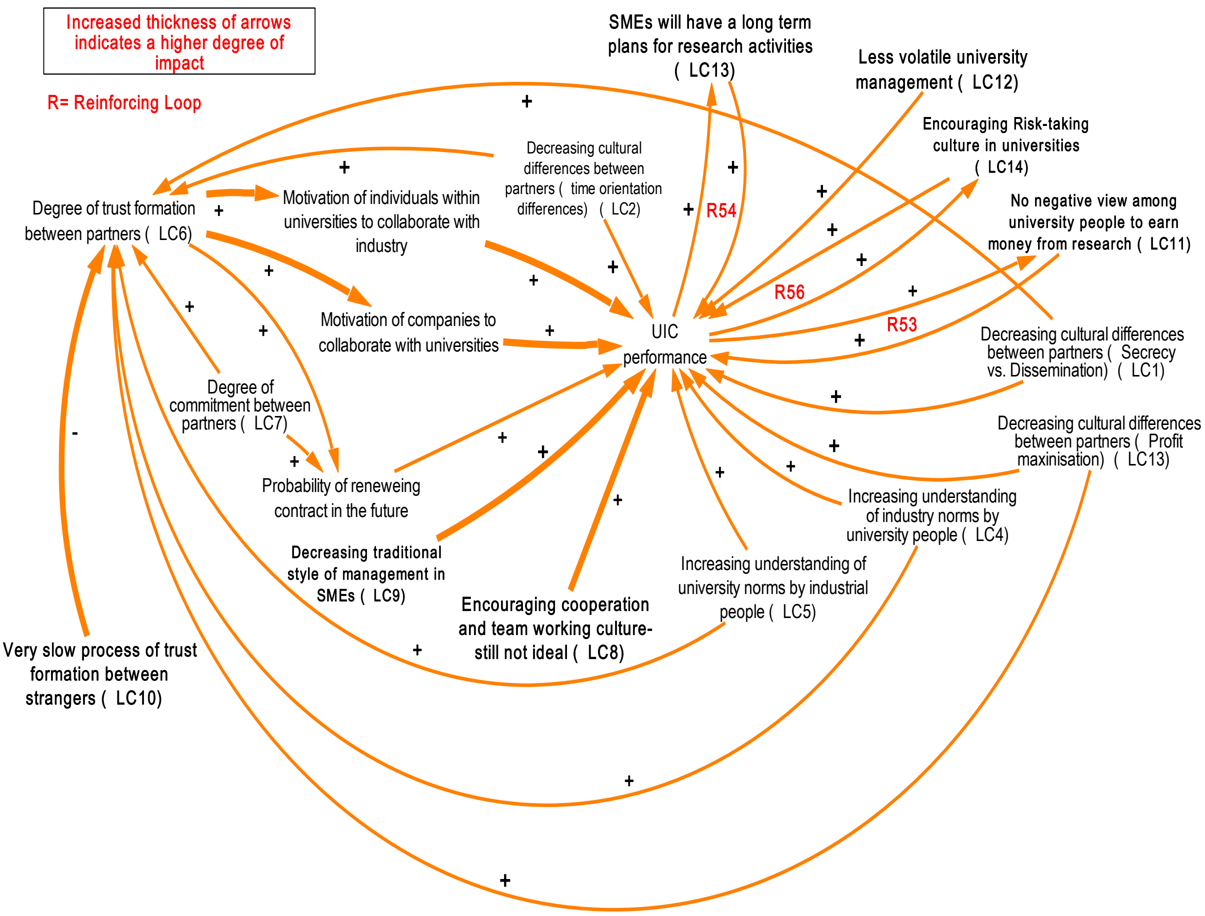


Figure 11.17: Leadership and Culture sub-system in the third scenario: constructed from the results in Table 11.19

11.5.1.4 Organizational Capabilities sub-system (OC)

Table 11.20 includes results related to each element of the Organizational Capabilities sub-system in the third scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>OC1</td><td>“Strong performance of research consortia and other similar kind of mechanisms for collaboration (e.g. R&D contract or joint activities) and availability of CCG programme”</td><td colspan="2">AST5 (11U, 4G) (Figure 11.20)
AST6 (11U, 4G) (Figure 11.20)
AST7 (11U, 1G) (Figure 11.20)
AST8 (9I, 9G) (Figure 11.20)
LC1 (11U, 9I, 12G) (Figure 11.20)
LC2 (11U, 7I, 12G) (Figure 11.20)
LC3 (11U, 12G) (Figure 11.20)
LC4 (8U, 9I, 12G) (Figure 11.20)
LC5 (11U, 12G) (Figure 11.20)
LC7 (3U, 5I, 1G) (Figure 11.20)
OC2 (11U, 9I, 12G) (Figure 11.18)
OC3 (11U) (Figure 11.18)
OC4 (8U) (Figure 11.18)
OC5 (9I) (Figure 11.18)
OC6 (8I) (Figure 11.18)
OC7 (8I) (Figure 11.18)
OC8 (7I) (Figure 11.18)
OC9 (7I) (Figure 11.18)
GOV9 (5U, 3I, 3G) (Figure 11.20)
Increase UIC performance (11U, 9I, 12G) (Figure 11.18)</td></tr>
<tr><td colspan="4">*Additional comments:

(11U, 9I, 12G): CCG programme is successful in this scenario because of availability of strong IP in institutional level and in national level and also availability of strong enforcement laws. Therefore, contractual trust will be shaped between partners in collaboration. As a result of repeating the relationships between the same partners the competence and goodwill trust will be shaped. This programme is very similar to the output of collaborating in more complex forms of mechanisms e.g. research consortia.

(1U): “In this scenario partners have more interactions with each other and they will be more familiar with the boundaries norms and limitations of other partner. Therefore, the probability to respect each others’ culture and norms will be increased (LC1-5)”.</td></tr>
<tr><td>OC2</td><td>“Increasing firms’ absorptive capacity on knowledge transfer”</td><td colspan="2">Increase UIC performance (11U, 9I, 12G) (Figure 11.18)</td></tr>
<tr><td colspan="4">*Additional comments:

(9I, 12G): Because in this scenario industry increase its R&D expenditure and in many cases government give grant for those companies who established research facilities, the ability of firms to identify, absorb and exploit internally and externally generated knowledge created by other firms or universities; especially those are located in research consortia will be increased. All declared that this action will improve UIC performance and increase rate of technology transfer from universities to industry.</td></tr>
<tr><td>LOOPS</td><td>“Increasing UIC performance”</td><td colspan="2">OC1 (23 people in the pool) (See Loops R3, R9) (Figure 11.18)</td></tr>
<tr><td>OC3</td><td>“High opportunity for universities to access to applied knowledge with positive impact on research and teaching when collaborating with companies”</td><td>Increase motivation of universities (11U)</td><td>Increase UIC performance (11U) (Figure 11.18)</td></tr>
<tr><td>OC4</td><td>“High probability of generating entrepreneurial culture in universities when collaborating with companies”</td><td>Increase motivation of universities (8U)</td><td>Increase UIC performance (8U) (Figure 11.18)</td></tr>
<tr><td>LOOPS</td><td>“Increasing UIC performance”</td><td colspan="2">OC1 (7U) (See Loops R1, R2) (Figure 11.18)</td></tr>
<tr><td>OC5</td><td>“High level of impact on firms’ capabilities in R&D when collaborating with universities”</td><td>Increase motivation of companies (9I)</td><td>Increase UIC performance (9I) (Figure 11.18)</td></tr>
<tr><td>OC6</td><td>“High probability of generating innovation culture in companies when collaborating with universities”</td><td>Increase motivation of companies (8I)</td><td>Increase UIC performance (8I) (Figure 11.18)</td></tr>
</table>

Table 11.20: Organizational Capabilities sub-system and its related elements and connections in the third scenario

Coding	Description	Connections and weights	
OC7	"High chance of achieving competitive advantage for companies when cooperating with universities"	Increase motivation of companies (8I)	Increase UIC performance (8I) (Figure 11.18)
OC8	"High probability of increasing qualification level of employees in companies when collaborating with universities"	Increase motivation of companies (7I)	Increase UIC performance (7I) (Figure 11.18)
OC9	"High probability to improve sales and profitability of industry when collaborating with universities"	Increase motivation of companies (7I)	Increase UIC performance (7I) (Figure 11.18)
LOOPS	"Increasing UIC performance"	OC1 (6I) (See Loops R4, R5, R6, R7, and R8) (Figure 11.18)	
LOOPS	"Increasing UIC performance"	OC1 (7U) (See Loops R22, R23, R25) (Figure 11.20) OC1 (4I, 8G) (See Loop R24) (Figure 11.20)	
LOPS	"Increasing UIC performance"	OC1 (23 people in the pool) (See Loops R30, R31, R32, R44, R45, R46) (Figure 11.20) OC1 (19 people in the pool) (See Loops R36, R37, R38, R40) (Figure 11.20)	
OC10	"Strong management in collaboration in research consortia"	OC1 (8U, 7I, 3G) (Figure 11.18)	
OC11	"High government support from research consortia"	(OC1) (7U, 6I, 2G) (Figure 11.18)	

Table 11.20 (continued): Organizational Capabilities sub-system and its related elements and connections in the third scenario

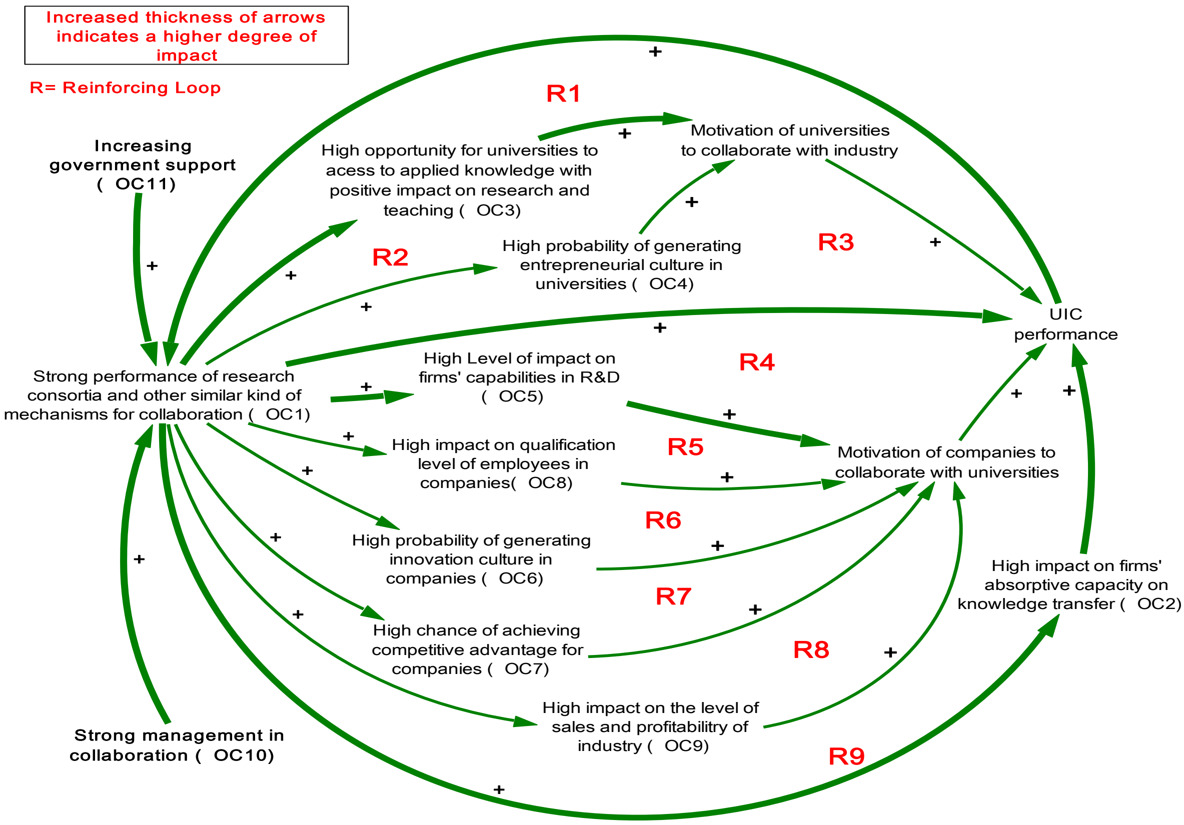


Figure 11.18: Organizational Capabilities sub-system in the third scenario: constructed from the results in Table 11.20

11.5.1.5 Government sub-system (GOV)

Table 11.21 includes results related to each element of the Government sub-system in the third scenario and shows the way that each element links to other elements in the same sub-system or other sub-systems.

<table>
<tr><th>Coding</th><th>Description</th><th colspan="3">Connections and weights</th></tr>
<tr><td>GOV1*</td><td>"Efficient mechanisms available to increase university budget when collaborating more with companies" "</td><td>Increase motivation of universities (11U, 4G)</td><td>Increase UIC performance (11U, 4G)</td><td>GOV1* (7U, 3G); See Loop R12* (Figure 11.19)</td></tr>
<tr><td rowspan="2">GOV1</td><td rowspan="2">"Increasing access to government funding when collaborating with other partner"</td><td>Increase motivation of universities (11U, 4G)</td><td>Increase UIC performance (11U, 4G)</td><td rowspan="2">GOV1 (7U, 5I, 9G); See Loops R12, R14 (Figure 11.19)</td></tr>
<tr><td>Decrease motivation of companies (9I, 9G)</td><td>Decrease UIC performance (9I, 9G)</td></tr>
<tr><td>GOV2</td><td>"Increasing efficiency of reward and incentive systems for innovative firms when collaborating with universities"</td><td>Increase motivation of companies (8I, 9G)</td><td>Increase UIC performance (8I, 9G)</td><td>GOV2 (5I, 6G); See Loop R10 (Figure 11.19)</td></tr>
<tr><td>GOV3</td><td>"Increasing stability of government regulations regarding UIC"</td><td colspan="3">GOV1* (11U, 9I, 12G) (Figure 11.19)
GOV2 (9I, 9G) (Figure 11.19)
Increase UIC performance (11U, 9I, 12G) (Figure 11.19)</td></tr>
<tr><td colspan="5">*Additional comments:

Respondents within the pool all agreed that because of the stability of government regulation in this regards; KTP programme (GOV1) will enhance motivation of universities and companies in Iran to collaborate together.
(1I): "KTP programme seems more organized and more practical compared to our previous 60/40 programme in first scenario to involve all the actors including government, university, industry and even students together".
(1G): "KTP programme can be considered as a mean which can provide funding for companies to recruit talented students; it will also help universities to have an access to government funding as a results of their support and it will enhance their capabilities in research as well".
(1I): "Although these kind of mechanisms for collaboration are useful; however, because we have many SMEs involving with this programmes, we need to consider their affordability to pay another 25% of funding. Based on my view it is better to increase the share of government for this mechanism to be successfully and practically applicable for the case of Iran".</td></tr>
<tr><td>GOV4</td><td>"Increasing university autonomy from government"</td><td colspan="3">OS2 (6U, 2G) (Figure 11.20)
Increase UIC performance (11U, 4G) (Figure 11.19)</td></tr>
<tr><td>GOV5</td><td>"Increasing efficiency of national policy on IP rights and strengthening enforcement of laws; IPR is consistent with international obligations"</td><td colspan="3">Increase UIC performance (11U, 9I, 12G) (Figure 11.19)
OS1 (11U, 9I, 12G) (Figure 11.20)
OC1 (11U, 9I, 12G) (Figure 11.20)
GOV8 (11U, 9I, 12G) (Figure 11.19)
GOV9 (11U, 9I, 12G) (Figure 11.19)</td></tr>
<tr><td>GOV6</td><td>"High efficiency and availability of venture capital- establishing association for VC which can supervise public and private VC"</td><td colspan="3">Increase UIC performance (11U, 9I, 12G) (Figure 11.19)
AST3 (6U) (Figure 11.20)
GOV8 (11U, 9I, 12G) (Figure 11.19)
GOV9 (11U, 9I, 12G) (Figure 11.19)</td></tr>
<tr><td>GOV7</td><td>"Strong government financing support system"</td><td colspan="3">GOV6 (4U, 6I, 9G) (Figure 11.19)</td></tr>
</table>

Table 11.21: Government sub-system and its related elements and connections in the third scenario

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>GOV8</td><td>“Strong performance of intermediary agents e.g. science and technology parks and incubators”</td><td colspan="2">Increase UIC performance (9U, 7I, 12G) (Figure 11.19)
LC1 (9U, 7I, 12G) (Figure 11.20)
LC2 (9U, 7I, 12G) (Figure 11.20)
LC3 (9U, 7I, 12G) (Figure 11.20)
LC4 (8U, 7I, 12G) (Figure 11.20)
LC5 (9U, 12G) (Figure 11.20)
LC7 (3U, 5I, 1G) (Figure 11.20)
GOV9 (9U, 7I, 12G) (Figure 11.19)</td></tr>
<tr><td colspan="4">*Additional comments:

(2U, 5I, 4G): Intermediary agents can successfully decrease cultural differences between partners (LC1-3) and also can increase understanding between partners (LC4-5) if the length of interactions between partners is sufficient enough and repeated.</td></tr>
<tr><td>LOOPS</td><td>“Increasing UIC performance”</td><td colspan="2">GOV8 (19 people in the pool) (See Loops R27, R28, R29, R41, R42, R43, R33, R34, R35, R39) (Figure 11.20)</td></tr>
<tr><td rowspan="2">GOV9</td><td rowspan="2">“Strong status of cluster activities and increasing favourability of entrepreneurial environment”</td><td>Increase UIC performance (11U, 9I, 12G) (Figure 11.19)
LC9 (4U, 2I, 3G) (Figure 11.20)
LC8 (2U, 4I, 2G) (Figure 11.20)
GOV10 (6U, 7I, 11G) (Figure 11.19)</td><td></td></tr>
<tr><td>LC13 (4U, 4I, 3G)</td><td>GOV9 (4U, 4I, 3G) (See Loop R55) (Figure 11.20)</td></tr>
<tr><td colspan="4">*Additional comments:

(11U, 9I, 12G): In this scenario government has a policy towards clusters which focuses on specialisation (economies of specialisation as well as geographic concentration). The focus will be on SMEs, both from the supply and demand side as well as cluster support institutions like universities. Respondents evaluated this activity of the government as an efficient mean which will gather together all actors and will improve the collaboration of them all in the region. They also declared that by gathering all supporting industry in the region the favourability of the region in terms of entrepreneurial activities will be increased and as a result it will have a positive impact on UIC performance.

(6U, 7I, 11G): Because favourable entrepreneurial environment is created in this scenario; it will have a positive impact on decision of entrepreneurs and researchers to stay in the country.

Rest of the respondents in the pool who believe in the impact of other factors (e.g. political relation) on brain drain (GOV10) also mentioned that because of improvement in political relation with other countries there would be more chance to be a part of global economy; therefore, it will have a positive impact on reducing the amount of brain drain.

(1G): “These activities not only increase the willingness of the people to stay in the country; but also it will motivate other people who are living abroad to come back and stay in the country as well”.</td></tr>
<tr><td>LOOPS</td><td>“Increasing UIC performance”</td><td colspan="2">GOV8 (7U, 4I, 6G) (See Loops R15, R16a) (Figure 11.19)
GOV9 (7U, 4I, 6G) (See Loop R16b) (Figure 11.19)
OC1 (5U, 3I, 3G) (See Loop R18a) (Figure 11.20)</td></tr>
<tr><td>GOV10</td><td>“Decreasing brain drain”</td><td colspan="2">Increase UIC performance (11U, 9I, 12G) (Figure 11.19)</td></tr>
<tr><td>LOOPS</td><td>“Increasing UIC performance”</td><td colspan="2">GOV8 (2U, 3I, 5G) (See Loop R17a) (see Figure 11.19)
GOV9 (2U, 3I, 5G) (See Loop R17b) (see Figure 11.19)
OC1 (5U, 3I, 3G) (See Loop R18b) (see Figure 11.20)</td></tr>
<tr><td>GOV11</td><td>“Increasing efficiency of privatisation policy”</td><td colspan="2">Increase UIC performance (9I, 9G) (Figure 11.19)
GOV9 (7I, 6G) (Figure 11.19)</td></tr>
</table>

Table 11.21 (continued): Government sub-system and its related elements and connections in the third scenario

<table>
<tr><th>Coding</th><th>Description</th><th colspan="2">Connections and weights</th></tr>
<tr><td>GOV12</td><td>“Decreasing level of government monopolies on market”</td><td colspan="2">GOV9 (7I, 6G) (Figure 11.19)
GOV11 (9I, 9G) (Figure 11.19)</td></tr>
<tr><td colspan="4">*Additional comments:

(9I, 9G): Because government also design anti-monopoly policy on market it would be better opportunities for the country to do the privatisation process more effectively compared to the second scenario.

(3I): Because there is no delay in the process of privatisation and because monopoly does not exist in the country, the level of trust of entrepreneurs to government will be increased. Therefore, the motivation of entrepreneurs to involve in economic activities will be increased. Also, the status of cluster formation will be enhanced and favourable environment for entrepreneurial activities will be created.</td></tr>
<tr><td>GOV13</td><td>“Providing effective databases for entrepreneurs”</td><td colspan="2">GOV9 (2U, 7I, 5G) (Figure 11.19)</td></tr>
<tr><td>GOV14</td><td>“Decreasing government natural resources income”</td><td colspan="2">GOV15 (1U, 3I, 4G) (Figure 11.19)</td></tr>
<tr><td>GOV15</td><td>“Increasing government value people creativity”</td><td colspan="2">GOV9 (1U, 3I, 4G) (Figure 11.19)</td></tr>
<tr><td colspan="4">*Additional comments:

(1U, 3I, 4G): When government value people creativity, it will create more positive perception towards government that government does value the industry and creativity of individuals. This belief will be shaped among the individual in the country and it will increase level of trust to government in terms of supporting entrepreneurs; which will have a positive impact on cluster formation and development.</td></tr>
<tr><td rowspan="2">GOV16</td><td rowspan="2">“Strengthening political relation and entry of Iran to the WTO”</td><td colspan="2">GOV5 (2G) (Figure 11.19)
GOV9 (3I, 5G) (Figure 11.19)</td></tr>
<tr><td>Increase motivation of companies (5I, 9G)</td><td>Increase UIC performance (5I, 9G)
(Figure 11.19)</td></tr>
<tr><td rowspan="2">GOV17</td><td rowspan="2">“Decreasing embargos imposed by the West”</td><td>Increase motivation of companies (5I, 9G)</td><td>Increase UIC performance (5I, 9G) (Figure 11.19)</td></tr>
<tr><td colspan="2">GOV18 (6I, 5G) (Figure 11.19)</td></tr>
<tr><td colspan="4">*Additional comments:

(9I, 9G): By improving political situation and by increasing proportion of foreign strategic technology alliances and attracting more FDI; UIC performance will be increased and it has a positive impact on the level of competition in the region. Majority of respondents declared that in this scenario favourable environment for entrepreunerial activities exist and therefore, foreign companies are very interested to enter the country.</td></tr>
<tr><td>GOV18</td><td>“Increasing export opportunities and decreasing the risk of investment “</td><td colspan="2">GOV9 (6I, 5G) (Figure 11.19)</td></tr>
<tr><td>GOV19</td><td>“Increasing efficiency of government programmes to enhance awareness/training for entrepreneurial activities”</td><td colspan="2">Increase UIC performance (8U, 6I, 12G) (Figure 11.19)
GOV9 (8U, 6I, 12G) (Figure 11.19)</td></tr>
<tr><td>GOV20</td><td>“Decreasing level of corruption in government for allocating resources to entrepreneurs”</td><td colspan="2">GOV21 (2U, 2G) (Figure 11.19)
GOV21* (3I, 2G) (Figure 11.19)</td></tr>
<tr><td colspan="4">*Additional comments:

(1G): “Two mechanisms are available in this scenario which help to decrease the level of corruption of government. The first factor is joining of Iran to international organizations e.g. WTO and increasing degree of transparency of government activities. The second one is establishing association for national VC to support and monitor public and private VC industry which allows to monitor their activities and decrease the possible ways of corruption in allocating of resources to entrepreneurs”.</td></tr>
</table>

Table 11.21 (continued): Government sub-system and its related elements and connections in the third scenario

Coding	Description	Connections and weights		
GOV21	"Increasing trust between entrepreneurs within universities and government"	Increase motivation of individuals within universities (2U, 2G)	Increase UIC performance (2U, 2G)	**GOV21** (2U, 2G); See Loop R11 (Figure 11.19)
GOV21*	"Increasing trust between entrepreneurs and government"	Increase motivation of companies (3I, 2G)	Increase UIC performance (3I, 2G)	**GOV21*** (3I, 2G); See Loop R13 (Figure 11.19)
LC8	"Strong and efficient cluster activities (GOV9) can encourage team working and cooperation culture (LC8)"	Increase UIC performance (2U, 4I, 2G)	GOV9 (2U, 4I, 2G) See Loop R26b (Figure 11.20)	
	"Strong and efficient intermediary agent (GOV8) can enhance cluster activities (GOV9) which can encourage team working and cooperation culture (LC8)"	Increase UIC performance (2U, 4I, 2G)	GOV8 (2U, 4I, 2G); See Loops R19, R21 (Figure 11.20)	
	"Strong and efficient research consortia (OC1) can enhance cluster activities which can encourage team working and cooperation culture (LC8)"	Increase UIC performance (2U, 3I, 2G)	OC1 (2U, 3I, 2G); See Loops R20, R26a (Figure 11.20)	
***Additional comments:** (1I): "*Efficient cluster activities in the region can change the culture of companies to be more collaborative, because they will see the advantages of collaboration*".				
LC9	"Strong and efficient cluster activities (GOV9) can change traditional style of management in SMEs to adopt more rational approach for UIC (LC9)"	Increase UIC performance (4U, 2I, 3G)	GOV9 (4U, 2I, 3G) See Loop R51(Figure 11.20)	
	"Strong and efficient intermediary agent (GOV8) can enhance cluster activities (GOV9) which can change traditional style of management in SMEs (LC9)"	Increase UIC performance (4U, 2I, 3G)	GOV8 (4U, 2I, 3G); See Loops R47, R49 (Figure 11.20)	
	"Strong and efficient research consortia (OC1) can enhance cluster activities (GOV9) which can change traditional style of management in SMEs (LC9)"	Increase UIC performance (4U, 2I, 3G)	OC1 (4U, 2I, 3G); See Loops R48, R50 (Figure 11.20)	
GOV22	"Government do not have negative view about property ownership and capitalism of individual"	GOV5 (1U, 3I, 2G) (Figure 11.19)		
GOV23	"Decreasing bureaucratic procedure to form start-ups"	GOV9 (5I, 4G) (Figure 11.19)		
GOV24	"Strong management in collaboration in intermediary agents"	GOV8 (9U, 7I, 12G) (Figure 11.19)		

Table 11.21 (continued): Government sub-system and its related elements and connections in the third scenario

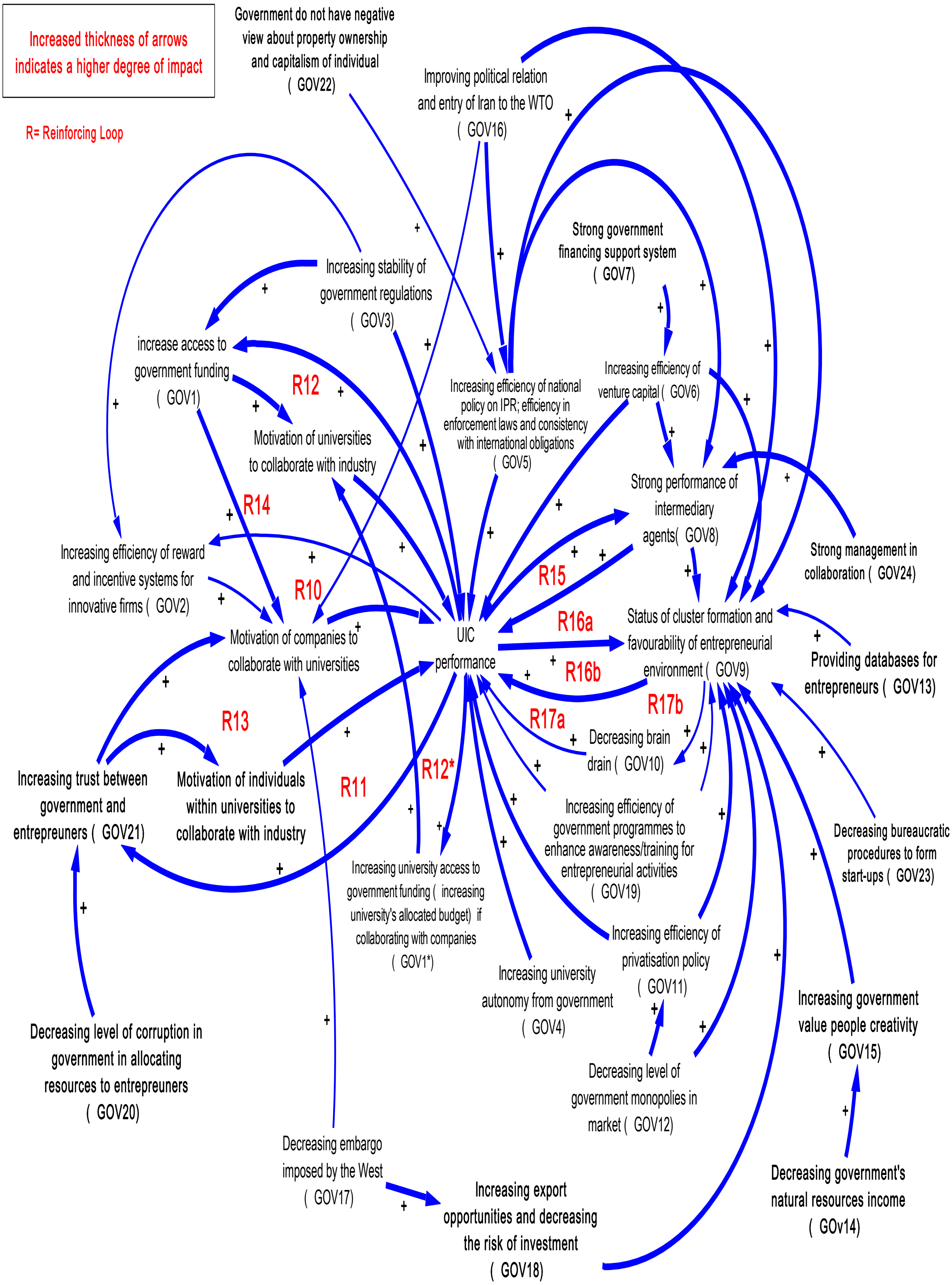


Figure 11.19: Government sub-system of the third scenario: constructed from the results in Table 11.21

11.5.1.6 Connection between sub-systems

The complete picture of connection between elements of different sub-systems and also all other reinforcing loops in the third scenario are presented in Figure 11.20.

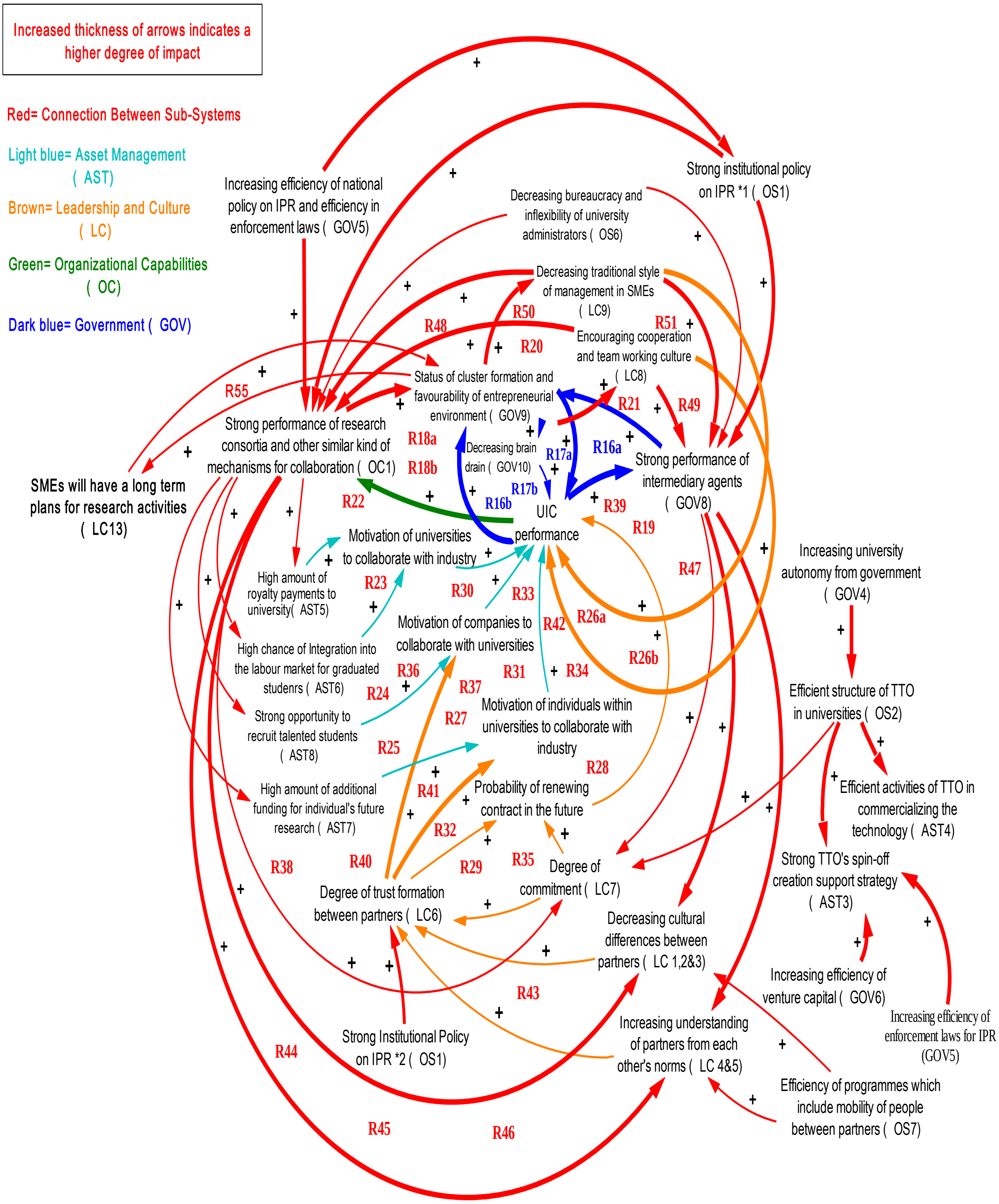


Figure 11.20: Relationships between elements of five sub-systems in the third scenario: constructed from the results in Tables 11.17-21

CHAPTER 12

DELPHI GROUP SESSIONS (TESTING THE VALIDITY OF CONSTRUCTED SCENARIOS)

12.1 INTRODUCTION

This Chapter reports the validation results for the three scenario scripts, and completes the adapted Delphi method started in the interviews (Chapter 11). Two separate Delphi Group sessions were arranged (2009 and 2010) using two sets of independent participants i.e. not from the interview pool.

These discussion sessions were chaired by the researcher and considered essential to test the behaviour of the models and also to validate the outcomes from the interviews. The main focus of this research is to evaluate the expected impact of planned policy changes; at this stage the validity of the policy manifestations as scenario models to achieve such changes were tested. Respondents were also asked to consider the role of culture and trust at both the institutional and national level in both sessions.

It should be stated that, at the beginning of both sessions the objective of the research was presented to the respondents; then the instrument which included questions for generating the DSM's was distributed among the respondents and they were asked to review these questions (see Appendix D) for 15 minutes. After that, in both sessions, the main topics for discussion (scenario questions- see Appendix D) were discussed by panel members. Any consensus, common agreement or disagreement among respondents was noted as a result for analysis. Both sessions were voice and video recorded, lasting around two hours each.

- First session: This session (Figure 12.1and Figure 12.2) was highly interactive and challenging, it involved 25 people from the industrial sector (30%), researchers from universities (50%) and politicians (20%). The location was a government-based organization under the MSRT in Ferdowsi University of Mashhad by the name of Jahad-e-Daneshgahi meaning “University Revoloution”.

Figure 12.1: First Session a (Jahad-e-Daneshgahi, Ferdowsi University, Mashhad, 2009)

Figure 12.2: First Session b (Jahad-e-Daneshgahi, Ferdowsi Univesrity, Mashhad, 2009)

- Second session: This session (Figure 12.3) involved 18 people from, respectively, the industry sector (40%), researchers from universities (20%) and politicians (40%) and it took place in the Khorasan Science and Technology Park in the city of Mashhad. This organization was principally established as an intermediary organization to promote UIC in the region and to support cluster activities in Mashhad.

Figure 12.3: Second Session: Khorasan Science and Technology Park, Mashhad, 2010

12.2 SCENARIO SCRIPT 1 (STAGNATION)

The model related to the first scenario is depicted in Figure 12.4.

The format of the sessions encouraged open discussion on what the group considered to be the most controversial or important scenario issues. Those not addressed specifically in open forum were acknowledged as valid, since no challenge to the forecast was raised. As a result of sessions, the model and scenario findings in Chapters 10 and 11, were reinforced and thereby validated by independent panels.

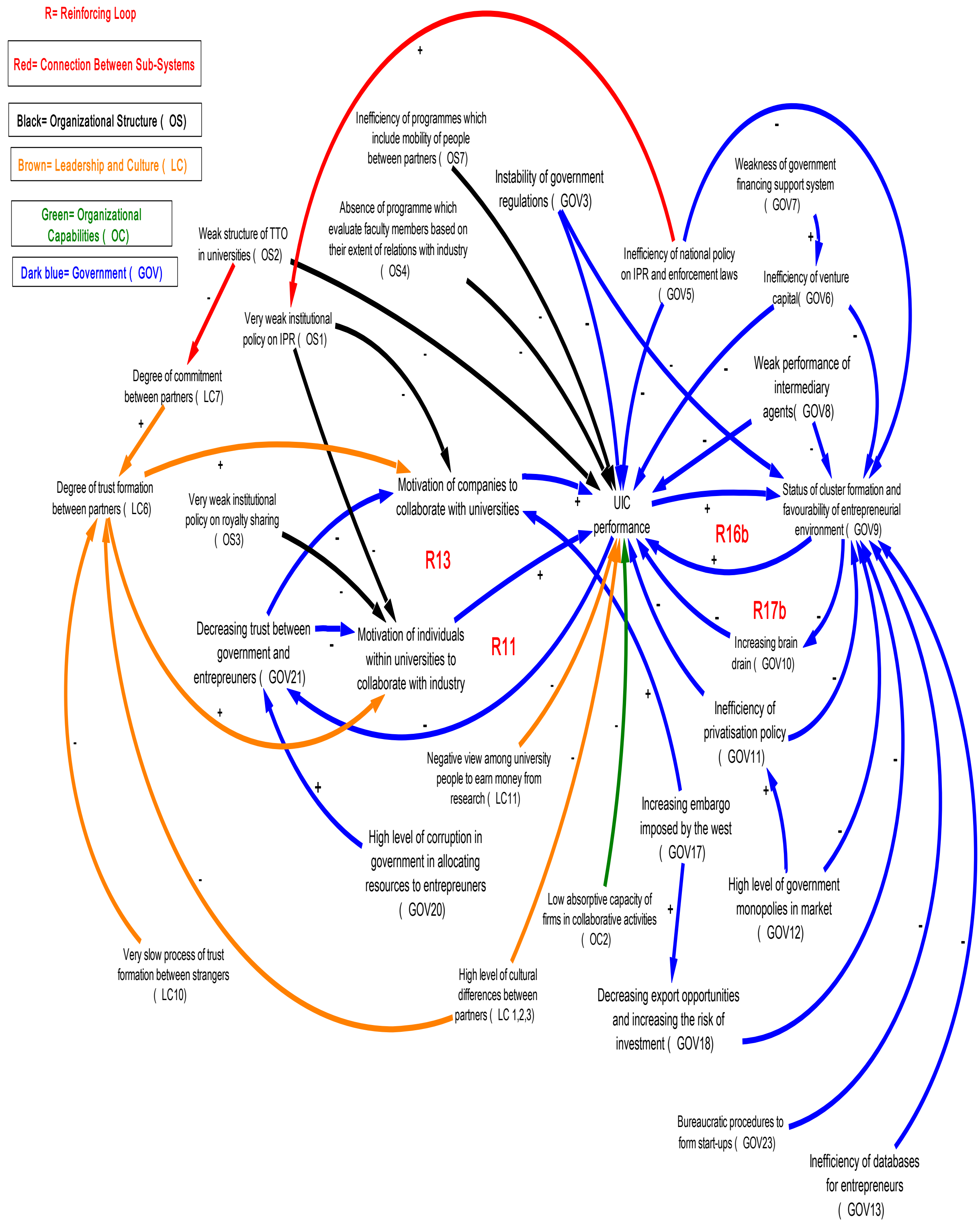


Figure 12.4: Scenario 1 Model

12.3 SCENARIO SCRIPT 2 (EFFICIENCY-DRIVEN ECONOMY)

The model related to the second scenario is depicted in Figure 12.5. Results from both sessions reinforced the findings related to the second scenario (Chapter 11).

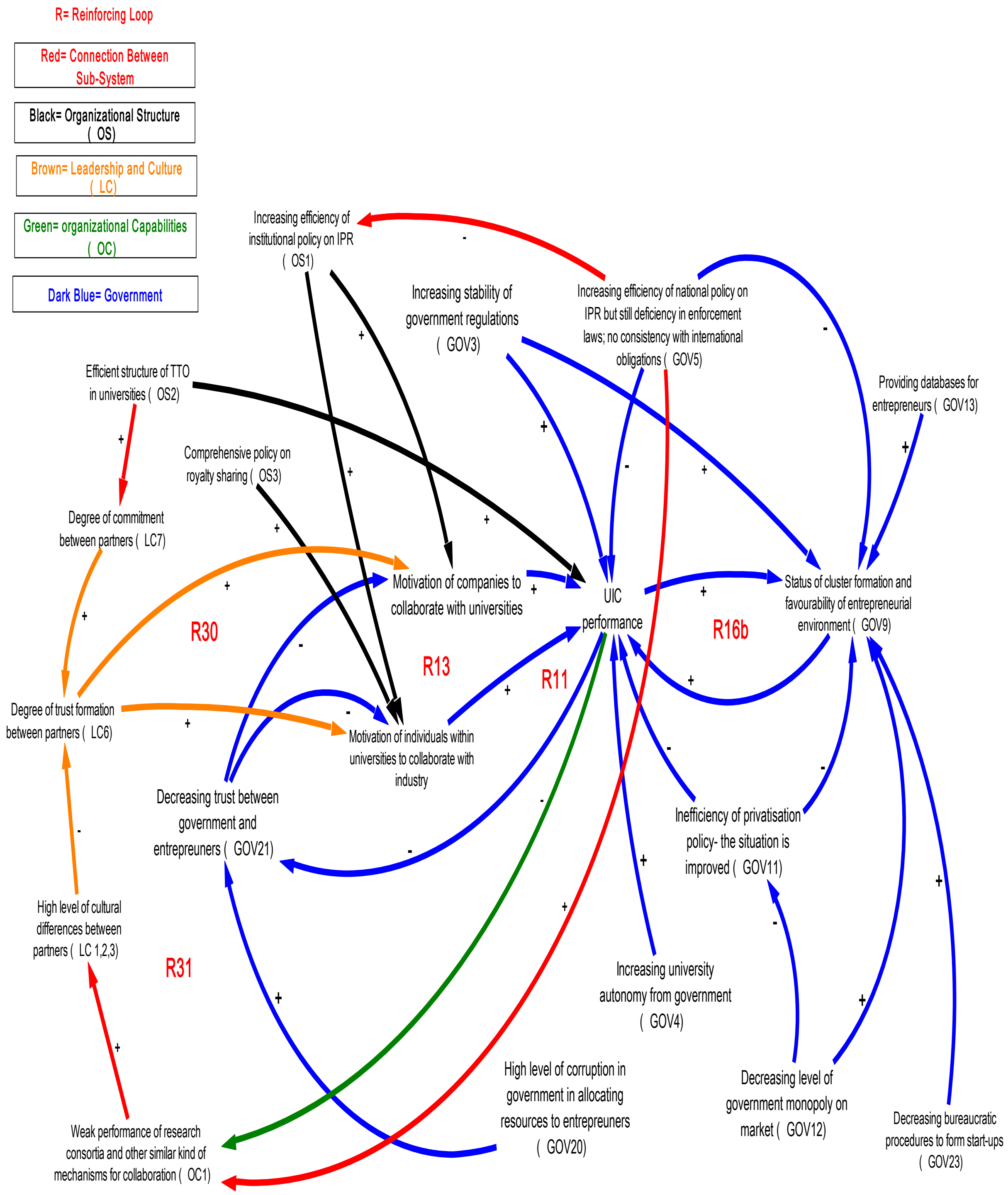


Figure 12.5: Scenario 2 Model

12.4 SCENARIO SCRIPT 3 (INNOVATION-DRIVEN ECONOMY)

The model related to the third scenario is depicted in Figure 12.6. Results from both sessions reinforced the findings related to the third scenario (Chapter 11).

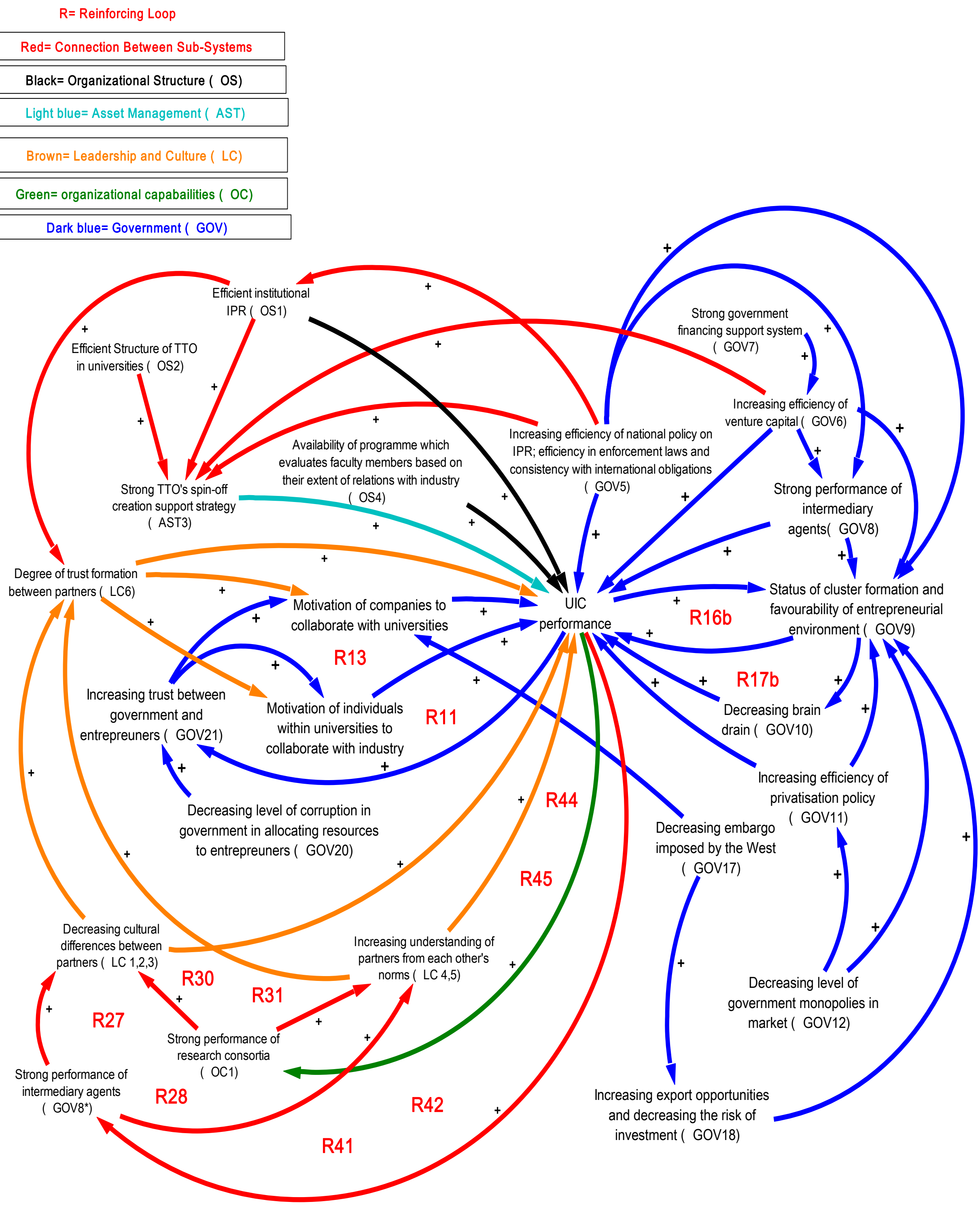


Figure 12.6: Scenario 3 Model

CHAPTER 13

DISCUSSION

13.1 INTRODUCTION

Using the constructed systems models and the scenario approach offers significant scope for experimentation with policy choice. The set of scenarios produced here are illustrative of the transition challenges facing Iran and therefore of the policy direction for UIC evolution and subsequent contribution to a knowledge based economy. To fully address the research question the issues of specific policy impacts on UIC behaviour need to be discussed and evaluated using the unified system model platform (DSM). This discussion is logically structured around the three primary outputs from the research methodology:

1- Development of a unified dynamic systems model (DSM): A policy neutral model of a UIC system;
2- Constructing and testing policy changes using the DSM – building scenarios;
3- Derived Policy agenda

13.2 CONSTRUCTING THE UNIFIED DYNAMIC SYSTEMS MODEL (DSM) OF UNIVERSITY INDUSTRY COLLABORATION

The unified DSM is formed by developing a series of influence diagrams and consists of five sub-systems which interact revealing the complex patterns of behaviour. This model forms the development platform to design and evaluate different future transition scenarios for Iran (or other developing nations), by uncovering system behaviours to policy elements necessary to overcome embedded cultural and trust barriers. These sub-systems are illustrated in Figure 13.1 and are discussed in the following section:

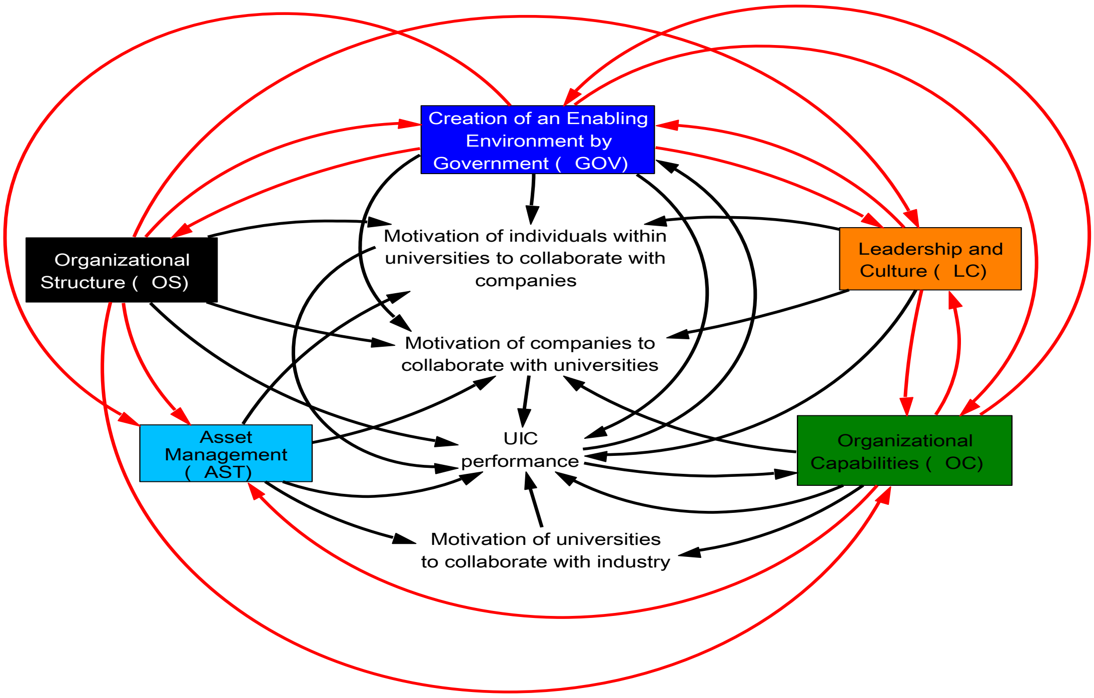


Figure 13.1: Dynamic Systems Model showing interaction between five sub-systems

13.2.1 Five sub-systems: the Key Forces (High Impact)

The five structural sub-systems illustrated in the following figures are summarized key-force versions developed from the analysis results (Tables 10.9-13). Interpretation of these system diagrams is self-explanatory, for instance in Figure 13.2, the efficiency of institutional policy on IPR (OS1) directly impacts both the degree of motivation of individuals within universities and degree of motivation of companies to collaborate. It was also found (Table 10.9) that OS1 has implications for trust formation between partners (OS sub-system has an impact on LC sub-system). OS1 was also found (Table 10.9) to be heavily influenced by the structure of TTOs in universities as well as the efficiency of **national policy** on IPR and also the efficiency of enforcement laws (GOV has an influence on OS).

OS sub-system consists of 3 key forces. These forces and their connections are shown in Figure 13.2 and include:

- OS1: Efficiency of institutional policy on IP rights
- OS2: The structure of technology transfer office in universities
- OS3: Efficiency of institutional policy on royalty sharing

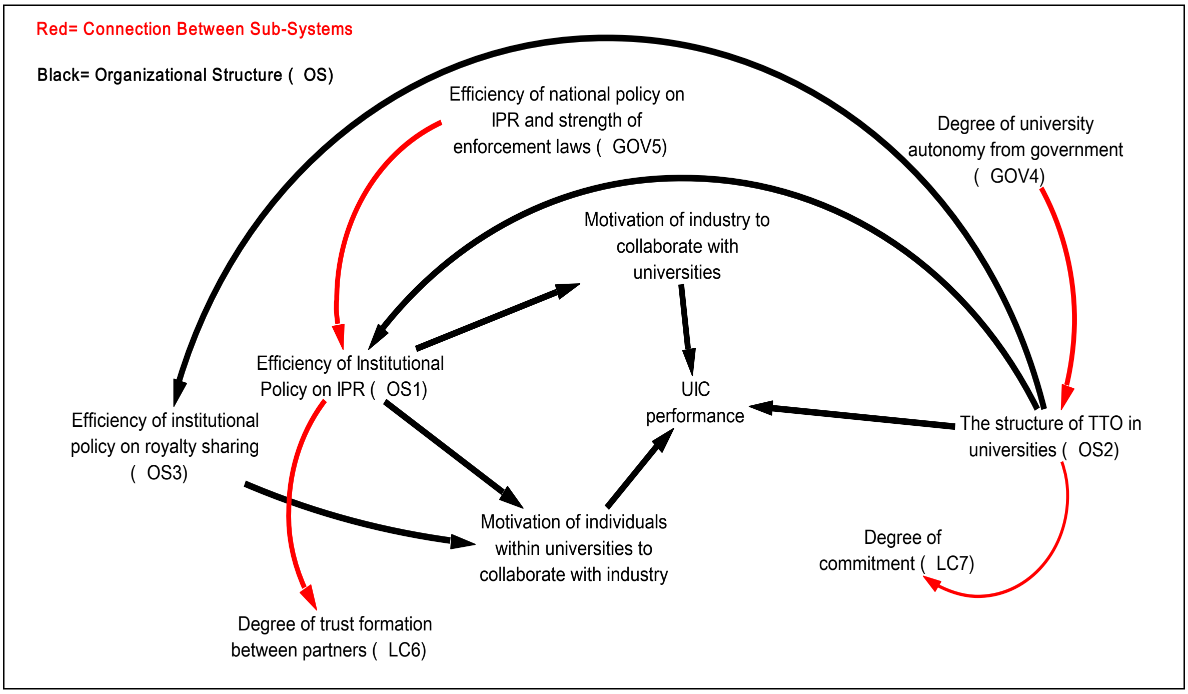


Figure 13.2: Elements of Organizational Structure sub-system and their connections: constructed from the results in Tables 10.9 and 10.13

AST sub-system consists of 2 key forces. These forces and their connections are shown in Figure 13.3 and include:

- AST2: Availability of various skills in technology transfer offices
- AST3: TTOs' Spin-off creation support strategy

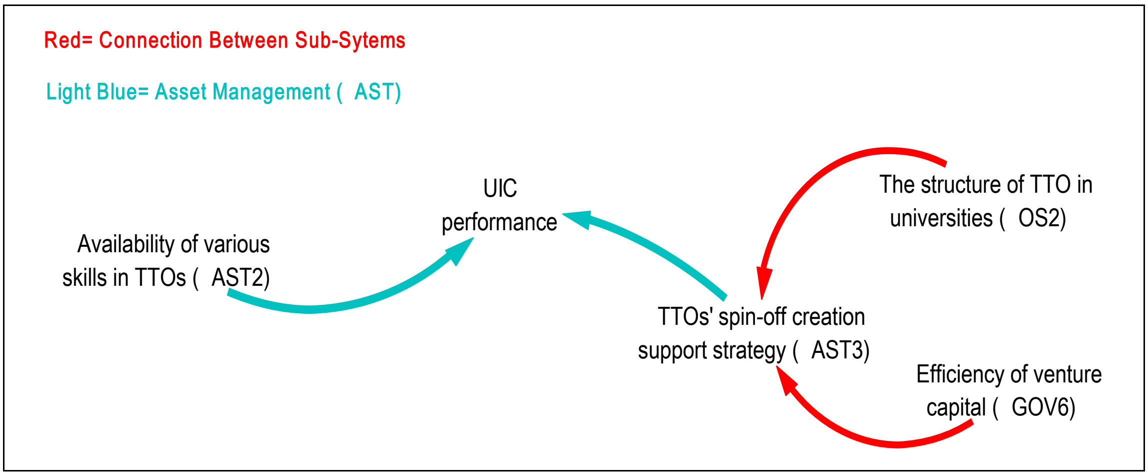


Figure 13.3: Elements of Asset Management sub-system and their connections: constructed from the results in Tables 10.9, 10.10, 10.13

LC sub-system consists of 10 key forces. These forces and their connections are shown in Figure 13.4 and include:

- LC1:Degree of cultural differences in university-industry collaboration (secrecy vs. dissemination)
- LC2: Degree of cultural differences in university-industry collaboration (time orientation differences)
- LC3: Degree of cultural differences in university-industry collaboration (profit maximization)
- LC4: Degree of lack of understanding of industry norms by university people
- LC5: Degree of lack of understanding of university norms by industrial people
- LC6: Degree of trust formation between partners
- LC7: Degree of commitment between partners
- LC8: Team working and cooperation culture
- LC9: Style of management in SMEs
- LC10: Pace of trust formation between strangers

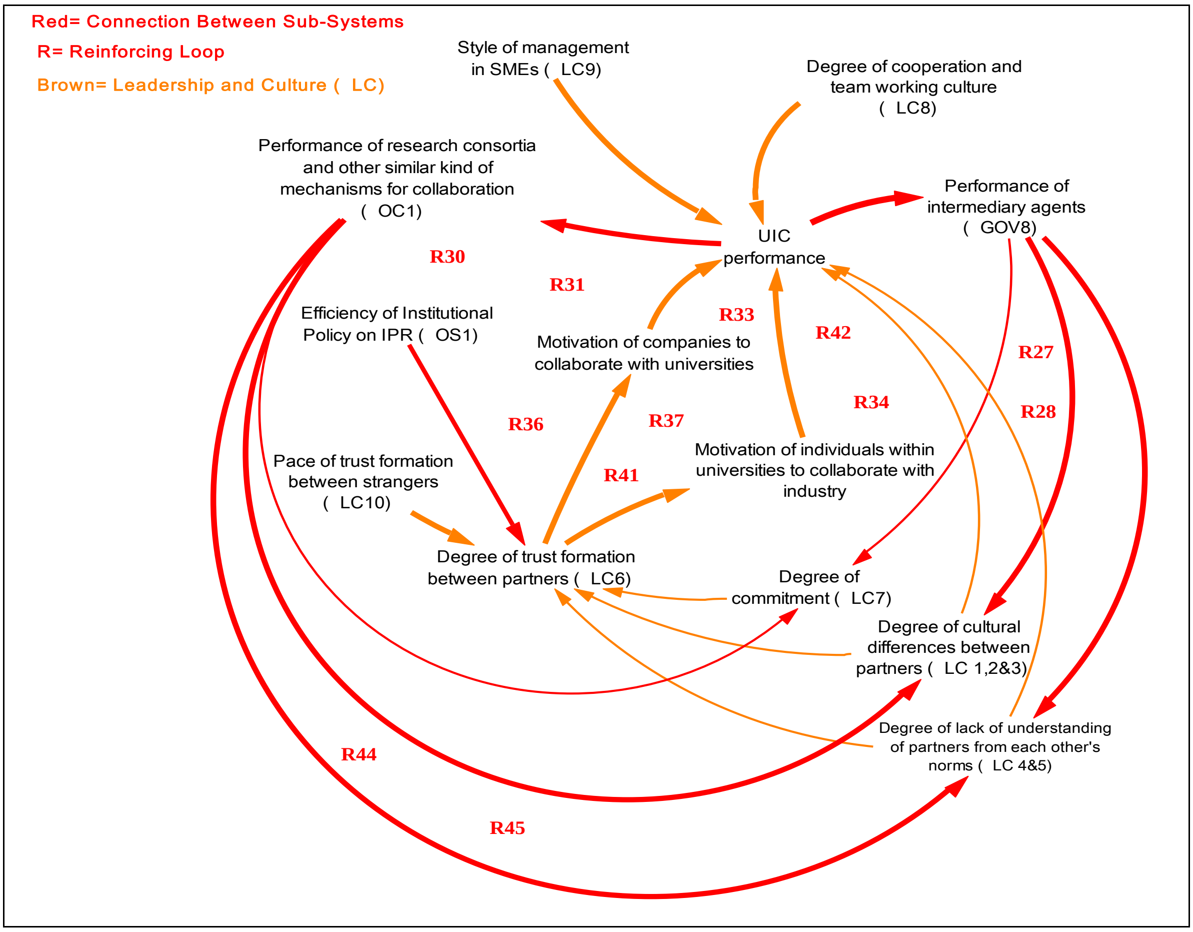


Figure 13.4: Elements of Leadership and Culture sub-system and their connections: constructed from the results in Tables 10.9, 10.11, 10.12, 10.13

OC sub-system consists of 9 key forces. These forces and their connections are shown in Figure 13.5 and include:

- OC1: Performance of research consortia and other similar kind of mechanisms for collaboration
- OC2: Degree of firms' absorptive capacity on knowledge transfer
- OC3: Level of university access to applied knowledge with positive impact on research and teaching
- OC4:Probability of generating entrepreneurial culture in universities
- OC5: Level of firms' capabilities in R&D
- OC6: Degree of generating innovation culture in companies
- OC7: Degree of achieving competitive advantage for companies
- OC8: Status of qualification level of employees in companies
- OC9: Ability of universities to improve sales and profitability of industry

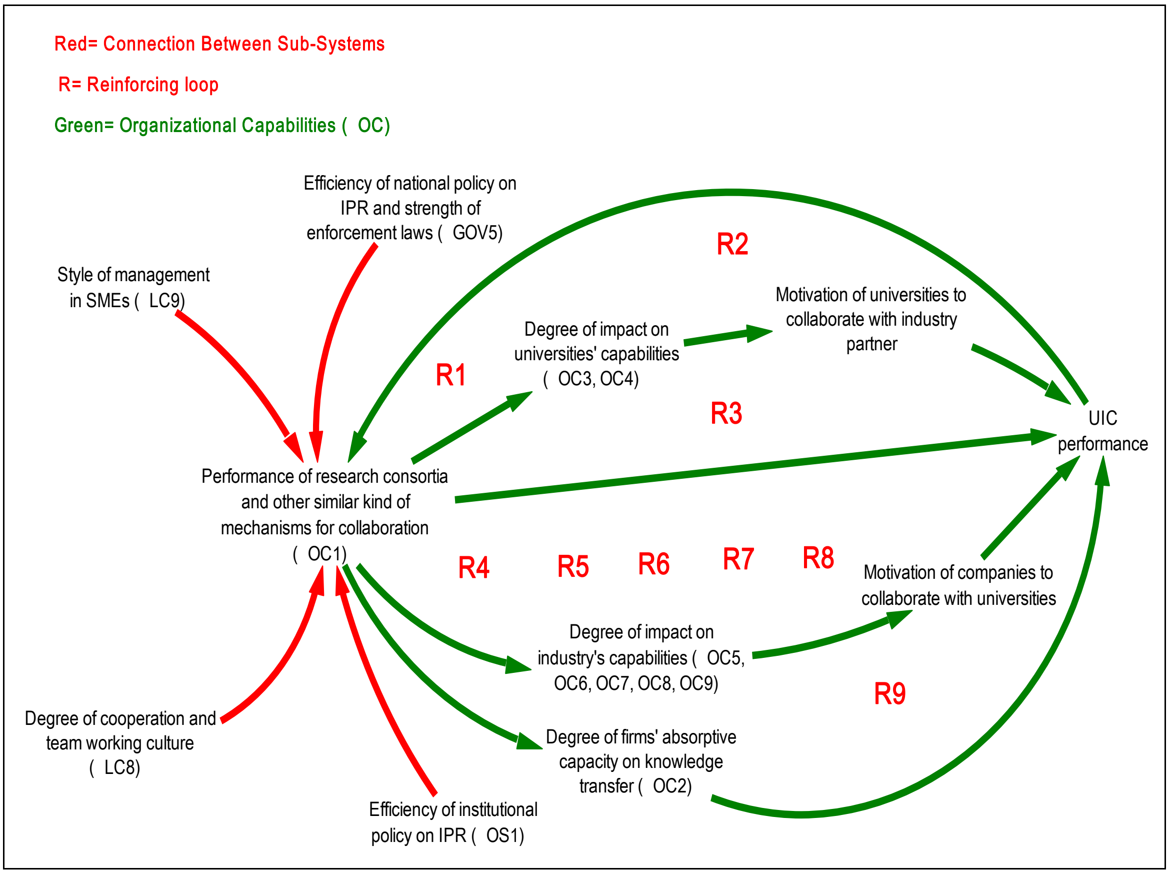


Figure 13.5: Elements of Organizational Capabilities sub-system and their connections: constructed from the results in Tables 10.9, 10.11, 10.12, 10.13

GOV sub-system consists of 18 key forces. These forces and their connections are shown in Figure 13.6 and include:

- GOV1: Degree of access to government funding when collaborating with partner
- GOV3: Degree of stability of government regulations
- GOV4: Degree of university autonomy from the government
- GOV5: Efficiency of national policy on IP rights and enforcement of laws
- GOV6: Efficiency of venture capital
- GOV7: Status of government financing support system
- GOV8: Performance of intermediary agents like science and technology parks and incubators
- GOV9: Status of cluster formation and favourability of entrepreneurial environment
- GOV10: Status of brain-drain
- GOV11: Degree of efficiency of privatisation policy
- GOV12: Degree of government monopolies in market
- GOV14: Amount of government natural resources income
- GOV15: Degree of government value people creativity
- GOV16: Political situation status and probability of entry to the WTO
- GOV17: Degree of embargos imposed
- GOV18: export opportunities and the risk of investment
- GOV20: Degree of corruption in government
- GOV21: Degree of trust formation between entrepreneurs and government

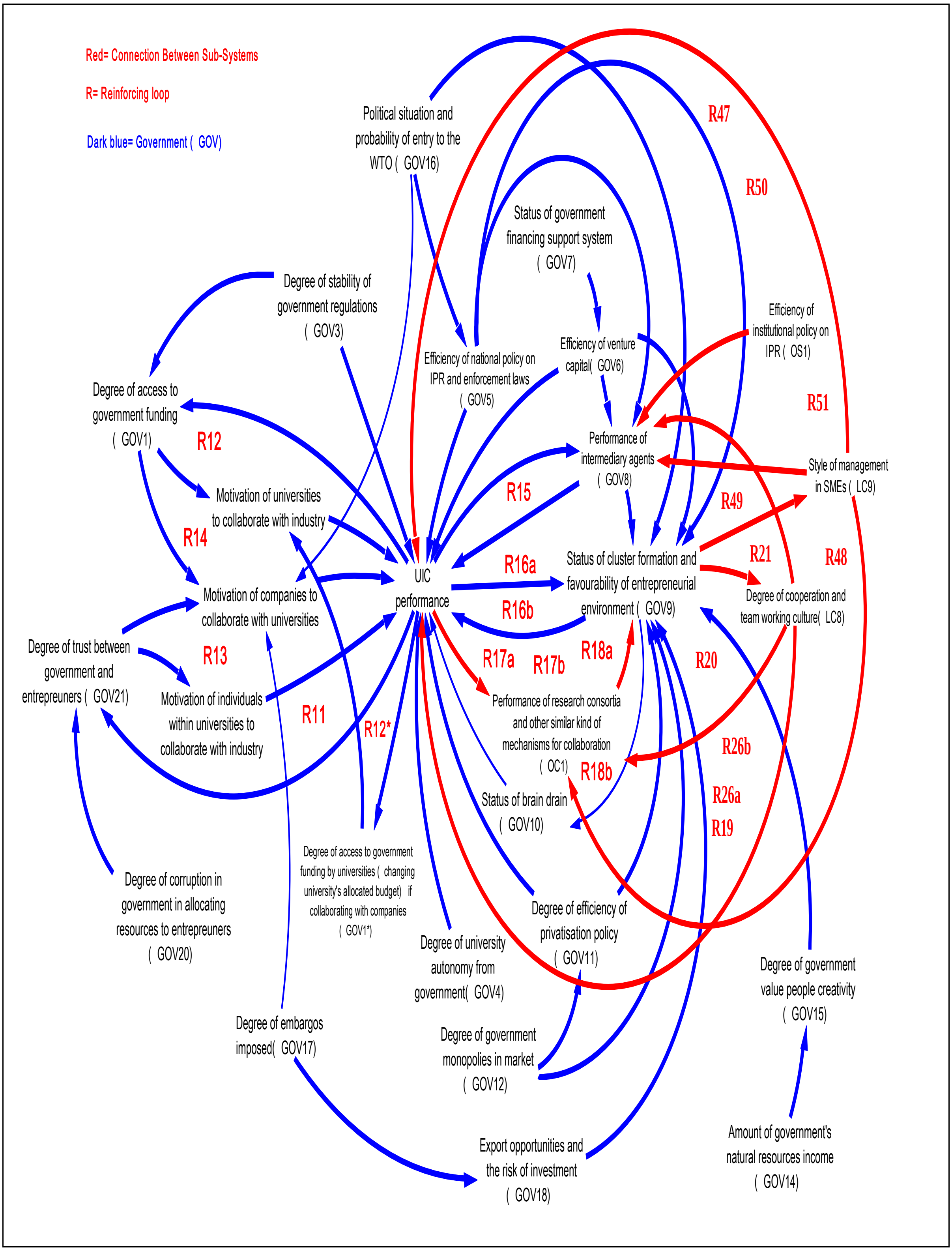


Figure 13.6: Elements of Government sub-system and their connections: constructed from the results in Tables 10.9, 10.11, 10.12, 10.13

13.2.2 Critical Infrastructural Forces in the DSM

It was found (Tables 10.9-13) that 18 of the forces that form the DSM can be considered as critical infrastructural forces. These forces are the most important key forces based on their impact on many other (three or more) elements of the system, or their impact on a creating a cascade of events (e.g. corruption). Unless these forces are addressed, changes to other elements of the system are likely to prove ineffective. These critical infrastructural forces are listed below:

- Efficiency of institutional policy on IPR (OS1)
- The structure of TTOs in universities (OS2)
- Degree of trust formation between partners (LC6)
- Degree of team working and cooperation culture (LC8)
- Style of management in SMEs (LC9)
- Pace of trust formation between strangers (LC10)
- Performance of research consortia (OC1)
- Degree of stability of government regulation regarding UIC activities (GOV3)
- Degree of university autonomy from government (GOV4)
- Efficiency of national policy on IPR and enforcement of laws (GOV5)
- Efficiency of venture capital (GOV6)
- Performance of intermediary agents (GOV8)
- Status of cluster formation and favourability of entrepreneurial environment (GOV9)
- Degree of efficiency of privatisation policy (GOV11)
- Degree of government monopolies in market (GOV12)
- Political situation and probability of entry to the WTO (GOV16)
- Degree of embargoes imposed (GOV17)
- Degree of corruption in government (GOV20)

Highlighted connections related to these critical forces are:

The **efficiency of national policy on IPR and enforcement of laws** (GOV5) has an influence on: the efficiency of institutional policy on IPR (Figure 13.2), the performance of mechanisms for collaboration including research consortia (Figure 13.5), intermediary agent's performance (Figure 13.6), status of cluster formation and favourability of the entrepreneurial environment (Figure 13.6), UIC performance, and indirectly has a strong influence on the degree of trust formation between partners (Figure 13.4). Aspects of these system connections are found in the literature (Geuna and Nesta, 2006; Hertzfeld et al., 2006), however the extent of the forces influenced by GOV5 were found to be much wider and therefore more structural in the current research.

Cultural characteristics indicated a strong influence on **the pace of trust formation between strangers** (LC10) which impacts on degree of trust formation between partners. Some other forces derive from this cultural feature including, **degree of team working and cooperation culture** (LC8) and **Style of management in SMEs** (LC9). These impact UIC performance, performance of research consortia, performance of intermediary agents, and status of cluster formation and favourability of entrepreneurial environment.

Of particular note is the level of performance of some of the mechanisms for collaboration including **research consortia** (OC1) and also **intermediary agents** (GOV8). These two forces have strong influences on UIC performance as well as status of cluster formation and favourability of entrepreneurial environment. These forces also have an impact on degree of cultural differences between partners and as result have an impact on trust formation between partners.

The **degree of corruption in government for allocating resources to entrepreneurs** (GOV20) impacts on degree of trust formation between government and entrepreneurs and consequentially impacts the motivation for collaboration (Figure 13.6). Likewise the extent of the state monopolies through the factors of **degree of efficiency of privatisation policy** (GOV11) and **degree of government monopolies in market** (GOV12) impact the status of cluster formation and favourability of entrepreneurial environment, and on the degree of trust formation between entrepreneurs and government. All of which reinforces a cultural embeddedness of lack of trust between strangers.

13.3 DEVELOPING SCENARIO THEMES FOR IRAN

The DSM includes the highlighted sub-systems and all the relevant forces on UIC behaviour. For the purposes of developing policy instruments to change the system behaviour, it is clear from the analysis that there are a few key forces which offer greatest policy impact potential i.e. they have high impact scores (see Section 13.2.1). These key forces are discussed in detail in the following sections along with the policy direction required to achieve scenario goals (future backward).

A large number of scenario themes could be developed at this stage. These themes range from a significantly backward future to an evolutionary future of the UIC system in the country. This research focuses on the policy planning framework necessary to optimize the UIC contribution for Iran to develop, i.e. to consider the conditions to create an aspirational but pragmatic scenario rather than optimistic, sub-optimal or worse-case ones (see Section 8.7.2.5).

Based on consideration of these criteria and in order to be more logical in the process of selecting scenario themes (Ward and Schrierfer, in Fahey and Randall, 1998), the procedures of special metrics were followed (global competitiveness index, 2008; Triple Helix I, II, III; National systems of innovation including Passive NLS, Active NLS and NIS) which cover all the related criteria for economic development. The logic behind using these metrics was to limit scenario themes to those considered pertinent to the evolutionary stages of development. As a result of using these metrics, three preliminary scenario themes emerged.

Names were assigned to each scenario theme that symbolised its core conditions.

Scenario theme A: Stagnation (current Iranian policy framework + 15 years)
Scenario theme B: Efficiency driven (current to new proposed policy framework + 15years)
Scenario theme C: Innovation driven (Scenario 2 + enhanced policy framework + 15years)

13.3.1 Scenario Theme A: Scenario Script 1 (Stagnation: current policy framework + 15years)

The DSM remains neutral until the system is loaded with a series of policy strengths and direction. Using the current Iranian policy framework to forming Scenario Theme A, the policy levers are set as follows:

- Inefficiency of national policy on IPR and enforcement laws (GOV5)
- Lack of university autonomy from government (GOV4)
- Weakness of government financing support system (GOV7)
- Inefficiency of VC (GOV6)
- Instability of government regulations (GOV3)
- Low level of access to government funding (deficiency of government initiatives for collaboration) (GOV1)
- No change to allocated budget of universities if collaborating with companies (GOV1*)
- Lack of government support from research consortia and intermediary agents (OC11)
- High level of government monopolies in market (GOV12)
- Inefficiency of privatisation policy (GOV11)
- High level of corruption in government in allocating resources to entrepreneurs (GOV20)
- Deficiency of government strategy to support cluster formation (GOV9)
- Deficiency of government policy to control brain-drain (GOV10)
- Increasing embargoes imposed by the Western Governments (GOV17)
- Weakness in political relation and less probability of Iran entry to the WTO (GOV16)

Related policy elements forming Scenario Theme A are as follows:

- Very weak institutional policy on IPR (OS1)
- Very weak institutional policy on royalty sharing (OS3)
- Weak structure of TTO in universities (OS2)
- Insufficient skills in the TTO (AST2)
- Inefficient TTOs strategy to support spin-off companies (AST3)

The following sections use the DSM to perform a system “work-through” of these policy instruments.

13.3.1.1 Organizational Structure sub-system (OS)

The outcome of 15 years of current policy on the OS sub-system (future state analysis from Tables 11.2 and 11.9) is shown in Figure 13.7.

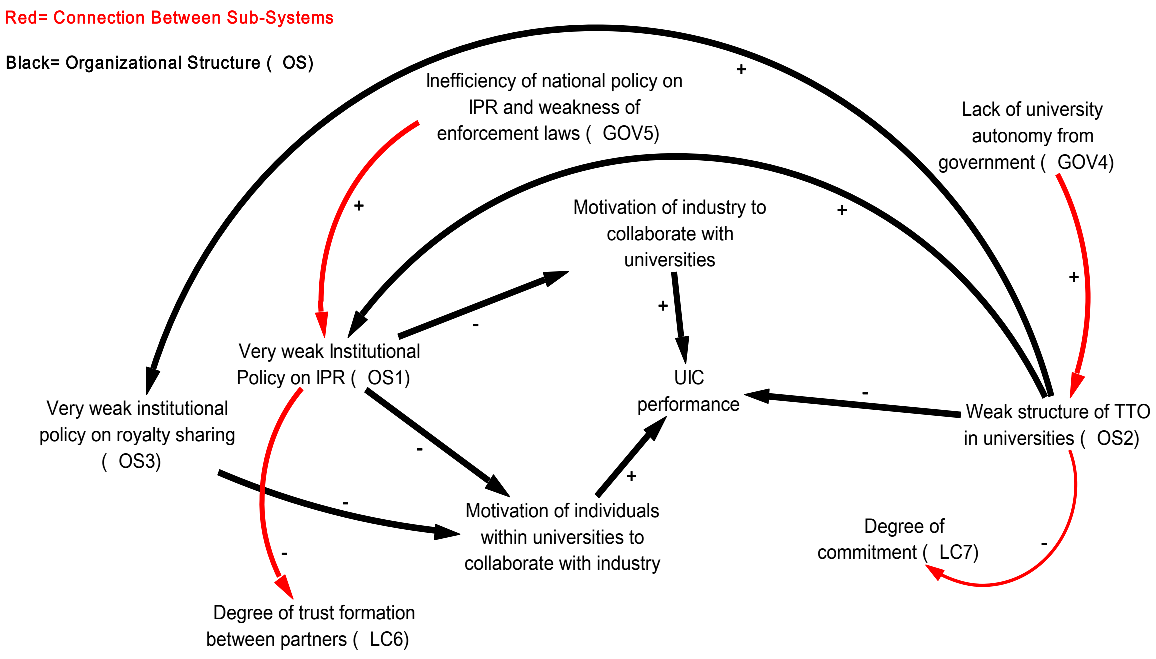


Figure 13.7: Elements of Organizational Structure sub-system and their connections in the first scenario: constructed from the results in Tables 11.2 and 11.9

<u>Policies: IPR (national and institutional), Structure of TTOs</u>

The primary features (Table 11.2) of this future are clear deficiencies of institutional policy on IPR which in turn decreases motivation to collaborate, and ultimately decreases UIC performance. This structural barrier causes a deepening lack of trust between partners or potential partners (confirmed by both validation sessions- see Section 12.2). Eventually collaboration activities are forecast to cease, resulting in little or no knowledge transfer between universities and industry other than through graduate employment or consultation. Hertzfeld et al., (2006, p828) found that because of unclear rules regarding IP in the early 1980s "*many firms were reluctant to enter research partnerships because they were uncertain as to how the alliance would be treated by the courts if challenged*". The main reasons found for the deficiency of IPR ownership in universities are a lack of necessary skills due to the absence of multidisciplinary teams in TTOs and also at the national level, the weak national policy on IPR protection and deficiency of enforcement laws (see Figure 13.7). These issues form significant barriers for academics considering collaborating with companies. The absence of strong multidisciplinary-teams in TTOs creates problems in effective formulation of institutional policies on royalty sharing and contractual support, ultimately causing poor commitment among partners.

Policies: University autonomy from government, Structure of TTOs

The current low degree of university autonomy from government (Table 11.9) has a negative impact on structure of TTO in universities (see Figure 13.7). TTOs hierarchical structure and their budget are defined directly by MSRT and there is no autonomy for universities' top management to change this. If this situation remains, capital for the support for, and direct involvement with, entrepreneurial activities will be low level; because activities in TTO's and the building appropriate teams depends heavily on the budget. Currently, most UIC activities which are arranged through formal university procedures are limited to simpler mechanisms for collaboration (e.g. consultation, conferences) due to the perceived barriers and risks for deeper collaboration e.g. inefficiency of IPR. Consequently, informal collaborations i.e. not arranged with institutions, take place through personal networks between academics and companies including friendship, reputation and expertise – demonstrating the Iranian short range trust approach. The extent of such collaboration is therefore limited to trusted partners and consequently few in number. More complex forms of collaboration through formal mechanisms (university system) also happen through personal networks (e.g. personal friendships between TTO staff and individuals in companies) rather than systematic procedures. Only in these rare situations do partners stay committed to each other and the collaboration. If this situation continues, almost all collaborative activities will be limited to small scale individual networks rather than larger scale formal arrangements. Strategic innovations and coherent technology transfer programmes are likely to continue to be limited to the defence industries.

Based on Inzelt's (2004) categorization of technology transfer activities (see Section 4.5), most types of UIC activities in Iran focus on simpler forms of interaction (see Sections 9.4.2 and 9.5.3) e.g. consultancy and technical service provision, or conference and publications. UIC activities requiring more interaction (sophisticated forms of interaction) are either occasional e.g. cooperative R&D agreement, or not present - spin-off company formation. According to Inzelt (2004) as interactions move from the simple to more sophisticated, patterns of interaction between actors should also evolve from being isolated to more dynamic and continuous. Greater communications and trust are needed for collaborations to become more sophisticated. It was found (Table 11.5) that, in the case of Iran these two elements are largely absent.

13.3.1.2 Asset Management sub-system (AST)

The outcome of 15 years of current policy on the AST sub-system (future state analysis from Tables 11.2, 11.3, 11.9) is shown in Figure 13.8.

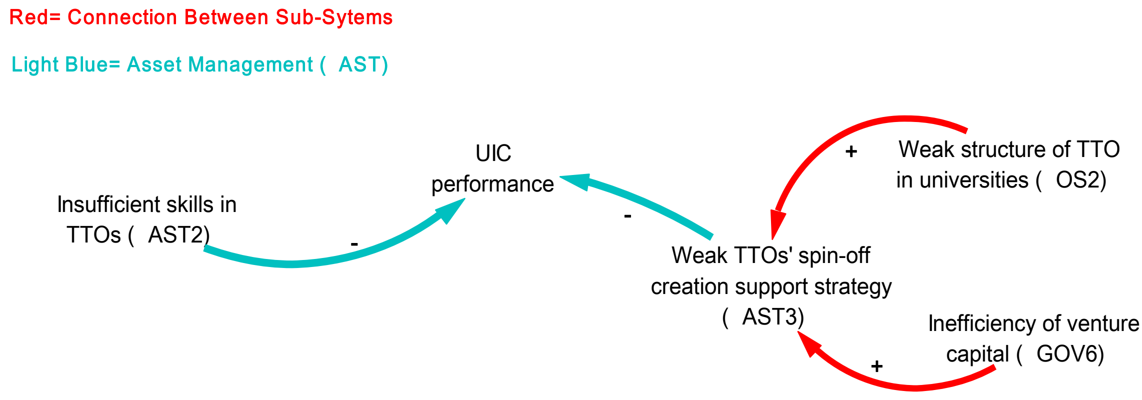


Figure 13.8: Main Elements of Asset Management sub-system and their connections in the first scenario: constructed from the results in Table 11.2, 11.3, 11.9

Policies: Venture Capital, Skills in the TTOs, Structure of TTOs

Birley (2002) and Macho-Stadler et al., (2008) defined spin-off formation as an indication of entrepreneurial orientation of universities. Currently, universities in Iran are considered as low with respect to entrepreneurial orientation since TTOs do not support spin-off company formation (Table 11.3) creating few instances of spin-off companies from universities (confirmed by the result of both validation sessions- see Section 12.2). This is unlikely to change in this scenario.

Additionally, the weakness of TTO support for researchers during development phases of their innovations and also the weakness of the network of these offices to connect entrepreneurs to potential venture capitals, their potential to facilitate spin-off company formation is limited (fee Figure 13.8). Prolonging this will cause UIC performance to reduce further, since such barriers to academic entrepreneur ambitions facilitate the ongoing national brain-drain, resulting in an increasing concentration of non-entrepreneurial academics in University departments. For Iran, which has ambitions for universities "*future outlook of the country in 1404=2025*" which envisions universities to become completely entrepreneurial. However, by continuation of current policies Iran is unlikely to achieve this vision, since TTOs play no efficient role other than managing apprenticeships programmes for students which is different from their defined and required responsibilities.

Degroof and Roberts (2004) identified four archetypes of spin-off policy based on level of support and selectivity of academic institutions (see Section 4.11). In this scenario Iran is classified in the first archetype - absence of proactive spin-off policies - due to the inefficient structure of TTOs and the lack of multi-disciplinary skills, and also because of the low level of activities of venture capital in the country. Based on these different archetypes, Degroof and Roberts (2004) suggested that in order to have efficient spin-off formation particularly in entrepreneurially underdeveloped environments, high levels of institutional support and access to VC is required.

This shows that although there is a network weakness of TTO's to connect entrepreneurs to VC, a fundamental problem is the low level of VC activities in the country (this is out of control of these offices and related to government support and favourability of entrepreneurial environment for VC activities). If this situation continues, the aims to increase the entrepreneurial status of universities will fail.

13.3.1.3 Leadership and Culture sub-system (LC)

<u>Policies: Research consortia, Intermediary agents</u>

The outcome of 15 years of current policy on the LC sub-system (future state analysis from Tables 11.2, 11.5, 11.7, 11.9) is shown in Figure 13.9. The weak performance of research consortia and other similar kind of mechanisms for collaboration (Table 11.7) e.g. R&D contract of joint activities, and also the weak performance of intermediary agents, are likely to continue to increase barriers to collaboration. Consequently, the cultural differences of current and potential partners remains high, and opportunities to increase understanding of partners for each other' norms will decrease, exacerbating the polarization of university and industry.

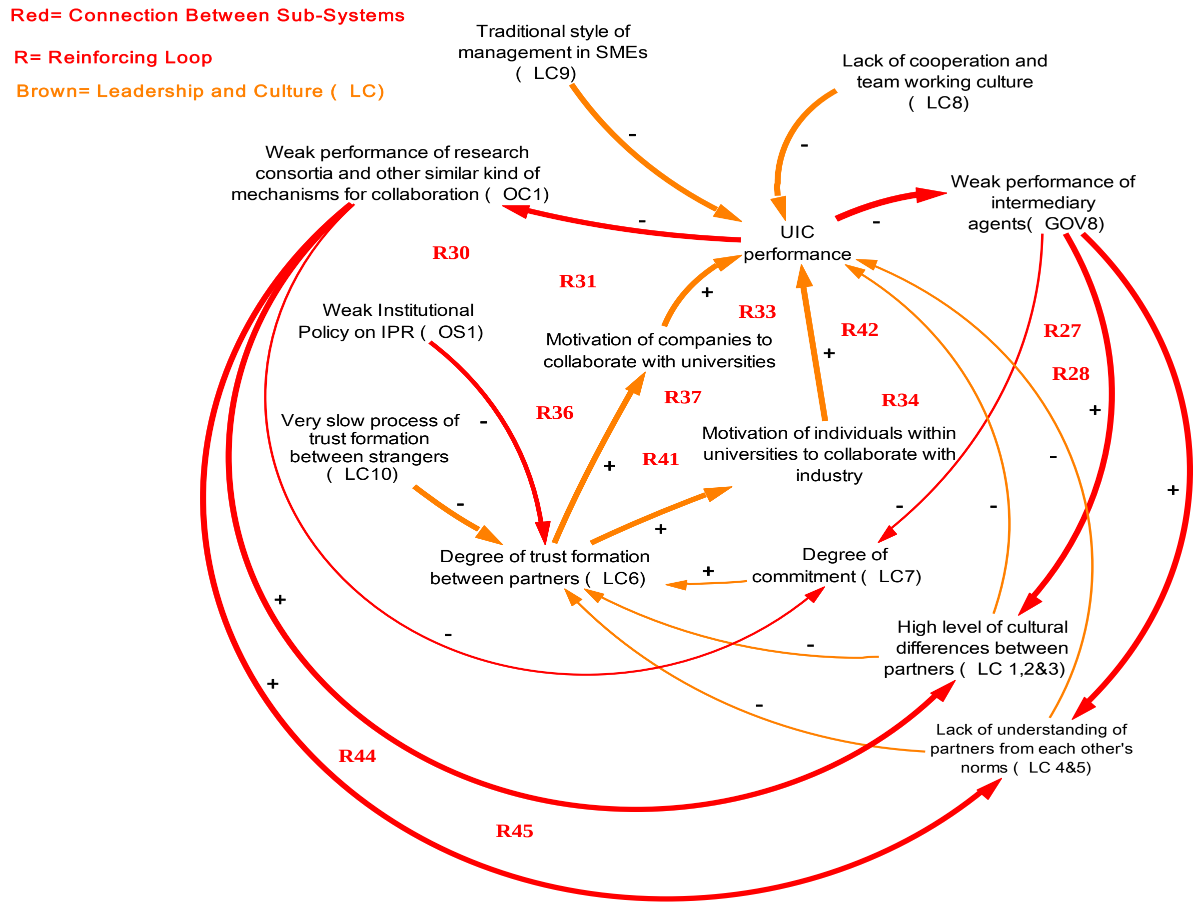


Figure 13.9: Elements of Leadership and Culture sub-system and their connections in the first scenario: constructed from the results in Tables 11.2, 11.5, 11.7, 11.9

The Iranian cultural characteristics that require a long term approach to trust formation creates an emphasis on the role and value of efficient and active intermediate organizations and agencies in the National Innovation System. This reliance on indirect trust chains creates an interesting opportunity to develop policy instruments.

Cultural difference between partners and also lack of understanding of partners norms were recognized as the major barriers to UIC. This situation leads to a decrease in the opportunities for trust formation between partners (see Figure 13.9). The weak structure of intermediary agents and research consortia causes a reduction in the degree of commitment among partners. This is due to poor procedures of collaboration administration (including contract responsibilities for each partner and penalties if the collaboration terms are abused) to oblige partners to stay committed to each other for the duration of the collaboration project. Such suppression of collaboration commitment ensures trust formation is unlikely. Lack of trust between partners is one of the major barriers which decreases motivation of individuals in universities and companies to collaborate. If there are no changes in the state of these mechanisms (research consortia and intermediary agents) the projected future holds little potential for trust formation or willingness to participate in these collaborations, forming a negative reinforcement loop with poor performance of research consortia and intermediary agents (see Loops R27, R28, R30, R31, R33, R34, R36, R37, R41, R42, R44, and R45) (Figure 13.9). List of loops are available in Appendix E. These negative reinforcing loops are structural in the UIC system, ensuring a situation in which any investments by government, companies and universities to establish mechanisms for collaboration are likely to fail. In this event companies pull their investment from these initiatives and universities will then do likewise. Ultimately, significant economic value to the NIS is lost with the increasingly rare opportunities for more complex forms of collaborations.

Low levels of team working and non-cooperation culture in the country, coupled to low SMEs management skills based on traditional management practices have a distinct negative impact on UIC performance. Very slow trust formation with strangers is a major cause of low trust formation between partners. These three forces have a strong cultural root in the Iranian context (see Figure 13.9). Iran’s cultural predisposition to a lack of trust would suggest that formal trust forming mechanisms (contract and IPR) are likely to be more important than in other cultures. These cultural features also manifest in the lack of trust between partners creating a barrier to motivation of companies to collaborate with universities and also motivation of individuals within universities to collaborate with companies.

Gambardella (1995) postulated that companies that follow more scientific research approach perform better compared to companies that following more traditional approach. Compared to the case of Iran it is clear that traditional style of management in SMEs cause a problem which decreases a performance for collaboration. According to Williams and McGuire (2008) each particular culture supports novelty, risk taking, collective action and team working activities differently and as a result the degree of creativity and innovation implementation are different across nations. Based on the findings of the current research (see Table 11.5), it was found that in the case of Iran, the national culture does not effectively support these activities thus forming barriers enabling an entrepreneurial environment in the country. As noted by Javidan and Dastmalchian (2003) the most prominent part of Iranian culture is its family and in-group orientation. This type of culture has a negative correlation with country competitiveness and economic prosperity. Fukuyama (1996) proposed that one major negative consequence of strong family orientation is that the "radius of trust" will be reduced (see Section 5.8), which is largely reinforced by the current findings.

13.3.1.4 Organizational Capabilities sub-system (OC)

Policies: IPR (national and institutional)

The outcome of 15 years of current policy on the OC sub-system (future state analysis from Tables 11.2, 11.5, 11.7, 11.9) is shown in Figure 13.10. Weak national policy on IPR protection, deficiency of enforcement laws and also absent of efficient institutional policy on IPR (Tables 11.2, 11.9) has a negative impact on the performance of research consortia (see Figure 13.10). This situation creates an environment where companies and universities are reluctant to form joint activities because of the perceived risk of leakage of strategic information. In the absence of effective enforcement laws, collaboration investments are risky as a result of the disconnection between collaboration contracts and legal status – the judicial system has no mechanisms to compensate or protect partners regarding the loss of intellectual property. If this situation continues then efforts to increase involvement with, and enhance the performance of, research consortia are futile.

Policy: Degree of government support from research consortia

Weakness of consortia management and lack of government support from this mechanism were identified as significant barriers which contribute to a decrease in the efficiency of consortia collaborations. As a consequence of the national culture of the country, the low levels for cooperation and team working and the traditional style of management in SMEs have a direct negative impact on the performance of research consortia. The tendency of SME's to follow a traditional style of management is a challenge issue in this scenario. Many SMEs are reluctant to seek and adopt new ideas e.g. to collaborate with universities in research consortia. According to Arbonies and Moso (2002) the efficiency of research consortia depends on the willingness of companies to participate and invest – i.e. to experience the value to involvement. In the Iranian case it was found that the willingness for collaboration is low, therefore those companies that do decide to invest in research consortia will find a lack of network connections with other companies.

Policy: Research consortia

The overall performance of research consortia is weak with few opportunities to demonstrate a positive impact to enhance the capabilities of universities and industry as a result of collaboration in these consortia. Therefore, reducing the probability of motivation for this mechanism for collaboration (see Figure 13.10). Universities and companies who invested heavily in this kind of mechanism for collaboration did not get the anticipated return on their investments. As this situation progresses, it is likely to de-motivate universities and industries from further participation and limit further investment. These form negative reinforcing loops (see Table 11.7) which will reduce the performance of this kind of mechanism for collaboration in the long term (see Loops R1, R2, R3, R4, R5, R6, R7, R8, and R9) (Figure 13.10). This indicates that the lack of structural IPR policies are undermining the role of research consortia in the NIS

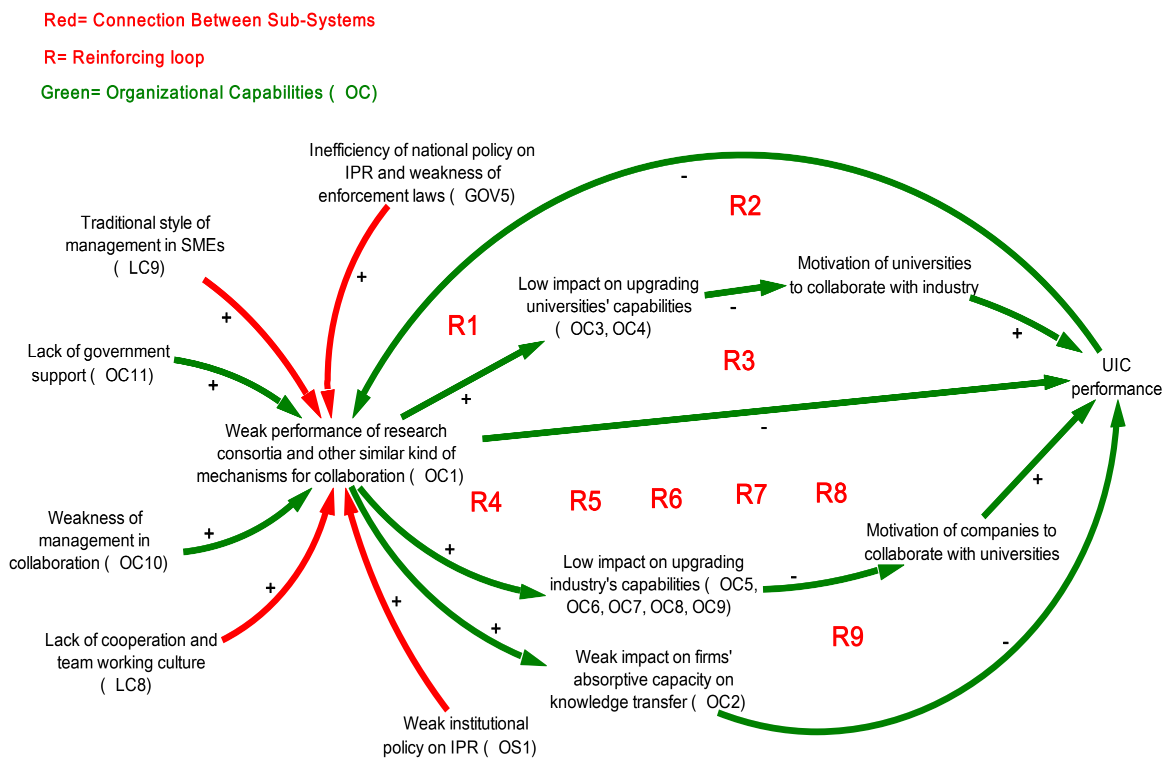


Figure 13.10: Elements of Organizational Capabilities sub-system and their connections in the first scenario: constructed from the results in Tables 11.2, 11.5, 11.7, 11.9

13.3.1.5 Government sub-system (GOV)

The outcome of 15 years of current policy on the GOV sub-system (future state analysis from Tables 11.2, 11.5, 11.7, 11.9) is shown in Figure 13.11. As expected, the majority of policy levers are present in this sub-system.

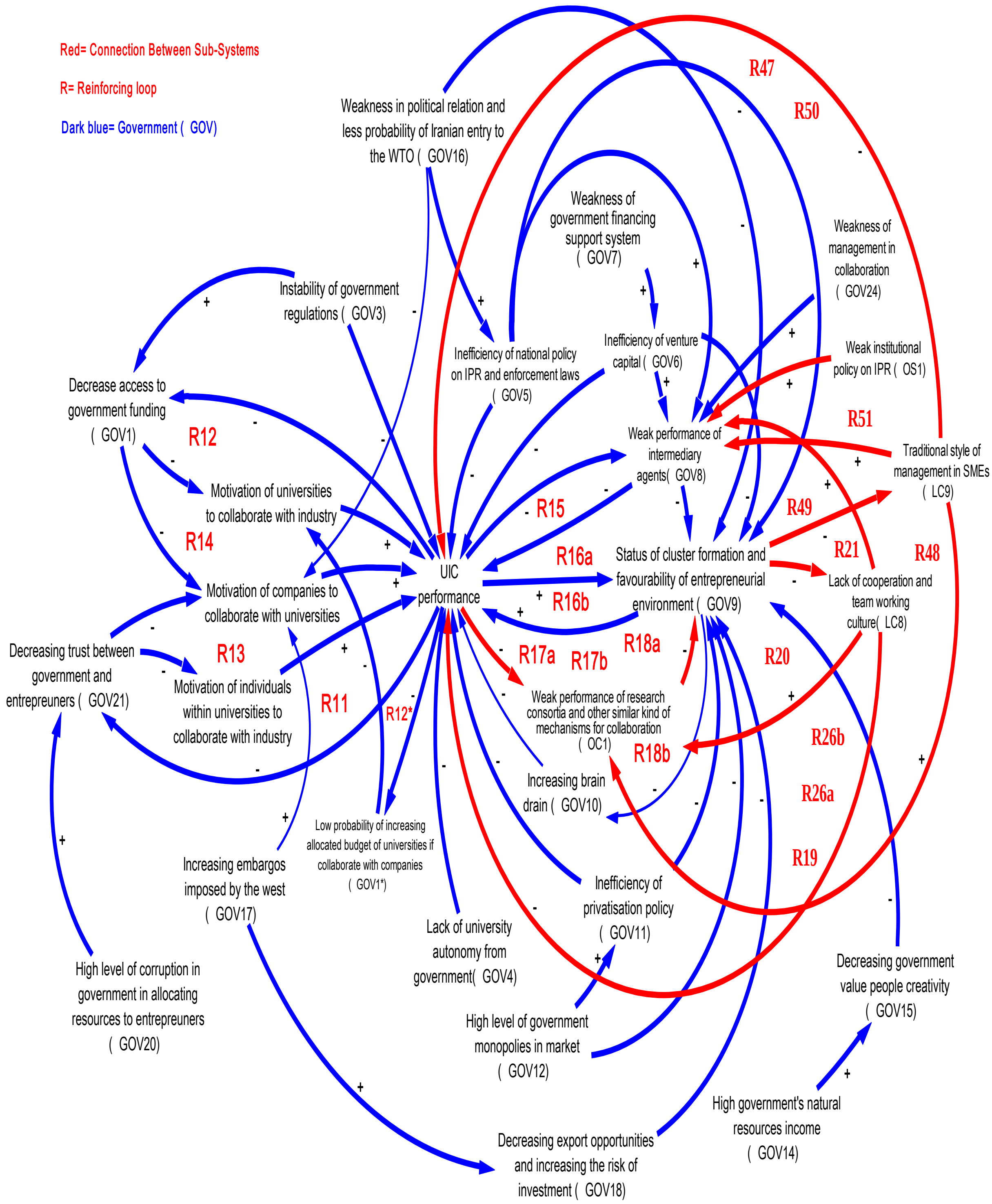


Figure 13.11: Elements of Government sub-system and their connections in the first scenario: constructed from the results in Tables 11.2, 11.5, 11.7, 11.9

<u>Policy: Stability of government regulations, Government initiatives for collaboration</u>

There are various government support mechanisms for collaboration (e.g. tax incentives or partial government funding '60%' for companies which have collaborative activities with universities). These activities can also inject extra money into universities as a result of collaborative projects. However, these support mechanisms have proved ineffective due to instability of the government regulations (see Figure 13.11), and inefficient IPR protection and enforcement laws. Most of these collaborations are limited to simpler forms of activities e.g. consultation. It was found (Sections 9.4.4.5 and 9.5.5.4) that, instability of government regulations regarding university-industry collaborations is **the most important barrier** to collaboration. This reflects the difficulties for either party to invest in particular mechanisms of collaboration while they are unsure about the terms and conditions of these stop-start support initiatives.

The discontinuous (stop-start) pattern of these initiatives created a fragmented and unreliable basis for collaboration resulting in decreased motivation of companies and universities to re-engage in these initiatives (Table 11.9). If this situation is repeated, there would be very low level of willingness to participate from either party. This will decrease the amount of government funding which could be delivered effectively fro collaborative activities and furthermore decrease the efficiency of these government programmes. These form negative reinforcing loops which continuously decrease the performance of these government initiatives for collaboration (see Loops R12, R14) (Figure 13.11). Consequently, trust in the government as a facilitator is reduced.

Lack of financial incentives directly demotivates institutions from large scale collaborative activities since universities have no additional resources allocated by government for increasing their collaboration activities with industry. As highlighted earlier, the value and depth of these collaborations is low, limiting the income from industry and therefore motivation for involvement. If this situation continues in the future, universities would view participation in further rounds of UIC activity as economically unfeasible (see Loop R12*) (Figure 13.11).

Policy: University autonomy from government

Iranian universities have a very low degree of autonomy from government. All of their activities are coordinated by MSRT regulations. This decreases UIC performance and increase degree of bureaucracy in universities even for simple kind of activities (see Figure 13.11). Any changes in universities' collaborative policy with companies are required to be arranged in advance with MSRT. If this situation continues, companies' motivations for UIC activities will decrease to the point where companies may decide to invest and adopt their required technology from alternative sources e.g. other research organizations. However, these alternative sources are still not strong since increasing embargoes in this scenario will limit access to foreign partners.

Policies: IPR (national and institutional), Venture capital, Intermediary agents

The Weakness of national IPR policy to protect inventions and new ideas and the absence of effective mechanisms for enforcement of laws, deficiency of institutional policy on IPR, and very weak availability of VC in the country (Tables 11.2 and 11.9) all have a negative impact on both UIC performance (see results of validation sessions – Section 12.2) and also performance of intermediary agents e.g. science and technology parks and incubators. Very weak availability of VC creates a situation where intermediary agents are unable to link potential spin-offs or start-ups companies to VCs. Over the long-term, companies (tenants) or universities that establish facilities e.g. incubator facilities in these intermediary agents will find that there are few opportunities to access efficient funding and may decide to withdraw their investment or involvement with these intermediary agents. Consequently, other companies in the region that use the services of these (now impoverished) agents are de-motivated for further collaboration. This will have a negative impact for both intermediary agents and also companies or universities from investing money due to perceived risks of poor returns. Likewise, inefficiency of national IPR and enforcement laws leads to a situation that these intermediary agents created to facilitate entrepreneurial networks only serve the purpose of organizing conferences and seminars or brokering consultancy to companies.

Policies: IPR, Government financial support, Venture capital

Weakness of national IPR policy to protect inventions and new ideas and also absence of effective mechanism for enforcement of laws, together with very weak availability of VC have negative impact on the status of cluster formation and favourability of entrepreneurial environment. Weakness of venture capital in this scenario is related to the weakness of government financing support system to support venture capital activities (see Figure 13.11). Santos and Mello (2009) found this situation to be common in developing countries. They focused on the Brazilian government initiatives to promote UIC, and confirmed that a lack of legitimacy and the required conditions (e.g. availability of efficient VC) to carry out a national innovation policy are the main barriers to execute effective mechanisms for UIC. In the Iranian case by contrast, instability of government programmes regarding UIC makes the situation worse. This instability has a wide impact on all of the activities within Iranian NIS.

Policies: Intermediary agents, Research consortia

Overall performance of intermediary agents and research consortia were evaluated as weak (Table 11.7 and 11.9). Weakness in the management of research consortia and intermediary agent was identified as another reason for this weakness. The systems model identifies the poor performance of intermediary agents and research consortia as main cause for UIC underperformance and failure to upgrade the status of cluster formation and the favourability of the entrepreneurial environment (confirmed by the result of second validation session- see Section 12.2).

Policies: Cluster activities

The status of economic cluster activity is weak in this scenario and as a result it in turn has a strong negative impact on UIC activities. In the long term, the weakness of cluster will continue to have a detrimental impact on UIC performance, leading to non-achievement of the "*future outlook of the country in 1404=2025*" vision for the country to be the first economic power in the region. Competition among firms in the clusters is very weak and as a result they are not motivated to increase the quality of their product or innovate new products. Therefore, there will be strong barriers for companies to seek competence enhancing knowledge or new technologies from research organizations and universities. If this situation continues, the probability of enhancing UIC performance will decrease; leading to lower likelihood that universities, researchers and companies will collaborate again in these forms of collaboration (intermediary agents and research consortia) or contribute to cluster forming activities. These activities create negative reinforcing loops that decrease the performance of these mechanisms for collaboration and have negative impact on the cluster formation process in the long term (see Loops R15, R16a, R16b, and R18a) (Figure 13.11). This situation is also confirmed by validation sessions which mentioned that in the first scenario still crucial prerequisites for entrepreneurial activities are not in place which make a barrier for effective cluster formation (see Section 12.2).

The validation sessions (see Section 12.2) reinforce the conclusion from the interviews that entrepreneurial culture is not encouraged in Iran and particularly in universities. In the first validation session, common consensus was evident to link the weak entrepreneurial culture with the family background, environment and media emphasizing the belief that it incorporates too much risk. According to Rauch and Frese (in Cooper and Robertson, 2000) besides personal attributes, the economic environment, family background, social networks and national culture all have an effect on the probability of an individual acting entrepreneurially. It can be concluded that in the case of Iran, there is no support from each of these factors for individuals to act entrepreneurially.

If this situation continues, there will be two major challenges for Iran in the future, weakness of government activities in providing a favourable environment for entrepreneurs (e.g. deficiency of IPR and enforcement of laws, deficiency of VC, government monopolies in market, corruption, and instability of government regulations) and also the national culture of the country which acts as a barrier for these activities. Although the first challenge is manageable by adopting appropriate policy strategies, the second challenge is a long term social phenomena.

<u>Policies: Cluster activities, Political instability, Brain-drain</u>

Non-favourability of entrepreneurial environment and weak status of cluster formation, political instability, and low standard of living have a strong impact on the decision of entrepreneurs and researchers to leave the country (Table 11.9). This will be a threat for Iran to attain its objectives ("*future outlook of the country in 1404=2025*") which aspires to become a knowledge-based economy. Brain-drain is also identified as a major barrier to UIC (confirmed by the result of both validation sessions – see Section 12.2). By decreasing the potential performance of UIC as a result of the national brain-drain, the country will lose more entrepreneurs due to reduced opportunities and developments. Therefore, it has a negative impact on performance of research consortia and intermediary agents, and also the status of cluster formation. These connected activities create negative reinforcing loops which decrease the performance of the mechanisms for collaboration and also decrease the probabilities of promoting cluster activities (see Loops R17a, R17b, and R18b) (Figure 13.11).

Policies: Degree of monopolies in government, Privatisation process

The monopolies of government in the market is a crucial factor which has a negative effect on privatisation process (see Figure 13.11). Bitzenis (2003) also found this negative impact of monopolies on the privatisation process (see Section 3.7). Effective privatisation and a smaller role for government in the economy is heavily dependent on decreasing levels of government monopolies in market (Wignaraja, 2003; Marshal et al., 2005).

Such deficiencies of the privatisation policy reinforces government monopolies, decreases cooperation of the private sectors in economic activities because of the limited entrepreneurial opportunities, which in turn decrease the level of competitiveness in the country. Overall this issue has a negative effect on the status of cluster development in Iran. Additionally, such low levels of competitiveness decrease the motivation of companies for collaborative activities with universities. Prolonging this situation creates a negative perception of entrepreneurs to government initiatives and is likely to de-motivate participation in economic activities. Komijani (2006) found that the long process of privatisation is one of the main barriers to Iran moving towards a knowledge-based economy.

According to Wignaraja (2003), countries suffering from a lack of coordinated vision and mechanisms to establish effective competition require some form of national competitiveness council to independently formulate strategy and monitor its implementation. However, the case of Iran shows that without efficient infrastructure (decreasing monopolies) these schemes are not effective. Domination of state-own enterprises is a common phenomenon in the majority of developing countries "*which* *are not only inefficient and unprofitable but also crowed out domestic private sector activity*" (Wignaraja, 2003, p35). This problem can form barriers for the growth of SMEs in many important sectors in developing countries where most of them do not have effective policy frameworks available for domestic competition (Wignaraja, 2003).

<u>Policies: Level of government support from entrepreneurial activities</u>

In this scenario, high levels of GDP income from natural resources has a negative impact on government decisions on support for entrepreneurial activities, which in the long-term could entrench government thinking that it is not economically necessary to value individual's creativity. If this situation continues it will decrease levels of trust of government in terms of supporting entrepreneurs; which in turn will have a negative impact on cluster formation and development (see Figure 13.11).

<u>Policies: Political relations and WTO, Embargoes</u>

Barriers like weakness of political relations and the non-readiness of the country, increases ambiguity and delays the process of Iranian entry to the WTO. Therefore, it has a negative impact on motivation of companies to collaborate with universities to increase their capacity for innovation in order to compete in international markets. This issue also has a negative impact on enhancing levels of competition in the cluster (see Figure 13.11).

The current embargo level is not sufficient to have much negative effect on companies' relations with foreign partners and joint activities; especially in the automotive or biotechnology sectors. The main problem is the effect on accessibility to raw materials for their operations. A study carried out by Ghazinoory (2003) also identified problems related to embargoes in Iran (see Section 2.3). It was found (Table 11.9) that increasing embargoes and greater limitations for joint activities with foreign partners, causes a short-term motivation to collaborate with universities to survive in the market. However, as mentioned earlier in this section, many other problems such as IPR issues, bureaucracy of universities limits the degree of success. Some disadvantages of embargos in the long term were uncovered as well. Increasing the levels of embargoes risks investment and export opportunities. Less export opportunities and higher risks of investment will have a negative impact on both competition in the country and the status of cluster formation (see Figure 13.11). Torbat (2005) found that as a result of embargoes, the willingness of investors to invest in Iran will decrease (see Section 2.2).

Although macroeconomic stability is a prerequisite for improving export competitiveness, it cannot guarantee competitiveness since many other factors are required including efficient infrastructure. However, macroeconomic instability alone can unavoidably harm competitiveness (Wignaraja, 2003). In the case of Iran, the macro economic instability (embargoes and political situation) negatively affects all other activities within the Iranian NIS.

A unique challenge to Iran is clearly the political environment and the relationship with the rest of the world. The low probability of improving political situation and also Iran's entry to the WTO and embargoes imposed by Western Government are two forces which have an impact on motivation of companies to collaborate with universities, UIC performance, and also the status of cluster formation and favourability of entrepreneurial environment. An interesting finding from the current research was the short and long term impact these forces have on motivation to collaborate. In the short term, the enforced reliance on local knowledge and technology generation increased the collaboration activities, however, in the long term (i.e. now the current state due to the longevity of the western embargo) the motivation to collaborate has shifted to negative because of the lower perceived value of the knowledge and technology transfers directly due to the lack of interaction with the rest of the world – competitive drift. Although the Iranian cultural characteristics would still offer barriers to collaboration even if the embargoes were lifted.

Related to the embargo impact is the lack of FDI and open financial markets. Deficiencies of VC negatively impact UIC performance, the performance of intermediary agents, and also the status of cluster formation and favourability of entrepreneurial environment.

Policy: Corruption

High levels of corruption in allocating resources to entrepreneurs was identified as an important factor which decreases trust of government by entrepreneurs, leading to decrease motivation to establish start-up companies. This creates negative reinforcing loops that decrease the degree of trustworthiness of the government (see Loops R11, R13) (Figure 13.11). Results from the first validation session confirm this and further suggest that once trust of government is eroded it will be a very difficult and long term process to rebuild (see Section 12.2). Khajehpor (2000) also found corruption as one of the major obstacles in Iran for private sector investment. It is also one of the major constraints to entrepreneurship and SMEs development in transition countries (Bulumac and Apostolina, in Bulumac and Bendis, 2001) (see Section 2.3.1). The present study however, highlighted another important consequence of corruption which is the erosion of trust of government and subsequent difficulties in rebuilding. Elangovan et al., (2007) found that trust will be eroded gradually in the majority of cases. Therefore, it is necessary to understand how to maintain trust or how to avoid rapidly diminishing it.

Policies: Intermediary agents, Research consortia, Cluster activities

Low levels of cooperation, a limited team working culture and preference to follow a traditional style of management in SMEs (Table 11.5) negatively influence UIC performance. Decreasing UIC performance has a negative impact on both performance of intermediary agents and research consortia. This results in a negative impact on the status of cluster formation and favourability of entrepreneurial environment. If this situation is left to continue, not only the chance to motivate collaborative behaviour among actors will decrease; but it will also have a detrimental and negatively reinforcing impact on developing a co-operation and a team-working culture. Furthermore, if this situation continues, the probability of changing the structure of SMEs to adopt more innovative methods will decrease. Low levels of cooperation and team-working culture and also following traditional style of management in SMEs have a direct negative influence on research consortia's performance and also performance of intermediary agents. These activities create negatively reinforcing loops which reduce the performance of UIC (see Loops R19, R20, R21, R26a, R26b, R47, R48, R49, R50, R51) (Figure 13.11).

Comparison and Update from World Economic Forum (WEF 2010/2011)

The previous versions of WEF competitiveness report did not consider Iran in their analysis, however, the recent WEF version includes Iran and many findings of this research related to the current situation of the country are also reinforced by the evidence in the WEF report. For example based on this report, the most problematic aspect for doing business in Iran was identified as access financing, policy instability, inadequately educated workforce, and corruption. Furthermore compared to other countries, brain-drain and deficiency of IPR protection and enforcement are recognized as major barriers for Iran's economic transition (World Economic Forum, 2010).

13.3.2 Scenario theme B: Scenario Script 2 (Efficiency-Driven Economy: current to new policy framework + 15 years)

An efficiency driven economy has enhanced features for Higher Education and Training, Goods Market Efficiency, Labour Market Efficiency, Financial Market Sophistication, Technological Readiness, and Market Size (see Appendix A) (World Economic Forum- WEF, 2008). However, the WEF categorization of an economies status offers little insight for individual nations to achieve the transition. It is through a series of consistent policies that nations evolve. This requires a deep understanding of the national mechanisms for economic activity usually based on accepted policy models (Porter's, NIS etc).

The developed DSM of university-industry collaboration the basis for the deep understanding for the purposes of this research, and hence the basis for policy manifesto development to achieve the maximum contribution from UIC activities toward achieving an Efficiency Driven Economy state (see Table 11.10 and Section 3.3.2).

Tables 11.11-15 indicate the derived future backward analysis using the DSM platform to establish 17 key policy change forces to achieve the Efficiency Driven state in 15years – the minimum period to realize full policy impact (Schwartz and Ogilvy, in Fahey and Randall, 1998). These policy changes are discussed in more detail at the sub-system level in the following sections.

These policy changes include

- Increasing efficiency of national policy on IPR but still deficiency in enforcement laws; no consistency with international obligations (GOV5)
- Increasing university autonomy from government (GOV4)
- Increasing efficiency of government financing support system- still not efficient enough (GOV7)
- Increasing efficiency of VC but still in a limited scope (GOV6)
- Increasing stability of government regulations (GOV3)
- Increase access to government funding (increasing efficiency of government initiatives for collaboration) (GOV1)

- Decreasing level of government monopolies in market – still monopolies exist (GOV12)
- Inefficiency of privatisation policy- the situation is improved (GOV11)
- Increasing efficiency of government strategy to support cluster formation; but still many barriers exist (GOV9)
- Government policy on regulation of human capital to control brain-drain (GOV10)
- Decreasing embargoes imposed by the Western Governments (GOV17)
- Improving political relation and higher probability of Iran entry to the WTO (GOV16)

Related policy elements forming Scenario Theme B are as follows:

- Increasing efficiency of institutional policy on IPR (OS1)
- Comprehensive institutional policy on royalty sharing (OS3)
- Efficient structure of TTO in universities (OS2)
- Availability of multi-disciplinary skills in the TTO (AST2)
- Still TTOs do not completely support spin-off companies

This policy manifesto is designed to address the major structural failings identified in Scenario Theme A. All weaknesses of the system cannot be undertaken without these structural features installed and proved over a period of time.

13.3.2.1 Organizational Structure sub-system (OS)

The outcome of 15 years of policy changes on the OS sub-system (future state analysis from Tables 11.11 and 11.15) is shown in Figure 13.12.

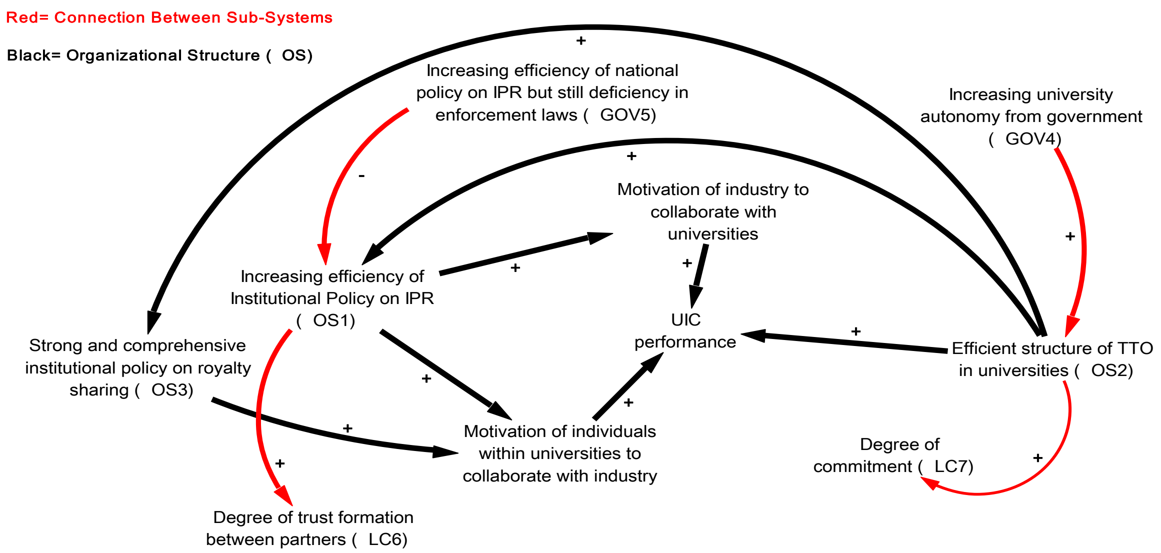


Figure 13.12: Elements of Organizational Structure sub-system and their connections in the second scenario: constructed from the results in Tables 11.11 and 11.15

Policies: IPR (national and Institutional), Structure of TTOs, University autonomy

By strengthening IPR policies in universities, motivation of individuals to collaborate with companies, and motivation of companies to collaborate with universities will increase (Table 11.11), thus enhancing UIC performance. Inzelt (2004) considered the evolution of university-industry-government relationships in five stages of transition and confirmed that, in the Vertical and Arm's Length forms of interaction, the existence of comprehensive IPR is necessary in order to have joint IP ownership between university staff and firm employees (see Section 4.5).

This scenario offers improvements compared to Scenario Theme A; TTO structure is upgraded and multidisciplinary teams recruited so the level of commitment between partners should be enhanced. The national policy framework for IP is in place which creates opportunities to increase the efficiency of institutional IP policies and also to design more effective royalty-sharing formulations. However, because of the continued weakness of enforcement laws, there will be less potential for collaborations to achieve high levels of success (see Figure 13.12). This makes for some improvements; however, they are likely to be simpler forms of collaboration. This happens because partners still perceive risk without strong enforcement of IPR laws. The foundations for contractual-trust formation are not complete, but because of increasing levels of commitment of partners due to more proactive TTOs, decreased levels of uncertainty and some weak-forms of trust might be generated (confirmed in the second validation session – see Section 12.3). Although shortcomings still exist in this scenario, some of the advantages have a positive impact on UIC. For instance, a government policy to grant all national universities autonomy (Table 11.15) from close government supervision allows them scope to develop their research policy and relations with companies, creating more opportunities for universities to determine the structure of their TTOs based on their specialisms and needs at crucial period of development.

13.3.2.2 Asset Management sub-system (AST)

The outcome of 15 years of policy changes on the AST sub-system (future state analysis from Tables 11.11, 11.12, 11.15) is shown in Figure 13.13.

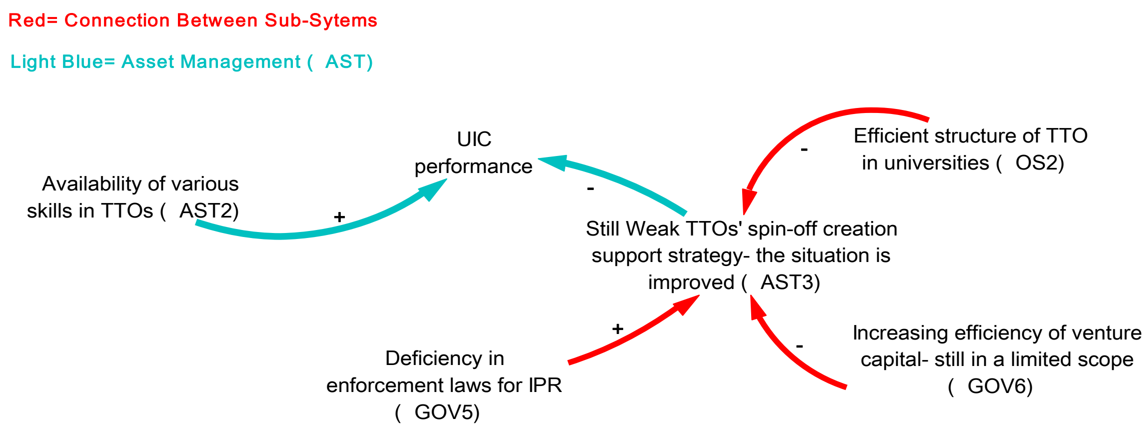


Figure 13.13: Elements of Asset Management sub-system and their connections in the second scenario: constructed from the results in Tables 11.11, 11.12, 11.15

<u>Policies: Venture Capital, Skills in the TTOs, Structure of TTOs</u>

Some of the prerequisites of supporting spin-off company formation from universities exist in this scenario (Tables 11.11, 11.12, 11.15). These include efficient structures of TTOs and availability of experts in various disciplines which can help researchers and entrepreneurs to identify business opportunities for their ideas. Government policy has shifted its strategy to be more supportive of VC rather than just focusing on traditional financing support; which can enhance the probability of spin-off company formation from academia. However, because VC is still not widely available TTOs may face difficulties to link potential entrepreneurs with investors, ultimately limiting the probability of successful spin-off company formation from academia. Although some advantages exist to support spin-off formation (e.g. availability of institutional IPR), there are still weak levels of support for company formation in TTOs (not proactive).

This is due to the fact that still universities at this stage of development are not entrepreneurial and they do not still value the benefits of spin-off company formation. The critical success factor for the formation of spin-off companies is strong enforcement laws for IPR, which are not in place yet (see Figure 13.13). Singer and Peterka (2009) also found this problem in the case of Croatia.

13.3.2.3 Leadership and Culture sub-system (LC)

The outcome of 15 years of policy changes on the LC sub-system (future state analysis from Tables 11.11, 11.13, 11.14.11.15) is shown in Figure 13.14.

<u>Policies: IPR, Research consortia, Intermediary agents</u>

UIC performance is improved compared to the first scenario; however, there are not enough interactions to promote a shift in the cultural aspects of collaboration; which means that more sophisticated forms of collaborations are not strong enough to decrease the cultural differences between partners. The main reason for underperformance of these mechanisms is due to the fact that inefficient enforcement of IPR is still the norm (Table 11.15). Partners are unlikely to be interested in collaborations which may lead to strategic partnerships (still lack of government support, weakness of management in collaboration, and inefficiency of IPR enforcement laws).

Research consortia and intermediary agents are still not developed enough to facilitate bridging the cultural differences and levels of understanding between partners. Because of the weak structures of intermediary agents and research consortia, commitment among partners is also weak. As a result of decreasing commitment, the opportunity for trust formation through these mechanisms is also subdued. Therefore, it will act as a barrier which decreases motivation of individuals within universities and companies to collaborate in more sophisticated forms of collaboration. This will continue to have a negative impact on UIC performance (see Figure 13.14). These negative reinforcing loops decrease the performance of these kinds of mechanisms for collaboration in the long term. Therefore, the opportunity for stronger forms of trust formation for deeper collaborations will be limited (see Loops R27, R28, R30, R31, R33, R34, R36, R37, R41, R42, R44, and R45) (Figure 13.14).

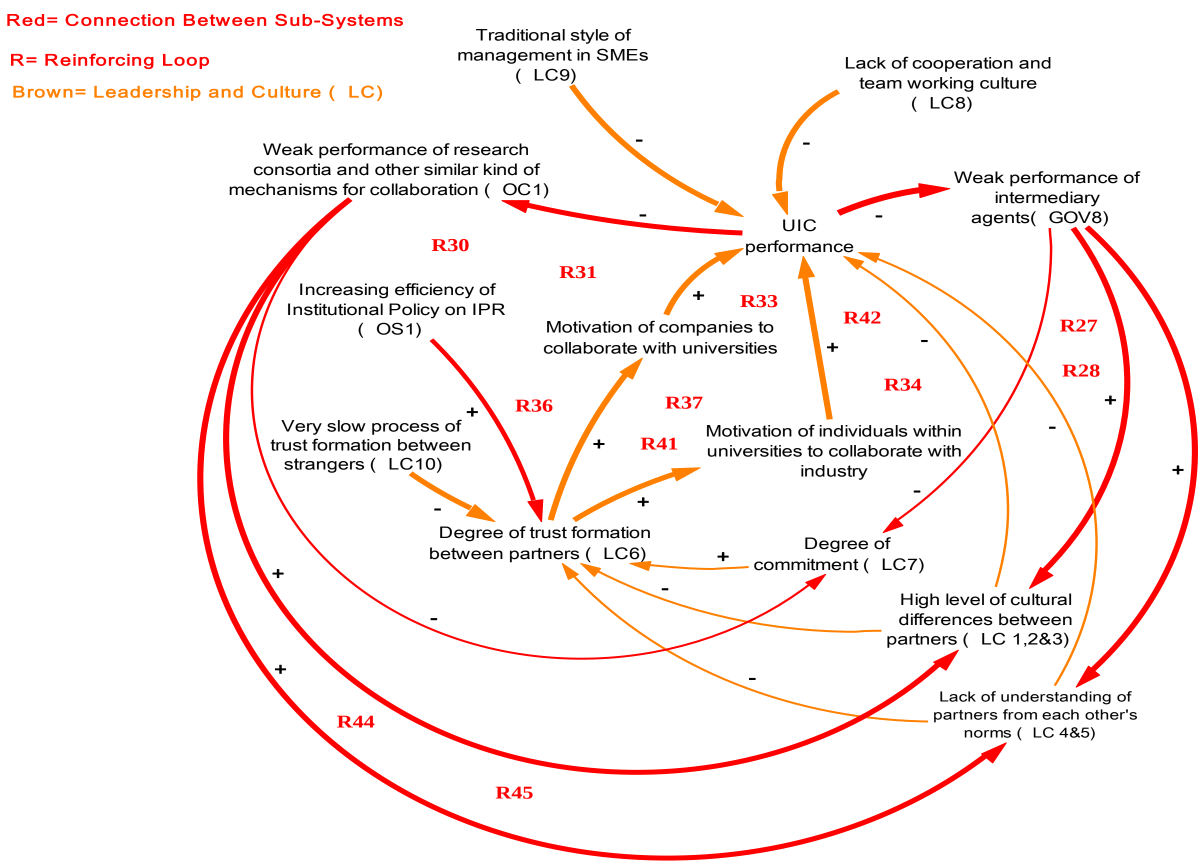


Figure 13.14: Elements of Leadership and Culture sub-system and their connections in the second scenario: constructed from the results in Tables 11.11, 11.13, 11.14, 11.15

Lack of team working and cooperation culture among the people in the country, and low SMEs management quality based on traditional management practices have a negative impact on UIC performance. Very slow trust formation with strangers is a barrier for trust formation between any partnership combinations. These three forces have a strong cultural root in the Iranian context which forms barriers to successful UIC (see Figure 13.14).

13.3.2.4 Organizational Capabilities sub-system

The outcome of 15 years of policy changes on the OC sub-system (future state analysis from Tables 11.11, 11.13, 11.14, 11.15) is shown in Figure 13.15.

<u>Policies: IPR, Degree of government support from research consortia</u>

The advantage of this scenario compared to the first is the comprehensive national policy for IPR and more efficient institutional policies on IPR, which can act as a positive drivers to enhance the performance of research consortia; but because enforcement laws are not in place there will be continued risks to these kind of mechanisms for collaboration (Table 11.15). These IPR weakness issues ensure there can be no strong motivation of universities and industry to participate; because these collaborations are expected to lead to commercialization of product, when IPR arrangements become prominent. Weakness of management in collaboration and lack of government support from research consortia still act as major barriers which decrease their efficiency for collaborations. Low-levels of cooperation and team working culture and traditional styles of management in SMEs have a direct negative impact on performance of research consortia (see Figure 13.15).

<u>Policy: Research consortia</u>

The performance of research consortia, which requires more interaction between partners, is not strong enough to have a positive impact on capabilities of universities and industry. Therefore, motivation of universities and industry to collaborate in these kinds of mechanisms is reduced, leading to underperformance of UIC activities. These create negative reinforcing loops for collaboration in the long term and the chances to enhance the capabilities of universities and industry through these mechanisms will be limited (see Loops R1, R2, R3, R4, R5, R6, R7, R8, and R9) (Figure 13.15). Compared to the first scenario, although there are few opportunities to collaborate through sophisticated forms of interactions, the situation is improved. Furthermore, there will be more opportunities to collaborate through simpler forms of collaborations such as technical supervision and consultancy, increasing the capabilities of partners.

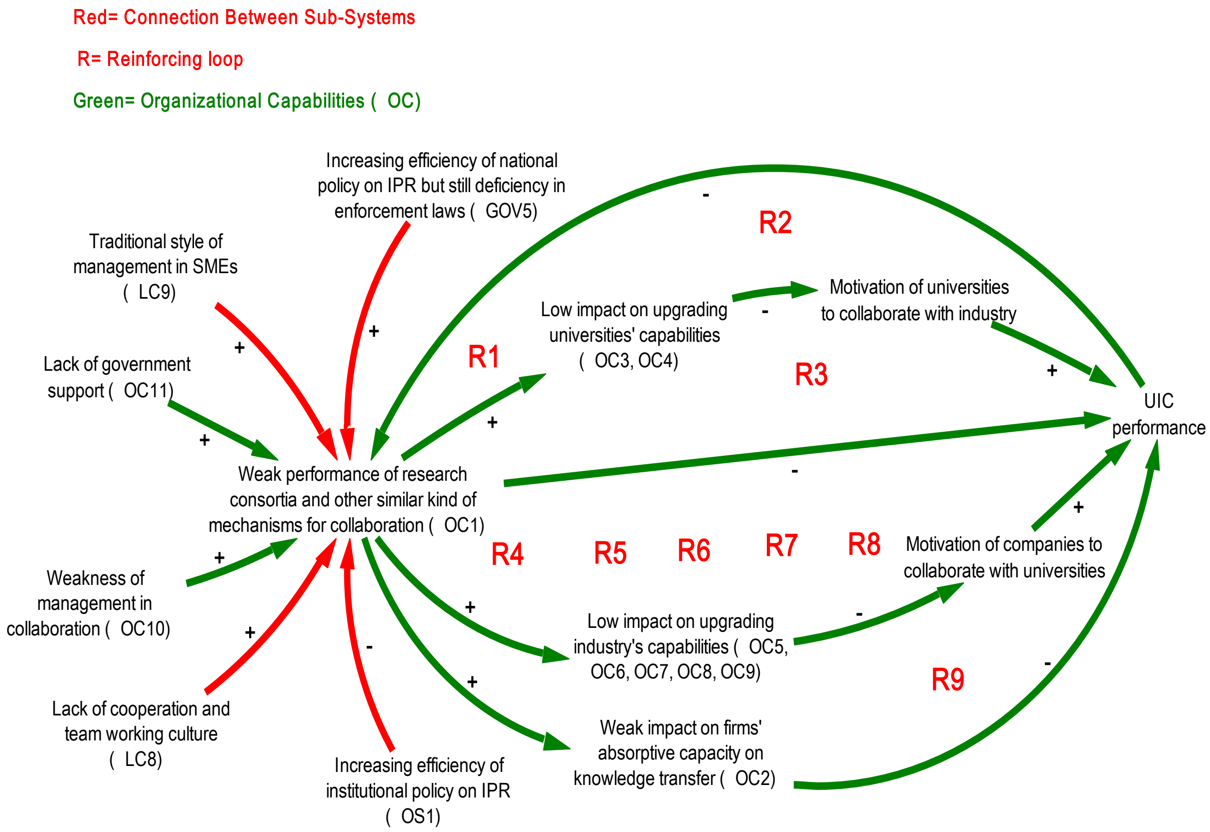


Figure 13.15: Elements of Organizational Capabilities sub-system and their connections in the second scenario: constructed from the results in Tables 11.11, 11.13, 11.14, 11.15

13.3.2.5 Government sub-system (GOV)

The outcome of 15 years of policy changes on the GOV sub-system (future state analysis from Tables 11.11, 11.13, 11.14, 11.15) is shown in Figure 13.16.

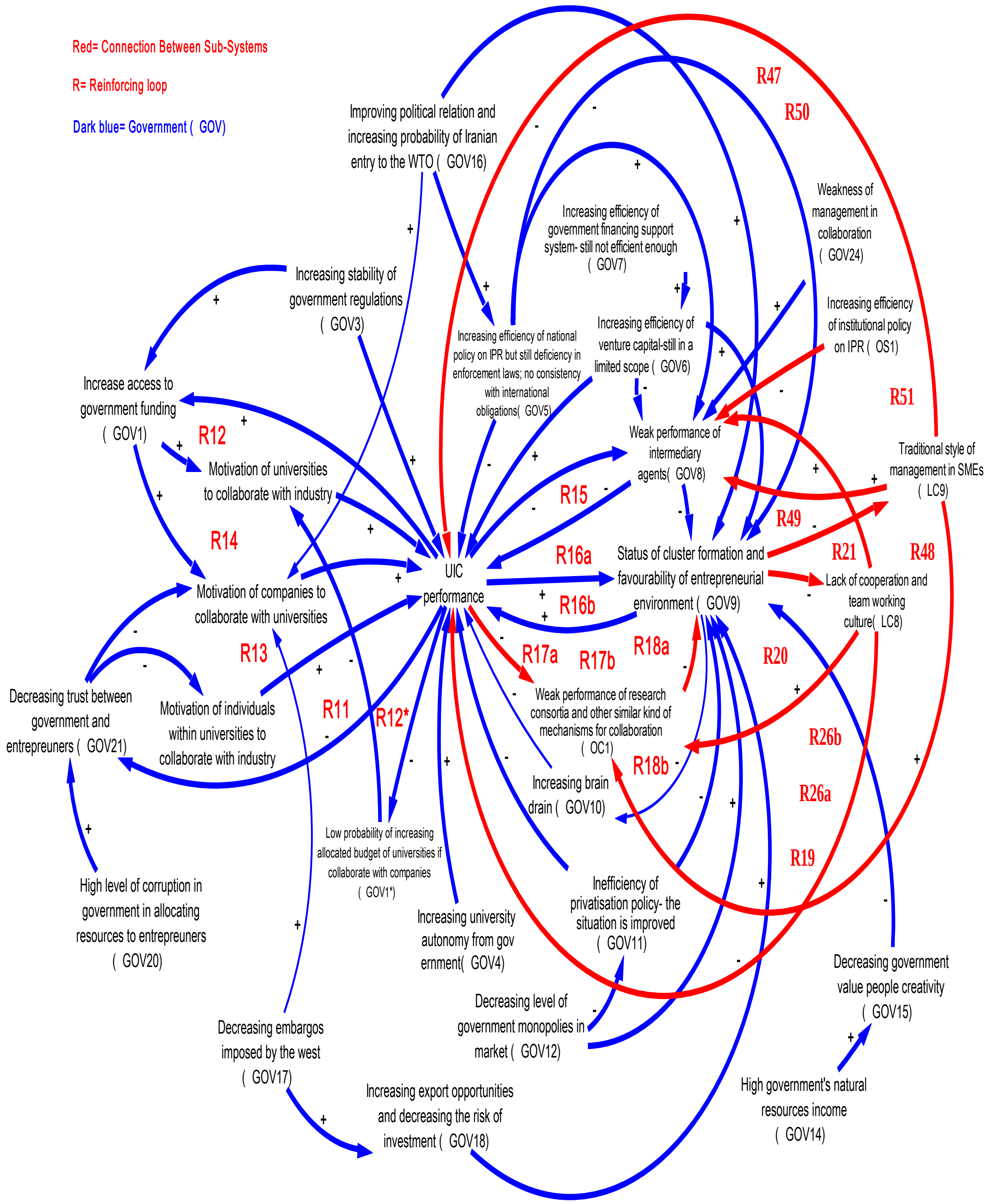


Figure 13.16: Elements of Government sub-system and their connections in the second scenario: constructed from the results in Tables 11.11, 11.13, 11.14, 11.15

<u>Policies: Stability of government regulations, Government initiatives for collaboration</u>

There is still no difference in the universities budget allocation for collaborative activities. Therefore, the motivation of universities to collaborate with industry will be subdued and as a result UIC performance will be limited. According to the respondents, it will de-motivate universities to participate again in UIC activities in order to increase their budget; because there would be less probability to access to government funding (see Loop R12*) (Figure 13.16). An increasing stability of government regulations to support universities and industry in collaborative activities is one of the strength compared to the first scenario (Table 11.15). Although there are still very few mechanisms available for companies and universities to access government funding; because of the stability of government regulation in this regards; these programmes offer some degree of enhancement of motivation for universities and companies to collaborate. This indicates that even if there are weaknesses in some initiatives; the stability of these programmes makes them positive levers that can enhance UIC performance to some extent. This activity (although it is not ideal) can increase the willingness of companies and universities to collaborate with each other and also increase the awareness and willingness of other companies to collaboration as well. Therefore, both universities and companies can have a more access to government funding in the future. This activity can create positive reinforcing loops which increase the performance of these mechanisms for collaboration (see Loops R12, R14) (Figure 13.16).

<u>Policy: University autonomy from government</u>

In comparison with the first scenario, in this scenario, granting all national universities autonomy would offer more opportunities to improve UIC performance (see Figure 13.16). This was confirmed in the second validation session (see Section 12.3).

Result from the current study are reinforced by various studies (Etzkowitz et al., 2000; Abd Razak and Saad, 2009; Saad and Abdelkader, 2009) which highlight the impact of university autonomy from government on promoting UIC. This transition policy has been recently introduced by the Malaysian Government through a new programme called Accelerated Programme for Excellence (Apex) for its universities. Under this programme universities were promised autonomy in finance, service scheme, management, student intakes, study fees and determining the top leadership (Abd Razak and Saad, 2009). Increasing autonomy of universities from the state and increasing the degree of engagement with industry are major gradual shifts which can be identified in Europe and Latin American countries towards the transition into entrepreneurial universities (Etzkowitz et al., 2000).

Algeria has introduced different stages of reforms in order to achieve a transition to a triple helix model and to enable universities "*to address the key and new problems associated with the development of the Algerian economy and to play a crucial role in the generation of new knowledge*" (Saad and Abdelkader, 2009, p1). One of these reforms, introduced in 1998, was to grant a greater autonomy to universities who could then align part of their activities to the specific needs of their region and industry. "*This could help universities diversify their sources of funding for research and development programmes*" (Saad and Abdelkader, 2009, p4). These kinds of activities can prepare universities to support the transition process from a centralized to a market-based economy. Another series of reforms which was introduced in 2008 was to "*proclaim scientific research and technological development as national priorities*" (Saad and Abdelkader, 2009, p5). This reform was designed to enhance the role of universities as one of the main pillars of the social and economic development of the country (Saad and Abdelkader, 2009).

<u>Policies: IPR (national, institutional), VC</u>

In this scenario there are interactions of positive and negative levers (Table 11.11 and 11.15). On one hand, availability of national and institutional IPR policy to protect inventions and new ideas, and government policy shifted to support technology-based companies through changing its policy from traditional financing mechanism to risk capital can perform as positive levers. On the other hand, the absence of effective mechanism for enforcement of laws for IPR and limited availability of VC act as negative levers (confirmed by the results of both validation session – see Section 12.3). Although there are some improvements to the performance of UIC, performance of intermediary agents and also the status of cluster formation compared to the first scenario, the overall performance is still not strong since the negative forces are stronger than the positive, particularly in the case of IPR protection and enforcement. The weakness of the management of collaborations by intermediary agents continues to be a negative force in this scenario, forming a negative impact on intermediary agents' performance (see Figure 13.16). Research partnerships between universities and industry take many forms ranging from sharing of information or facilities to creating new research entities. These kinds of partnerships require effective IP protection mechanisms (Hertzfeld et al., 2006) (see Section 3.6.2). According to Robert and Ostergard (2000), the existence of IP laws and their enforcement are necessary prerequisites for IP protection. This scenario still has many shortcomings in this regard which creates negative consequences that ultimately impede efficient UIC activities.

<u>Policy: Intermediary agents</u>

Continued weakness of intermediary agents and research consortia, limit UIC support and offer little influence on the status of cluster formation and favourability of entrepreneurial environment (see Figure 13.16). The positive impact is only limited to some simpler forms of collaboration and collaboration partners still do not get any proper return for their investment; in the long term, UIC performance will decrease.

By looking at the experience of one of the technology parks in the Brazilian state of Bahia where the NIS is still embryonic, Lima and Filho (2009) suggested that, intermediary agents can take a proactive role in order to form linkages between companies and universities. They can act as a medium to make companies in the region and tenant companies aware of the specific scientific capabilities of universities and research institutes and also make universities aware of the special needs of these companies. By contrast to the experience of Brazil, the Iranian intermediary agents only enhance simpler kinds of interactions, and still lack capability to have a major positive impact in the UIC process. Compared to the case of Brazil, where there is evidence of success by these intermediary agents, in the Iran scenario, important negative forces (inefficiency of IPR enforcement laws, cultural barriers such as lack of team working and risk taking culture, and low degree of trust to strangers) have an impact on performance of these agents. This shows that although policy changes in this scenario are aligned with the experience of efficiency-driven economies, the characteristics of the country causes various degrees of success compared to others in the same stage of development.

Policy: Cluster activities

The status of economic clusters is improving compared to the first scenario, which may have a positive impact on UIC activities in some limited circumstances. There are still many obstacles to improving the entrepreneurial environment and supporting entrepreneurs. Therefore, the probability that universities, researchers and companies collaborate again in these kinds of mechanisms for collaboration (intermediary agents and research consortia) or participate in cluster activities will be limited. Furthermore, there will be no strong opportunity for companies to gain competitive advantage as a result of commercializing technology in this scenario. Thus, it will have a negative impact on process of cluster formation. The level of performance of intermediary agents and research consortia is subdued; therefore in the long term creating negative impact on the process of cluster formation and promotion of an entrepreneurial environment in the country (see Loops R15, R16a, R16b, and R18a) (Figure 13.16).

In this stage of development (efficiency-driven), Iran still lacks some of the major drivers to promote entrepreneurial environment in the country, in common with many other developing countries at the same stage of evolution. According to Singer and Peterka (2009), Triple Helix structures should be considered as a major driver for countries in a process of transition from efficiency driven to innovation driven economy. However, this is not common, for example Croatia lacks government support for innovative ventures, lacks venture funding, and has low levels of competitiveness and entrepreneurship which makes the transition process slow.

Policies: Brain-drain, Entrepreneurial and Political environment

Government policy on regulation of human capital was found (Table 11.15) to be inefficient because there are many motivational factors involved (which are not addressed in this scenario). Therefore, brain-drain was still considered as a barrier for UIC in this scenario since weak entrepreneurial environments do not convince entrepreneurs and researchers to stay in the country. By decreasing the performance of UIC as a result of the brain-drain, the country loses even more entrepreneurs. This creates a negative impact on the performance of research consortia and intermediary agents, and also the status of cluster formation. Although, the majority of respondents declared that because of un-favourability of entrepreneurial environment brain-drain increases; the respondents in the interview pool had different views and mentioned that because of improvements in the political environment, there could be more opportunities to be a part of the global economy; thus creating a positive impact to reduce the brain-drain. On balance (see 11.15) it seems that the intention of entrepreneurs to leave the country still has a negative effect on UIC performance. These activities create negative reinforcing loops which in the long term may decreases the performance of these mechanisms for collaboration (intermediary agents and research consortia) and also decrease the chance of promoting cluster activities (see Loops R17a, R17b, and R18b) (Figure 13.16).

Policies: Degree of monopolies in government, Privatisation process

There would be an improvement in the process of privatisation in this scenario; however, the long process makes it less efficient. This situation is not strong enough to enhance the performance of UIC, because of the decreasing monopolies of government in the market, it would be better for the country to undertake the privatisation process more quickly and completely compared to the first scenario (Table 11.15). To some extent decreased monopolies would have a positive impact on cluster activities and would be an advantage for creating an entrepreneurial environment in the country. However, the momentum is still not strong enough to enhance cluster activities and improve entrepreneurial environment to any great extent because of the persistence of monopolies in the market (see Figure 13.16). Due to the delay in the process of privatisation and the existence of some degree of monopolies, there would be less opportunity to increase level of trust of government. This situation is also confirmed by the result of second validation session (see Section 12.3). Bitzenis (2003) confirmed that when privatisation is slow and there is a delay in the process (e.g. the case of Bulgaria), it can have a negative impact on the trustworthiness of government (see Section 3.7).

Policy: Level of government support from entrepreneurial activities

The high proportion of government income from natural resources has a negative impact on government activities to support entrepreneurial activities. If this situation continues and the government does not value entrepreneurial creativity, it will decrease levels of trust of government in terms of supporting entrepreneurs; which in turn will have a negative impact on cluster formation and development (see Figure 13.16).

Policies: Political relations and WTO, Embargoes

International relation with other countries is improved with greater probability of joining the WTO. The level of embargoes by western governments decreases in this scenario, creating a positive impact on motivation of companies to collaborate with universities to increase their capacity for innovation. In this situation there will be an international force exerted on the country to be more competitive and innovative. This issue also has a positive impact on enhancing levels of competition in economic clusters (see Figure 13.16). However, deficiency in enforcement of IPR and many weaknesses in IPR policy persist which are not consistent with international obligations (Table 11.15). Therefore, the entrepreneurial environment, especially the conditions to match international trade, is still weak.

Decreasing levels of embargo will increase motivation of companies to collaborate with universities to compete in international marketplace. However, some industry respondents (Table 11.15) mentioned that although they would still use universities as a source of innovation; because other options like collaborating with more competitive foreign partners would be available motivation will be reduced. A decreasing embargo increases export opportunities and decrease risk of investment creating more opportunities to invite FDI or Joint Venture activities. This will have a positive impact on both competition in the country and the status of cluster formation.

By improving the political situation, increasing the proportion of foreign strategic technology alliances, and attracting more FDI, UIC performance will increase creating a positive impact on levels of competition in the region (see Figure 13.16). However, there are still many barriers in this scenario which limit the ultimate success in terms of cluster formation. Because of a lack of efficient financing mechanisms e.g. wide availability of VC, deficiency of IPR in terms of enforcement laws, weakness in IPR consistency with international obligations and also the existence of monopolies; the environment for foreign companies is still not favourable and therefore; it will have a negative impact on cluster activities. In this scenario although the political situation is promoted; foreign companies are still not very interested in entering the country because of these obstacles.

In this scenario the political situation is improving and firms in Iran can increase the proportion of foreign strategic technology alliances and attract more FDI (although some limitations still exist). FDI is associated with more export-oriented, developing countries who can find a "*shortcut method for entering the production of manufacturers for export and for technologically upgrading export competitiveness over time*" (Wignaraja, 2003, p36).

<u>Policy: Corruption</u>

Continuing impediments such as the level of corruption in government for allocating resources to entrepreneurs is still a characteristic of this scenario and was identified as an important factor which decreases trust of government by entrepreneurs. Decreasing levels of trust between entrepreneurs and government decreases motivation of entrepreneurs generally in society (to form spin-off or to establish start-up companies). Therefore, UIC performance will decrease. This activity creates negative reinforcing loops which decrease the degree of trustworthiness of government (see Loops R11, R13) (Figure 13.16).

<u>Policies: Intermediary agents, Research consortia, cluster activities</u>

Low levels of cooperation and team working culture and also the incumbent traditional style of management in SMEs still have a negative influence on UIC performance. Decreasing UIC performance has a negative impact on both performance of intermediary agents and performance of research consortia. This has a negative impact on the status of cluster formation and favourability of entrepreneurial environment. If this situation continues, not only the chance to motivate collaboration behaviour among actors will decrease but it will also have a detrimental impact on cooperation and team working culture. Furthermore, if this situation continues the probability of influincing the methods and style of SMEs will decrease. Low levels of cooperation and team working culture and also following traditional style of management in SMEs have a direct negative influence on research consortia's performance and also performance of intermediary agents. These activities create negative reinforcing loops which have a negative impact on the performance of UIC; it also has a negative impact on performance intermediary agents, research consortia and it also make a barrier for effective cluster formation and it will decrease the favourability of entrepreneurial environment (see Loops R19, R20, R21, R26a, R26b, R47, R48, R49, R50, R51) (Figure 13.16).

13.3.3 Scenario theme C: Scenario Script 3 (Innovation-Driven Economy: Scenario 2 + enhanced policy framework + 15 years)

An innovation driven economy has enhanced features for Business Sophistication and Innovation (see Appendix A) (World Economic Forum, 2008).

Table (11.17-21) indicates the derived future backward analysis using the DSM platform to establish 20 key policy change forces to achieve the transition from Efficiency-Driven (Scenario 2) to Innovation-Driven state in 15years. These policy changes are discussed in more detail at the sub-system level in the following sections.

These policy changes are introduced after successful achieving the efficiency-driven state depicted in scenario 2 include:

- Increasing efficiency of national policy on IPR and strengthening enforcement laws; more consistency with international obligations (GOV5)
- Increasing university autonomy from government (GOV4)
- Increasing efficiency of government financing support systems (GOV7)
- Increasing efficiency of VC (available in a broad scope) (GOV6)
- Increasing stability of government regulations (GOV3)
- Increase access to government funding (increasing efficiency of government initiatives for collaboration and introducing more efficient mechanisms for collaboration) (GOV1)
- Increasing allocated budget of universities if collaborating with companies (GOV1*)
- High government support from research consortia and intermediary agents (OC11)
- Decreasing level of government monopolies in market (GOV12)
- Increasing efficiency of privatisation policy (GOV11)
- High government support of cluster activities (GOV9)
- Encouraging entrepreneurial environment to control brain-drain (GOV10)
- Decreasing level of corruption in government in allocating resources to entrepreneurs (GOV20)
- Decreasing embargoes imposed by Western Governments (GOV17)
- Improving political relations and Iran joins the WTO (GOV16)
- Decreasing government reliance on natural resources income (GOV14)

Related policy elements forming Scenario Theme C are as follows:

- Increasing efficiency of institutional policy on IPR (OS1)
- Comprehensive institutional policy on royalty sharing (OS3)
- Efficient structure of TTO in universities (OS2)
- Availability of multi-disciplinary skills in the TTO (AST2)
- Increasing efficiency of TTOs strategy to support spin-off companies (AST3)

13.3.3.1 Organizational structure sub-system (OS)

The outcome of 15 years of policy changes on the OS sub-system (future state analysis from Tables 11.17, 11.21) is shown in Figure 13.17.

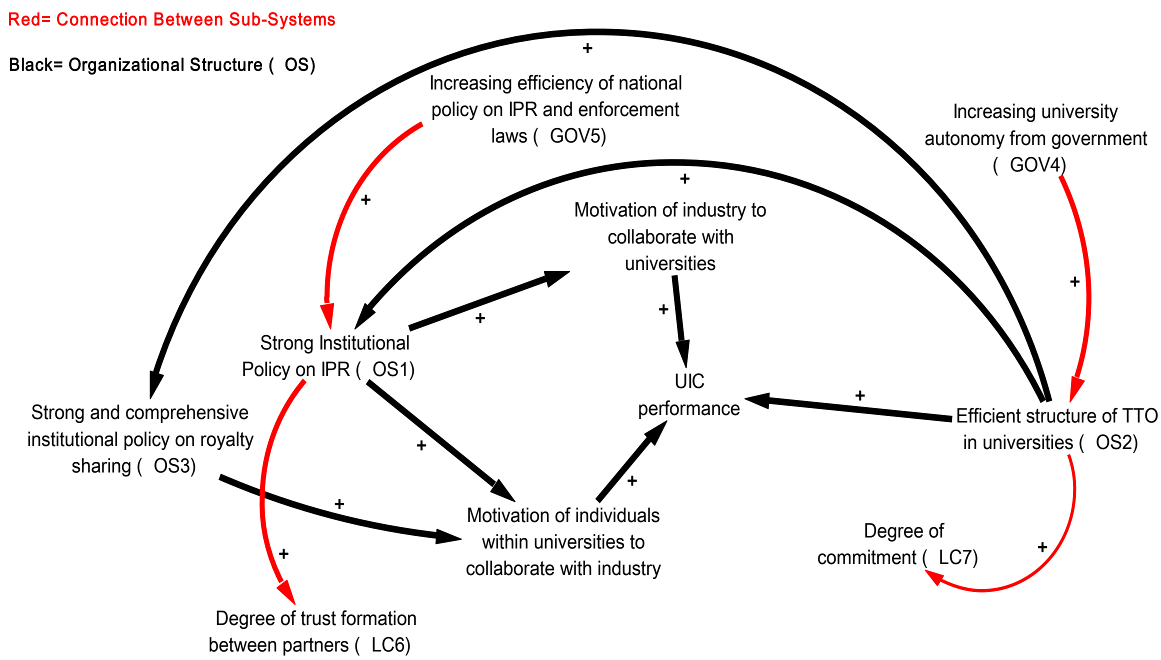


Figure 13.17: Elements of Organizational Structure sub-system and their connections in the third scenario: constructed from the results in Tables 11.17, 11.21

<u>Policies: IPR (national, institutional), Structure of TTOs</u>

By strengthening IPR policies in universities with consideration of IP ownership within collaborative research programmes and/or contractual agreement with various partners, the motivation of individuals within universities and companies to collaborate will increase (Table 11.17), also found by Debackere and Veugelers (2005). This positive lever can create the foundations for contractual trust. The main source of strong IPR policy in universities is the multidisciplinary teams in the TTOs (providing expertise in terms of IP and legal issues), availability of an efficient policy framework for IP at the national level, and increasing effectiveness of IP enforcement laws (see Figure 13.17). The existence of strong teams in TTOs leads to an increase of opportunities for universities to design more effective and clear royalty-sharing formulas, thus increasing commitment among partners.

13.3.3.2 Asset Management sub-system (AST)

The outcome of 15 years of policy changes on the AST sub-system (future state analysis from Tables 11.17, 11.18, 11.21) is shown in Figure 13.18.

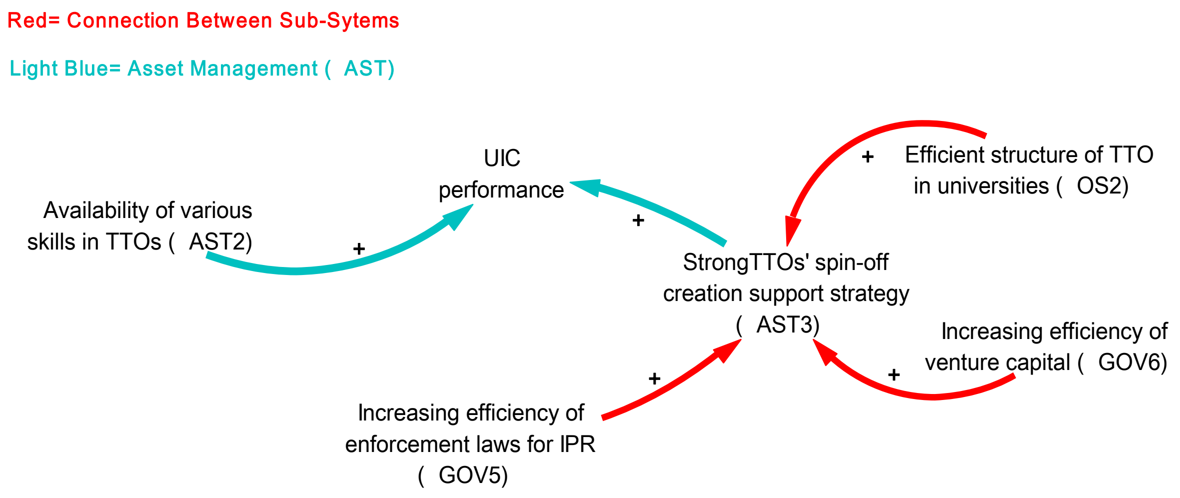


Figure 13.18: Elements of Asset Management sub-system and their connections in the third scenario: constructed from the results in Tables 11.17, 11.18, 11.21

<u>Policies: Venture capital, Skills in the TTOs, Structure of TTOs</u>

Effective marketing ability by TTOs identifies companies who are interested in acquiring new technology, and also those companies which have capabilities to develop the technology; therefore, the probability of the success of commercialization processes will increase. Compared to the second scenario, those connections with industry requiring strong protection of IPR (enforcement laws) are also very strong in this scenario which makes it successful in the later stage of the commercialization process. All of the prerequisites of supporting spin-off company formation from universities exist in this scenario e.g. TTOs becomes proactive in the process of supporting spin-offs. Furthermore, the efficient structure of TTOs and availability of experts in various disciplines can help researchers and entrepreneurs to identify the degree of market readiness for their invention. Also in this scenario, government has shifted its strategy to more support of VC rather than just focusing on traditional financing support, and establishes associations for venture capital which can supervise and support private and public venture capital, which in turn, can enhance the probability of spin-off company formation from academia. Since VC is now widely available TTOs will have more opportunities to link potential entrepreneurs with VC investors. Therefore, it increases the probability of successful spin-off formation from academia (confirmed in the first validation session – see Section 12.4). The advantage of this scenario compared to the second one is that universities and especially technology transfer offices increase their support for creation of spin-off companies from universities (Table 11.18). The critical success factor for formation of spin-off companies is the structural development of strong enforcement laws for IPR (see Figure 13.18). According to Siegel and Phan (in Libecap, 2005) university's expenditure on intellectual property protection and the business development capabilities of TTOs have a positive correlation with start up formation. The role of TTO is crucial for the formation of spin-of companies (Debackere and Veugelers, 2005). Also the formation of spin-off companies is necessary for those countries which are trying to attain some form of Triple Helix III (Etzkowitz and Leydesdorff, 2000).

Experiences of the Scottish Enterprise to support the commercialization of research strengths through the formation of spin-off companies shows that designing specific mechanisms to encourage spin-off formation and enhance the entrepreneurial activities of universities proved to be very useful for countries in the final stage of development like Scotland –innovation driven economies (Reeves et al., 2009).

13.3.3.3 Leadership and Culture sub-system (LC)

The outcome of 15 years of policy changes on the LC sub-system (future state analysis from Tables 11.17, 11.19, 11.20, 11.21) is shown in figure 13.19.

Policies: Research consortia, Intermediary agents

Government backed intermediary institutions designed to bring together universities and firms provide financial and developmental assistance to companies to undertake R&D projects in collaboration with universities, and encourage them to maintain or repeat these partnerships (CCG programme- see Section 11.5- questions for scenario 3).

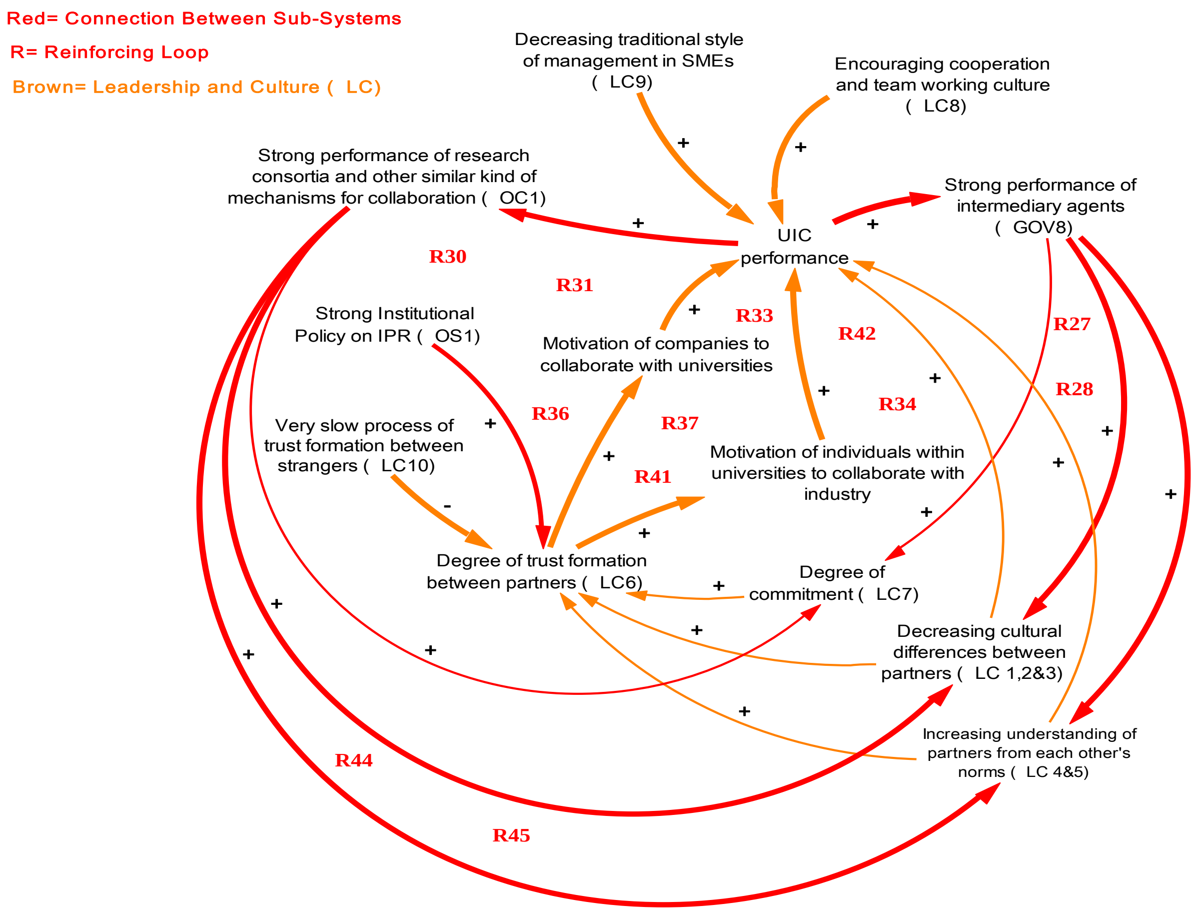


Figure 13.19: Elements of Leadership and Culture sub-system and their connections in the third scenario: constructed from the results in Tables 11.17, 11.19, 11.20, 11.21

The availability of strong IP structures at the institutional and national levels and the effective enforcement of IP laws, allows contractual trust to be shaped between collaboration partners. As a result of repeating relationships between the same partners competence and goodwill trust may be shaped in the long term (Table 11.20). In this scenario, because of strong and active research consortia and intermediary agents, and availability of CCG programmes, cultural differences between partners and a mutual recognition of partners' perspectives are improved (see Figure 13.19), creating opportunities for stronger forms of trust formation. The operation of active research consortia and intermediary agents evolves contractual commitment between partners; especially commitment of universities to industry. Such high levels of commitment between partners in this scenario lead to higher trust between partners. As a result it will act as a positive lever which can increase the motivation of individuals within universities and companies to collaborate. These activities create reinforcing loops which increase the performance of these kinds of mechanisms for collaboration over the long term. If collaborations are repeat with the same partner over a prolonged period, these reinforcing loops evolve trust from simple contractual-form through to competence-form and ultimately to good-will forms of trust (see Loops R27, R28, R30, R31, R33, R34, R36, R37, R41, R42, R44, and R45) (see Figure 13.19). This process of trust evolution was also confirmed by the second validation session – see Section 12.4. Results of this study reinforce the literature (Blois, 1999; Ceglie and Dini, 1999; Davenport et al., 1999; Huxham and Vangen, 2005; Worasinchai et al., 2008), which suggests that trust is a cumulative phenomenon, in which repeated interactions can enhance the level of trust between partners. This study highlights mechanisms (feedback loops) in which partners can enhance levels of understanding and decrease cultural differences, ultimately increasing levels of trust.

Efficient research consortia and intermediary agents, and a high degree of cluster activities will encourage team working culture among actors because they can now observe a high positive impact from the collaboration (Table 11.21). The cascade effect of this is to encourage other firms in the region to value collaboration – challenging the cultural values of non-collaborative behaviour. Thus has a positive impact on SMEs to alter their traditional style from the low-value perception of research. This occurs because these SMEs will find collaboration can bring opportunities not available to them when relying on their own resources (see Figure 13.9).

However, some participants (Table 11.19) anticipate that changing the lack of cooperation and team working culture is a very long-term phenomenon and even in this scenario there are likely to be few opportunities to improve it. Therefore, it still has a negative impact on UIC performance. Also, in this scenario, the pace of trust of strangers remains very low (see Figure 13.19). Cultural aspects of the problem for Iran are likely to make changes for perception of collaboration longer than it might be expected. This trend is also confirmed by Bstieler and Hemmert (2008) who concluded that in low-trust societies, trust is more difficult to achieve. Based on the results of the current research it is observed that even for those countries who are trying to achieve some forms of innovation-driven status (Iran), specific contextual factors (cultural dimensions) are likely to differ from one country to another. For Iran, these factors create greater challenges to economic transition compared to high trust-societies such as China.

13.3.3.4 Organizational Capabilities sub-system (OC)

The outcome of 15 years of policy changes on the OC sub-system (future state analysis from Tables 11.17, 11.19, 11.20, 11.21) is shown in Figure 13.20.

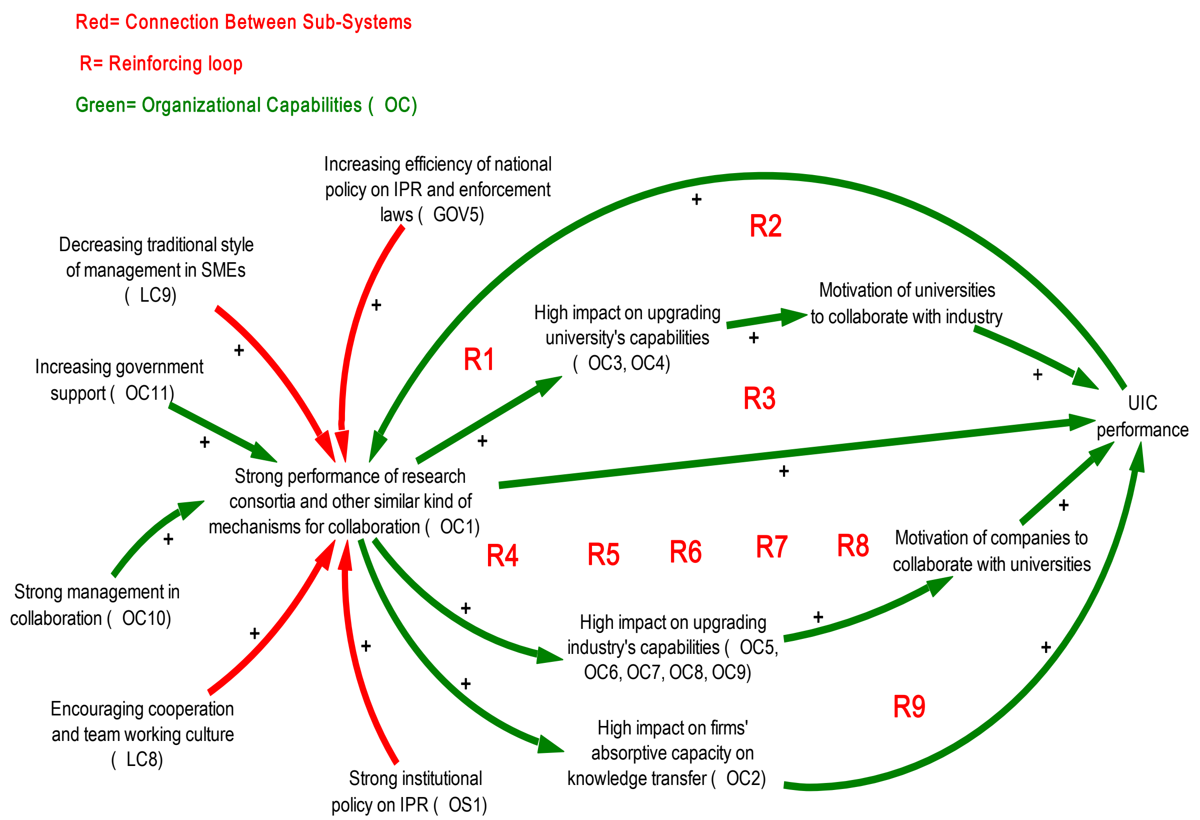


Figure 13.20: Elements of Organizational Capabilities sub-system and their connections in the third scenario: constructed from the results in Tables 11.17, 11.19, 11.20, 11.21

Policies: IPR, Degree of government support from research consortia

A comprehensive national policy for IPR and efficient institutional IPR policies can act as positive levers to enhance the performance of research consortia. Advantages from the effective enforcement laws for IPR are the higher probability for collaboration, and strong motivation of universities and industry to participate in research consortia (Tables 11.17 and 11.21). Strong management of collaborations and high government support for research consortia increases the effectiveness of these mechanisms. Cooperation and team working culture is encouraged and the traditional management styles in SMEs is challenged which will have a direct positive impact on research consortia performance (see Figure 13.20).

Policy: Research consortia

Performance of the research consortia is now very strong which in turn has a positive impact on the capabilities of universities and industry. The probability of creating an entrepreneurial culture in universities is also increased. As a result, the motivation of universities and industry to collaborate in this kind of mechanism is high and UIC performance is likely to increase (Table 11.20). These activities create reinforcing loops that increase the performance of research consortia in the long term and the chances to enhance the capabilities of universities and industry through these mechanisms will be increased (see Loops R1, R2, R3, R4, R5, R6, R7, R8, and R9) (Figure 13.20). Dooley and Kirk (2007) found that mechanisms such as research consortia are more suited to integrated university-industry-government triple helix model operations.

13.3.3.5 Government sub-system (GOV)

The outcome of 15 years of policy changes on the GOV sub-system (future state analysis from Tables 11.17, 11.19, 11.20, and 11.21) is shown in Figure 13.21.

Policies: Stability of government regulations, Government initiatives for collaboration

Increased university access to government funding (increasing their allocated budget based on the extent of collaboration with companies) motivates universities to collaborate with industry. This activity creates reinforcing loops which increase the willingness of universities to collaborate with industry and has a positive impact on the willingness of other universities to collaborate with industry. As a result, the allocated budget for universities increases (see Loop R12*) (Figure 13.21). High stability, long-term government regulations to support universities and industry in collaborative activities, is one of the primary strengths of this scenario which improves the probability of success for government initiatives (Table 11.21). In this scenario, government programmes (e.g. KTP's) are organized as practical knowledge transfer initiatives in order to involve all the system actors including government, universities, industry and even students together. Due to the high stability (long-term, consistent) of government regulation of these programmes motivation of universities and companies to collaborate together is enhanced. Availability of these kinds of schemes can increase the willingness of companies and universities to collaborate with each other, and by influence, increase the willingness of other companies in the region as well. Thereby gaining access to more government funding in the future. Results of the current study (Table 11.21) revealed that this activity can create reinforcing loops which increase the performance of these mechanisms for collaboration (see Loops R12, R14) (Figure 13.21).

Policy: University autonomy from government

In the third scenario, the government policy granting all national universities autonomy to develop their own research policy and relations with companies would create more opportunities to improve UIC performance (see Figure 13.21).

Policies: IPR (national, institutional), Venture capital, Intermediary agents

Strong national IPR policy and also effective mechanism for enforcement of IPR laws, strong institutional policy on IPR, and wide availability of VC all have positive impacts on UIC performance and also the performance of intermediary agents. These positively impact the status of cluster activities and favourability of the entrepreneurial environment (Tables 11.17 and 11.21). The existence of efficient venture capital in this scenario is related to the strength of government financing support systems to support the venture capital industry (see Figure 13.21). This is also confirmed by the results of both validation sessions (see Section 12.4). Availability of VC is vital for promoting entrepreneurial environment and economic development (Wilson, 1986; Koh and Koh, 2002; Wonglimpiyarat, 2006). Many countries like Singapore, South Korea and Japan considered efficient VC as the internal engine for growth (Koh and Koh, 2002).

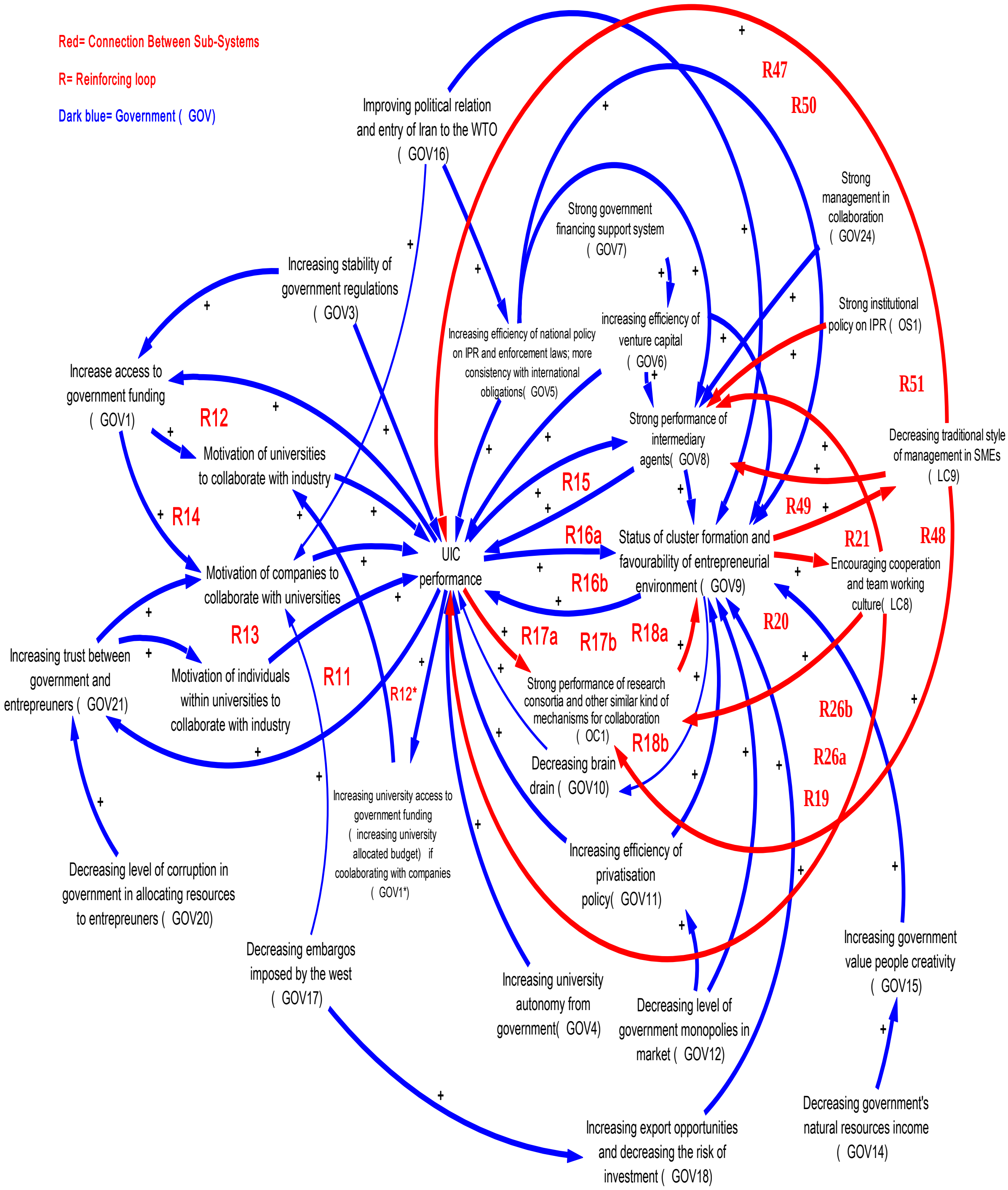


Figure 13.21: Elements of Government sub-system and their connections in the third scenario: constructed from the results in Tables 11.17, 11.19, 11.20, and 11.21

Policies: Intermediary gents, Research consortia

The performance of intermediary agents and research consortia are now considered very strong and efficient. Intermediary organizations have a higher degree of involvement in UIC with increases in government support and less intervention. This would enhance the management of collaborations related to these agents. The strength in performance of intermediary agents and research consortia can be considered as strong drivers on UIC performance to upgrade the status of cluster activities and favourability of an entrepreneurial environment.

Kodama (2008) considered the role of TAMA, an intermediary agent in Japan and found that a sufficient number of firms with high absorptive capacity are required to enhance the likelihood of success for cluster formation. This mechanism can develop linkages between firms with absorptive capacity to potential universities in the region.

Policy: Cluster activities

The status of the economic cluster is very strong and as a result will have a strong positive impact on UIC activities. Competition among firms in the cluster is very high; therefore companies will be inclined to increase the quality of their product. Thus, there will be very strong drivers to connect with research organizations and universities for competitive improvements. As a result, the probability of enhancing UIC performance will be increased. Consequently, this creates a strong probability that universities, researchers and companies will collaborate again in these kinds of mechanisms (intermediary agents and research consortia) and contribute to cluster activities. These activities create reinforcing loops (Table 11.21) that increase the performance of these kinds of mechanisms for collaboration and have a positive impact on efficient cluster formation process in the long term (see Loops R15, R16a, R16b, and R18a) (Figure 13.21). It was found (Table 11.21) that in order to enable cluster development, many other prerequisites should exist. These prerequisites are also necessary for shaping the entrepreneurial environment (e.g. comprehensive IPR policy and enforcement laws, high efficiency of funding, low level of corruption, decreasing monopolies, increasing stability of government regulations, eliminating embargoes, and also increasing efficiency of mechanisms for collaboration). As a result of promoting an entrepreneurial environment, the opportunity to form efficient clusters will increase. This forms a loop since efficient clusters can enhance entrepreneurial environment of the country. This research is substantiated by the work of Castillo and Fara (2002) and Karaev et al. (2007) who found that an appropriate entrepreneurial environment is one of the necessary preconditions of cluster development. These studies contradict the work of Porter (1998) who considered cluster formation as an instrument for creating an entrepreneurial environment (see Section 3.4). Analysis of the results of the first scenario confirms the government aim to form economic clusters without a supporting entrepreneurial environment offers few opportunities for success. However, in the third scenario, where the environment for entrepreneurial activities exists and efficient clusters are formed, positive reinforcing loops are created which moves Iran towards the status of an innovation-driven economy.

Policies: Cluster activities, Brain-Drain, Political environment

In the third scenario, government policy towards clusters focuses on specialisation (economies of specialisation as well as geographic concentration). The focus is on SMEs, both from the supply and demand side as well as cluster support institution like universities. By gathering all supporting industries in the region, the favourability of the region in terms of entrepreneurial activities will increase. High favourability of entrepreneurial environment and a strong cluster status, political stability, and a high standard of living have a strong impact on the decision of entrepreneurs and researchers to stay in the country. The control of the brain-drain is also identified as a major improvement for UIC (confirmed by the result of first validation session – see Section 12.4). By increasing the performance of UIC as a result of reducing the brain-drain, Iran will have more entrepreneurs to participate in entrepreneurial activities. Therefore, it has a positive impact on performance of research consortia and intermediary agents, and also the status of clusters. These activities create reinforcing loops which increase the performance of these mechanisms for collaboration and also increase the chance of promoting cluster activities (see Loops R17a, R17b, and R18b) (Figure 13.21). Results of the current study were also upheld by Mani (2004) who stated that control of brain-drain requires an environment which stimulates entrepreneurs to stay in the country. This is also confirmed by Davenport (2004) who stated that attempting to control brain-drain through tighter regulations without creating a favourable entrepreneurial environment will not be successful. It will only work when more opportunities for research, innovation and entrepreneurship are created in the country.

<u>Policies: Degree of monopolies in government, Privatisation process</u>

Since in this scenario the government has successfully privatised all state industries, a positive impact will be felt on UIC. A high efficiency of privatisation process in a country will have a positive impact on applying rational investment approaches in privatised companies. By designing an anti-monopoly policy the effect on UIC performance is more pronounced compared to the second scenario. Because of the high efficiency of privatisation policy and also decreasing monopolies of government in market, the cooperation of the private sector in economic activities will increase. Economic democracy in the country will be enhanced; therefore, the competitiveness in the country will be improved compared to the first and second scenarios. The status of cluster formation will be enhanced and also a favourable environment for entrepreneurial activities will be created. High levels of competition in the country ensure increased needs of companies to access universities in order to achieve competitive advantage and as a result UIC performance will be enhanced (see Figure 13.21) This situation was confirmed in both validation sessions (see Section 12.4). As there is no delay in the process of privatisation and because monopolies no longer exist, the level of trust of government by entrepreneurs will increase. Therefore, the motivation of entrepreneurs to be involved in economic activities will also increase. The status of cluster formation will be enhanced and a favourable environment for entrepreneurial activities will be created.

According to Wignaraja (2003), for those developing countries who wish to move to the final stage of transition towards a market-based economy it is essential not only to formulate a privatisation programme which is appropriate for the context of the country, but also encourage competition and to abolish monopolies.

Policy: Level of government support from entrepreneurial activities

In this scenario unlike previous scenarios, the price of oil is high, but there are not enough reserves of natural resources to form the majority of the government income. This will have a positive impact on government activities to support entrepreneurial environment in order to enhance economic position. If this continues in the future, government will be forced to value creativity. This situation increases levels of trust of government in terms of supporting entrepreneurs; which will have a positive impact on cluster activities (see Figure 13.21).

Policies: Political relations, WTO, Embargoes

It was found (Table 11.21) that, in this scenario international relations with other countries have improved, the country has joined the WTO, and embargoes by Western Governments have decreased. This is a driving force for companies to collaborate with universities to increase their innovation rates in order to compete in international markets. In this situation there will be an extra international force to the country adding more pressure to be competitive and innovative. This issue also has a positive impact on enhancing levels of competition in the cluster (see Figure 13.21). In the third scenario, levels of enforcement of IPR have increased and IPR policy is more consistent with international obligations. Therefore, the entrepreneurial environment, especially the environment which is satisfactory for international trade, exists in this scenario.

The existence of an efficient national policy framework for IPR in this scenario is heavily influenced by two factors. Firstly, improving political situation and entry of Iran to the WTO considered as a force to make enforcement laws constantly stronger and make IPR policy more consistent with international obligations e.g. the TRIP agreement. Secondly, a positive government stance with respect to property ownership and capitalism paves the way for the development of an efficient national policy framework for IPR (see Table 11.15 and Section 3.6.2).

In this scenario decreasing levels of embargo will increase motivation of companies to collaborate with universities to compete in international marketplace. Decreasing embargo will increase export opportunities and decrease risk of investment; therefore, there would be more opportunities to invite FDI or Joint Venture activities. In this scenario the risk of investment will decrease and export opportunities will increase (Table 11.21). This will have a positive impact on both competition in the country and the status of cluster formation. By improving the political situation and by increasing the proportion of foreign strategic technology alliances and attracting more FDI, UIC performance will be increased and have a positive impact on levels of competition in the region (see Figure 13.21).

Policy: Corruption

Decreasing levels of corruption in allocating resources to entrepreneurs is another barrier reduced. Low levels of corruption were identified as important factors which increase trust of government by entrepreneurs. Increasing levels of trust of government will increase motivation of entrepreneurs in society. If this situation continues, this activity creates reinforcing loops which increase the degree of trustworthiness of government (see Loops R11, R13) (Figure 13.21). According to the first validation session (see Section 12.4), building these positive loops even in this scenario may take a long time because trust was deeply eroded before, and time is needed to rebuild it to achieve a desirable state. In this scenario they are two mechanisms available which can decrease levels of corruption in government. These are; joining the WTO and increasing the degree of transparency of government activities, and also establishing association for national VC to support and regulate the public and private VC industry. By allowing detailed and independent monitoring of resource allocation activities and decreasing the possible opportunities for corruption in allocating of resources to entrepreneurs, transparency is improved. According to Treisman (2000) democracy and higher levels of international integration are critical elements to maintain low levels of corruption in a country (see Section 2.3.1).

Policies: Intermediary agents, Research consortia, Cluster activities

In this scenario unlike the first and second scenarios, because of availability of effective and active intermediary agents and research consortia, the status of cluster activities will be enhanced. Therefore, the cooperation and team working culture will be encouraged. Furthermore companies will be convinced to change the traditional management practices in their companies and the environment to develop more innovative business models will be encouraged. These will also have positive impacts on the performance of intermediary agents and research consortia. Existence of cooperation and team working culture and better management approaches by companies also will have a direct positive impact on intermediary agent's performance and also performance of research consortia. These activities create reinforcing loops which in the long term can have a positive impact on the performance of UIC; it also constantly encourage cooperation and team working culture among actors in Iranian NIS and also it will change traditional approach to management in companies (see Loops R19, R20, R21, R26a, R26b, R47, R48, R49, R50, R51) (Figure 13.21).

13.3.4 Comparison and Implications of the Scenarios

This section provides a comparison of the policy frameworks for each scenario (Table 13.1), the effect these policies have individually, and the overall impact of these policy changes on the whole system of University-Industry Collaboration (Table 13.2).

The objective of using the systems model for scenario creation is to understand the opportunities to intervene with policy changes to break into the negative reinforcing loops in order to alter the direction of these forces. This requires a system model of sufficient detail to uncover these loops and therefore provide insight to the actual policy options. As no model of sufficient detail existed it was necessary to develop one (the DSM). However, as the research uncovered, the transition to a knowledge based economy cannot be achieved in a single step. The necessary infrastructure (scenario 2) must first be created and embedded before the further refinements of scenario 3 can be considered. This sequence of events is illustrated in the policy frameworks and expected outcomes (Tables 13.1 and 13.2), and key features discussed below.

Using these scenario themes in order to identify crucial events and factors required the five factor groupings to be set in accordance with the suggested transition patterns from the global competitiveness index report (2008). Similar concepts of transition are found in the theories of Triple Helix (I, II, III) and the National Systems of Innovation (including passive NLS, active NLS and NIS) in which details of the state of several factors are associated with different stages of evolution, but compared to the DSM, these models lack the detail, mechanisms (feedback loops) and completeness to form coherent policy frameworks.

Policy Lever	**Policy Levers States**		
	Scenario 1: Stagnation	**Scenario 2: Efficiency-Driven Economy**	**Scenario 3: Innovation-Driven Economy**
Efficiency of national policy on IPR and enforcement laws (GOV5)	-Inefficient -Low level of IP law enforcement -Low international IPR obligation	-Increasing efficiency -Low level of IP Law enforcement -Low international IPR obligation	- Efficient -High levels of enforcement laws -High international IPR obligations
University autonomy from government (GOV4)	None	Increasing	Near Complete
Efficiency of government financing support systems (GOV7)	Inefficient	Increasing efficiency-still not efficient enough	High
Efficiency of VC (GOV6)	Inefficient	Increasing efficiency-still in a limited scope	Efficient
Degree of stability of government regulations	Instable	Increasing stability	Stable
Level of access to government funding and efficiency of government initiatives (GOV1)	Low, inefficient	Medium, increasing efficiency	High, efficient
Changing allocated budget of universities based on collaboration with companies (GOV1*)	No	No	Increasing allocated budget
Degree of government support from research consortia and intermediary agents (OC11)	Low	Low	High
Degree of government monopolies in market (GOV12)	High	Medium	None
Degree of efficiency of privatisation policy (GOV11)	Low	Medium	High
Degree of efficiency of policies for supporting clusters (GOV9)	Low	Medium	High
Efficiency of government policy to control brain-drain (GOV10)	Inefficient	Still inefficient but the situation is improved	Efficient
Level of corruption in government in allocating resources to entrepreneurs (GOV20)	High	High	Low
Level of embargoes imposed by the Western Governments (GOV17)	High	Low	Low
Status of political relation and probability of Iran entry to the WTO (GOV16)	Weak	Improved	Strong
Efficiency of institutional policy on IPR (OS1)	Inefficient	Increasing efficiency	High efficiency
Efficiency of institutional policy on royalty sharing (OS3)	Inefficient	Increasing efficiency	High efficiency
Structure of TTO in universities (OS2)	Weak	Strong	Strong
Availability of skills in the TTOs (AST2)	Low	High	High
Efficiency of TTOs strategy to support spin-off companies (AST3)	Inefficient	Increasing efficiency-Not ideal	Efficient

Table 13.1: Policy Lever settings: comparing the Scenario Policy Frameworks

	Comparing the policy impacts: Scenario outcomes
	Organizational Structure (OS): Sub-system 1
Scenario 1: Stagnation	**Inefficient (very few opportunities to support UIC):** -There are no strong motivational factors for universities and companies for collaboration (due to inefficiency of national and institutional IPR and institutional policy on royalty sharing) - UIC performance is very weak (Weak structure of TTOs, high bureaucracy, and lack of university autonomy from government)
Scenario 2: Efficiency-Driven Economy	**Increasing efficiency (limited success):** - Increasing motivation of universities and industry (strong institutional policy on IPR and clear royalty sharing) - Increasing autonomy of universities and increasing efficiency in the structure of TTOs to support and help researchers link to industry which enhance UIC performance - Still limited opportunities for UIC success (lack of enforcement IP laws)
Scenario 3: Innovation-Driven Economy	**High efficiency:** - Availability of strong motivational factors for universities and companies for collaboration (due to high efficiency of national and institutional IPR and institutional policy on royalty sharing, efficient enforcement of IP laws) - UIC performance is very strong (efficient structure of TTOs, decreasing bureaucracy, and increasing university autonomy from government)
	Asset Management (AST): Sub-system 2
Scenario 1: Stagnation	**Inefficient (very few opportunities to support entrepreneurial activities):** - UIC performance is very weak and limited entrepreneurial activities (insufficient skills in TTOs, inefficiency of venture capital, weak TTO's spin-off creation support strategy, weak enforcement of IP laws)
Scenario 2: Efficiency-Driven Economy	**Increasing efficiency (still few opportunities to support entrepreneurial activities):** - UIC performance is improved but still limited entrepreneurial activities (Availability of skills in TTOs, increasing efficiency of venture capital- but still in a limited scope, weak TTO's spin-off creation support strategy, weak enforcement of IP laws)
Scenario 3: Innovation-Driven Economy	**High efficiency (increasing opportunities to support entrepreneurial activities):** - UIC performance is strong and increasing entrepreneurial activities (Availability of skills in TTOs, high efficiency of venture capital, comprehensive TTO's spin-off creation support strategy, strong enforcement of IP laws)
	Leadership and Culture (LC) : Sub-system 3
Scenario 1: Stagnation	**High degree of cultural differences and low level of trust** - A high degree of cultural differences between partners and the lack of understanding of partners for each others' norms decrease the performance of UIC and also reduce the potential for trust formation (due to inefficiency of mechanisms for collaboration such as intermediary agents and research consortia) (Negative reinforcing loops emerged).
Scenario 2: Efficiency-Driven Economy	**Still high degree of cultural differences and low level of trust** - A high degree of cultural differences still exists between partners and such a lack of understanding of each other's norms decrease the potential for trust formation. Although some opportunities exist for trust formation; due to the absence of more complex forms of interactions (research consortia and intermediary agents), there are few opportunities to achieve more complete forms of trust between partners. Therefore, opportunities to motivate potential partners to collaborate are limited (Still loops are negative).
Scenario 3: Innovation-Driven Economy	**Decreasing cultural differences and enhancing level of trust** - Due to the high efficiency of research consortia and intermediary agents, cultural differences between partners are decreased and also it increases the potential for trust formation. Also there will be opportunities to achieve more complete forms of trust between partners (good-will trust). Therefore, opportunities to motivate partners for collaboration will be increased (Loops are positive).

Table 13.2: Comparing the policy impacts: Scenario outcomes

	Comparing the policy impacts: Scenario outcomes
	Organizational Capabilities (OC): Sub-system 4
Scenario 1: Stagnation	**Inefficiency of mechanisms for collaboration (Research consortia)** - Performance of research consortia and intermediary agents are very weak (due to inefficiency of national and institutional policy on IPR and weak enforcement laws, weak government support) - Low chance of enhancing the capabilities of universities and industry - Decreasing motivation of companies, researchers and universities to participate in these kinds of mechanisms (negative loops are created).
Scenario 2: Efficiency-Driven Economy	**Still inefficiency of mechanisms for collaboration (Research consortia)** - Performance of research consortia and intermediary agents are still weak (due to inefficiency of enforcement laws, weak government support). Only encourage simpler forms of collaboration. - Low chance of enhancing the capabilities of universities and industry - Decreasing motivation of companies, researchers and universities to participate in these kinds of mechanisms in the long-term (negative loops are created).
Scenario 3: Innovation-Driven Economy	**High efficiency of mechanisms for collaboration (Research consortia)** - Performance of research consortia and intermediary agents are strong (due to high efficiency of national IPR and enforcement laws, high government support) - Increasing chance of enhancing the capabilities of universities and industry - Increasing motivation of companies, researchers and universities to participate in these kinds of mechanisms (positive loops are created).
	Government (GOV): Sub-system 5
Scenario 1: Stagnation	Weakness of government financing support systems and inefficiency of venture capital has a negative impact on UIC. This leads to decrease the favourability of entrepreneurial environment and it creates barriers to cluster formation. High levels of government monopolies in market, inefficiency of privatisation policy, inefficiency of national policy for IPR and weakness of enforcement laws; make a situation where there are few opportunities to enhance entrepreneurial spirits in the country. Increasing brain-drain is an outcome of this scenario. Instability of government regulations is another major obstacle for collaboration which de-motivates entrepreneurs. High levels of corruption in government decrease the level of trust of government by entrepreneurs. Weak international relations and embargoes imposed by Western Governments also make the situation worse.
Scenario 2: Efficiency-Driven Economy	There are improvements in government financing support systems; however, venture capital is still not widely available. This leads to limitations of the entrepreneurial environment and fewer opportunities for cluster development. Although there are many improvements compared to first scenario such as decreasing government monopolies and increasing efficiency of privatisation policy they have limited impact on the UIC environment because monopolies persist and the privatisation strategy is incomplete. There are some major improvements like decreasing embargo by Western Governments and increasing probability of joining WTO which have positive impacts on UIC performance. Increasing stability of government regulations makes access to government funding easier compared to first scenario. Negative forces include: lack of IPR enforcement laws, corruption, and inconsistency of IPR regulations with international obligations and deficiency of intermediary organisations. Overall, a non-ideal entrepreneurial environment exists which leads to a situation of continued brain-drain.
Scenario 3: Innovation-Driven Economy	Venture capital is widely accessible for entrepreneurs which increases the favourability of the entrepreneurial environment and creates more opportunities for cluster activities. Compared to previous scenarios major improvement in government support exist. Decreasing government monopolies and increasing efficiency of privatisation policy, decreasing embargo by Western Governments and joining the WTO in this scenario have positive impacts on UIC performance. More opportunities for joint venture activities and FDI, causing increased levels of competitiveness. Increasing stability of government regulations, high efficiency of IPR enforcement laws, decreasing corruption in government, consistency of IPR regulations with international obligations and high efficiency of intermediary organisations are other positive forces in this scenario. As a result, a favourable entrepreneurial environment is created which naturally moderates the brain-drain from the country.

Table 13.2 (continued): Comparing the policy impacts: Scenario outcomes

The literature categorizes trust in several ways. According to Carayannis et al., (2000) trust can be weak-form, semi-strong, and strong-form (see Section 4.14). Sako (1991) also categorized trust into contractual, competence, and good-will trust (see Section 5.3). In the first scenario there are few opportunities for trust formation, even weak forms of trust. In the second scenario there are opportunities for weak-form trust but there are still challenges to the value of contractual forms of trust (absence of effective enforcement of laws). In the third scenario there are more opportunities to achieve stronger forms of trust and to create goodwill trust. According to De Wever et al., (2005) who considered four types of trust based on two dimensions of resiliency and specificity (see Section 5.3); it could be discussed that in the third scenario the dyadic resilient type of trust could be achieved. This is due to frequent and direct interactions and subsequent increasing feelings of benevolence.

The findings of the current study are consistent with the literature on the role of intermediate agents. Rohrbeck and Arnold, (2006, experience of Germany) and Smedlund (2006- experience of Finland) confirm intermediary agents have a critical role in brokering communication and trust between companies and universities.

The current research highlights the importance of the region in national competitiveness and confirms that some forms of trust between partners can be generated at the regional level (e.g. trust between partners in collaboration that have an impact on UIC performance). It was also found (Table 10.13) that considering the national level is also crucial for examining systems of innovation in the country; as some of the forces in the system such as national IPR issue, enforcement of laws for IPR, monopolies of government, privatisation policies and degree of stability of government regulations are controlled at the national level and create environmental conditions for the regional context. This is also confirmed by Chung (2004), who found that a regional innovation system is important because regions can generate and maintain trust vital for improvement of economic performance.

Results of this study also indicate that some forms of trust also can be shaped at the national level (e.g. trust between entrepreneurs and government that can have a positive impact on UIC performance- see Section 11.21). This research confirms the approach adopted by some systems of innovation theories in which the national level is the important level of analysis i.e. NIS.

Although many of the identified factors in the first scenario are generic for developing nations (strong comparisons with Algerian case, Saad and Zawdie, 2005), a significant and high impact range of factors are deeply culturally rooted in Iran. As a result of interaction between these five sub-systems in the first scenario and the state of Iran's international relationships, government-university-industry relationships in Iran are not strong and the culture in Iran for entrepreneurship is inert. Although in the second scenario the entrepreneurial environment is improved compared to the first scenario, it is only in the third scenario that the cultural direction in Iran for entrepreneurship is encouraged.

13.4 COMPARISON OF DSM & SCENARIO APPROACH TO OTHER INNOVATION SYSTEMS THEORIES

It could be discussed that a triple helix in the first scenario in Iran is coordinated entirely by the government and if this situation continues, according to Dzisah and Etzkowitz (2008, p103) it only "*allows for a limited source of ideas and initiatives. Under this circumstances government may take initiatives without consulting others; indeed it may subsume the other institutional spheres and direct their activities*". Therefore it is not a most productive form of triple helix relationships.

According to the Triple Helix typology which describes three phases of evolution for systems of innovation including “statist model”, “laissez-faire” and “type III” (Etzkowitz & Leydesdorff, 2000) (see Section 3.3.2), the first Iranian scenario fits the description of the first phase of evolution which is least effective. Scenario 2 can be considered as improved and in transition from “statist model” to “laissez-faire”. This is because Iran still has a very young and fractured innovation system (confirmed by results of second validation session – see Section 12.3). This situation is very common amongst developing countries, and government is still the dominant power in systems of development of knowledge and innovation; some developing countries like Malaysia (Abd Razak and Saad, 2009) and Brazil (Lima and Filho, 2009) are considered in transition from “statist model” to “laissez-faire”. The third scenario represents a form of “type III”. These are of course approximate since direct comparisons are limited due to the lack of completeness and complexity of the Triple Helix models compared to the behaviourally rich DSM model presented here.

In the first scenario, although many institutions exist to advocate innovation, it was found there were no systematic interactions between these institutions. According to Lee and Tunzelmann (2005) although different countries have similar institutions to advocate innovation, they differ considerably in the way in which these institutions interact with each other in order to pursue the innovation process; this reveals the importance of the concept of the system in NIS. Also as mentioned by Dzisah and Etzkowitz, (2008, p105) “*in all developing countries, the essential triple helix elements exist. The missing component is often the lack of a coherent strategy to integrate the fundamentals ingredients necessary for socio-economic development*”.

According to Viotti (2002) who classified different terminology of NIS for countries in different stage of transition (see Section 3.3.1), It might be discussed that in the first scenario Iran can be considered as a passive National Learning Systems (NLS); in the second scenario Iran is in transition from passive to active NLS. Finally, in the third scenario, Iran would meet the criteria to be considered as having an efficient NIS.

Wignaraja (2003) considered three levels for a NIS: (1) national industrial cluster; (2) set of institutions and organizations which support the learning process in industrial clusters; and finally, (3) set of policies that stimulate the learning process between industrial clusters and institutions (see Section 3.3.1). The first scenario of Iran has problems in all three levels, particularly in level 3. Although the situation is getting better in the second scenario, only in the third scenario are the improvements consistent with all three levels.

Rooks and Oerlemans (2005) highlighted innovative performance of firms depends largely on the existence of four major flows: human capital, financial capital, regulation and knowledge (see Section 3.3.1). It could be discussed that in the first scenario in terms of human capital, Iran is well positioned with a developed education structure and high numbers of graduates, but the brain-drain effect is a threat. The Financial capital system is inefficient, and regulatory systems are not effective – illustrated by the instability of government regulations. Overall, the effect on knowledge (represented as UIC performance) is quite subdued. In the second scenario the situation is improved with respect to lower levels of brain-drain (although this is still a problem), financial flows become more effective (but VC is still not widely available), and government regulatory flows become more effective. UIC performance has improved; therefore there would be more opportunities for increasing innovative performance of industry compared to the first scenario. However many other barriers still exist which have a negative impact on the process e.g. weak enforcement laws.

Finally, in the third scenario these flows become more effective and this is the point where innovative performance of industry could be significantly improved.

In Porter's (1990) Diamond model, the innovation system only operates effectively when the interaction between the determinants is efficient. Rivalry and availability of an efficient cluster are the crucial elements which can help to transform a region. According to the result of the current study, in the first scenario government has a negative intervention, the country suffers from brain-drain, embargoes, weak rivalry, a poor status of advance factors, and a handful of buyers dominate the home market. It might be discussed that the Iranian Diamond is not structured to act as an efficient system. Although in the second scenario there are many improvements compared to the first, such as improved international relationship, and reduction of intervention in the market by the government; negative forces still exist which impede efficient cluster formation and act as barriers to effective competition. However, in the third scenario the prerequisites to create an efficient Diamond are in place. This includes, but not limited to, the availability of advanced factors, stimulation of entrepreneurial environment by government, high degree of rivalry, and the creation of efficient clusters.

Although the situation is getting better in the second scenario, two major forces still present difficulties for Iran's transition from "statist model" to "laissez-faire" (based on Triple Helix typology), from passive to active NLS (Based on NIS categories), and to construct a favourable Diamond are due to the negative impact of lack of trust and cultural issues on the system. Results indicate that changing the culture of the country and generating trust is a long term phenomenon. Results of the current study highlight that these two factors play a crucial role in the model developed in this research and indicates that these three systems of innovation theories do not recognize the importance of these factors. One of the main findings of this research shows that behavioural factors associated with trust and culture should be fully addressed in order to form a complete understanding of the complexity of innovation systems.

13.5 CONCLUSION

To develop an effective policy manifesto for the transition of Iran it was necessary to design a more complete and useable model of UIC behaviour to address the gaps in existing related systems theories. This DSM model highlighted forces that can be considered as the critical infrastructural forces. The whole system behaviour formed from an interaction of five sub-systems is greatly influenced by the state of these critical infrastructural forces. These forces not only impact the sub-system in which they are related, but also impact on elements of the other sub-systems. According to the survey data set (see Chapter 9) all of these critical forces have a high degree of uncertainty regarding direction, pace or likelihood of occurrence of the future course, underscoring why these forces present greatest opportunity to construct policy realignment.

Experiments with policy options are explored in the scenario's constructed using the DSM. Trust and culture, found to be critical elements of the system, were discovered to be particularly problematic in the case of Iran. These two elements must be influenced by other critical forces as it was clear from the Iranian scenarios that trust and cultural aspects cannot be altered directly, but only indirectly through creating new (long term) environment conditions to reorientate learning and experience.

CHAPTER 14

CONCLUSION

14.1 INTRODUCTION

The research findings have several implications for NIS theory and practice; particularly for the role of UIC in NIS. This study is the first detailed investigation of the use of scenario methods developed using a systems model of the national mechanisms of UIC. Although some researchers have tried to uncover the dynamic behaviour of NIS and related theories in general (e.g. Galanakis, 2006); there is no research that particularly focuses on UIC. Therefore, this research is a first attempt to develop a comprehensive model (dynamic model consists of different sub-systems and loops) for university-industry collaboration (UIC). Furthermore, although scenario development has been employed before on UIC concepts (in simple forms and based on scenario matrix e.g. Harper and Georghion, 2005); there has been no research related to UIC scenario development based on a systems thinking approach. The systems approach was employed to deal with the evident complexity of the network of inter-related UIC elements. Adding dynamic features to the scenarios also represents an element unused in other research. This is also the first research to incorporate UIC element uncertainties, by virtue of the use of scenario methods.

14.2 METHOD OF USE

The Dynamic Systems Model (DSM) developed in the current research is a neutral model which can be loaded with policies to estimate their sub-system and whole system impact. This provides a learning tool for policy makers, as they can simulate the system behaviour of policies before they are tested in a real situation and therefore provide greater confidence of their policy-making capabilities. This can form a continuous loop in which the real world is subject to a constant comparison with a systems model equivalent. As noted by Checkland and Scholes (1999) (see Section 6.4.1) the real world situation should be examined to find out if those activities necessary to give the defined system functionality are actually going on in practice. When a small difference between the model and practice is found, some improvement might be assumed, but occasionally no improving action to manage this difference can be taken, in which case there must be a return to the system thinking stage and a fresh attempt at the modelling exercise.

In use, the method of scenario prediction, and therefore the DSM itself, can be tested with empirical evidence following the implementation of one or more of the assumed policies. This evidence can be collected from many national systems in order to further refine the match between the systems world and the real-world. This is a recommendation for further research, which should enhance the validity of the (continually refined) DSM platform.

Scenarios in this research were constructed using the DSM as a platform. One of the strengths of this research is that, the DSM can be considered as a dynamic systems model consists of five different sub-systems which include all of the major elements related to UIC activities. This model contains numerous feedback loops which integrate the five sub-systems together. Therefore, compared to other innovation systems theories, this model is considered more complete in terms of components and relation in the model (Structural View), and also dynamics of the model (Functional View). Furthermore, the DSM was constructed based on two dimensions of Impact and Uncertainty which are particularly relevant in the context of developing countries. As noted by Bagherinejad (2006), most developing nations (particularly the Middle Eastern countries) still face a degree of uncertainty regarding the efficiency of their policy for developing efficient NIS.

Scenarios constructed in this research are used to evaluate the economic policies of Iran on the UIC system. The objective here was to follow a political and societal manifesto in order to observe what would be the status of the country if some changes happened simultaneously and these changes are mostly informed from the experience of countries in transition from “factor driven” to “efficiency driven” and “innovation driven”. However, this should not be considered as a weakness of the model developed in this research, rather it is a major strength of the DSM that is a very flexible model which can be adapted in many kinds of scenarios e.g. worse case scenarios as well. This model (DSM) would be flexible for developing any scenarios, and by changing the direction of the forces, the DSM will respond accordingly. It might be suggested that other researcher in developing countries also can consider it as a platform for their study, however, a delicate change in the model is necessary to make it applicable based on the context of particular country.

This research shows that it is feasible to apply systems thinking approach to analyzing UIC and scenario development. Although the details of the causal relationships in the DSM were found to be the same for two industrial sectors that were studied in this research, it may be different for other industrial sectors; but the foundation of these diagrams should have a strong similarity. Therefore it could be generalized to other industrial sectors of the country that have capabilities to collaborate with universities. This could be considered as a basis for further investigations.

14.3 THEORETICAL IMPLICATIONS

Evidence shows that there has been little examination of the determinants of technological innovation and the critical factors for successful industrial innovation, particularly with reference to developing countries. Furthermore, due to the absence of a climate of innovation, enterprise in these countries remains underdeveloped (Bagherinejad, 2006) (see Section 3.2). One of the contributions of this study is an attempt to identify different stages and critical factors required in order to create a climate of innovation in general.

The series of qualitative models developed in this thesis provide rich insight to the causal nature of university-industry collaboration in general and the role of UIC in the Iranian national systems of innovation in particular. This cause and effect model can provide researchers, industrial sectors and policy makers, with a deeper understanding of the interdependence between UIC subsystems and also the policy challenges for the government in applying effective mechanism to manage the development of the nation. This model also provides an insight for stakeholders to consider UIC as a system; to focus on the whole entity rather than individual parts in order to eliminate the systemic barriers to UIC.

An extensive investigation of the primary impact factors for the case study nation (the current situation in Iran - scenario 1), and their causal relationships to UIC activities found many were biased to drive a behaviour pattern (culture) which is overwhelmingly negative. This negative behaviour is manifest as a significant lack of trust at all interfaces between the primary actors in the system. The findings show that trust and cultural development cannot be altered directly, but only indirectly through learned (and long term) experience of new environment conditions.

Degree of trust formation between partners, and between entrepreneurs and government which have a strong influence on UIC performance, could be influenced by many factors and it is considered as one of the most important elements which have a strong impact on the NIS. Some of these factors are related to government activities and some of them are related to the degree of institutional efficiency. For example efficiency of national policy on IPR and enforcement of laws, and efficiency of institutional policy on IPR have an impact on trust formation between partners. Some other factors related to government policies including efficiency of privatisation policy and the level of the market in state monopolies have an influence on trust formation between entrepreneurs and government. The degree of corruption in government in allocating resources for entrepreneurial activities has a great impact on trust formation between government and entrepreneurs. Trust has a strong cultural root at both the institutional and national level: cultural differences between partners and a lack of understanding of each other' norms (which are part of the culture of each institute) have an impact on trust formation, as does the pace of trust formation between strangers. Collaboration development activities have a strong influence on this cultural difference between partners and therefore present an opportunity to influence trust formation between partners.

The DSM illustrates the critical role culture and trust has on UIC activities. Informal institutions such as culture (Doney et al., 1998; Tillmar, 2006) and formal institutions such as rules and regulations (Tillmar, 2006), impact on trust formation. Although this literature highlights the important factors which have an impact on the process of trust formation, they do not explain the mechanisms involved and list only a few forces considered causal. Furthermore, the literature to explain the impact of important factors on the process of trust formation are chiefly focused on trust and culture from a wider management literature perspective rather than focusing on the UIC concept. One of the strengths of the current research is uncovering mechanisms of the factor influence on the process of trust formation from systematic perspective by considering all relevant forces (particularly those related to UIC activities). These findings also highlight the deficiencies in other innovation systems theories (NIS, Triple Helix and Porter's Diamond Model) which pay little attention to the status of trust and the process of trust formation (and destruction) in the system.

This research found that culture as individual force plays a significant role in any NIS. Some forces which have a cultural route including degree of team working and cooperation culture and style of management in SMEs have a strong impact on UIC behaviour and the national NIS. Interpretation of scenario 3 (i.e. a future state Iran as a developed nation, see Table 11.21) suggested that in an innovation-driven nation efficient mechanisms for collaboration, an entrepreneurial environment and high levels of cluster activity enhances the development of a cooperation and team working culture in a country. Observation of the gains from this type of environment has the power to convince companies to change traditional management practices and styles. This demonstrates influence a National System of Innovation can have on the national culture. Ney (1999) mentioned that NIS related literature is unable to explain the means through which development of national innovation systems has impacted on specific national cultures (see Section 3.3.1.2). The current research codifies the way evolutions of innovation system influence a national culture in the DSM model.

O'Shaunghnessy (1996) underscored the deficiencies in Porter's Diamond Model, and National Systems of Innovation (Ney, 1999) with respect to dimensions of culture. It is worth mentioning that although the literature (NIS, Porter's Diamond Model, and Triple Helix' concepts) highlight features of university-industry-government collaboration and suggest that culture and trust play a role; they lack sophistication of process models that explain the relationships. This incompleteness of theories suggests the concepts of innovation are simpler than they actually are. If the innovation concept was less complex that it actually is, then many more nations would have become advanced economies by now. However, managing the real situation requires that less tangible national assets are considered i.e. trust and culture. This knowledge gap is addressed in the developed systems model from the current research - the DSM incorporates the mechanisms by which trust and cultural facets are made manageable.

According to Etzkowitz and Leydesdorff (2000) many innovation system models focus on the complexity and dynamic process of innovation. However, the contribution of this research is a focus on the complexity and dynamic process of innovation from different but important angles, and also considers the role of culture and trust. According to De Wever et al., (2005) Business and Management research generally has been designed based on an assumed steady state of trust. Therefore, in the interest of completeness future research focus should consider the dynamic evolution of trust in inter-organizational networks. Results of the current study fill this gap and consider the dynamic evolution of trust as well.

Some researchers have proposed a global perspective for culture. They argue that it is the “international economic culture” which pushes every country toward productivity and values which will lead ultimately to a globally homogenous culture. A contrasting opinion is that particular culture traits are a prerequisite for economic development (Porter et al., 2000) (see Section 5.7). The current study is aligned with the work of Porter et al., (2000) and suggests that particular cultural issues in specific country have an impact on the degree of development of that country and also have an impact on their NIS. The current study is consistent with Dod and Patra's (2002) work which shows that the culture of each country is important in shaping the nature of entrepreneurial networks. This study suggests that national differences together with other cultural variables, has a significant impact on the level and nature of entrepreneurship, and they reject Universalist or generic theories regarding entrepreneurial activities (see Section 5.7). Thus the settings of the cultural and trust states for a nation are required inputs when building scenarios using the DSM.

A feature of this research is that many elements of the Dynamic Systems Model (DSM) were identified by the respondents from a developing country case (Iran). Thus capturing many features of weakness that are almost taken for granted in the main body of literature based on cases from developed nations, e.g. degree of stability of government regulations regarding UIC, high levels of corruption, or poor IPR systems. These models assumed that features related to developing countries are permanently positive as in the developed nations; whereas these models are required to be more generic in recognizing that alternative states can and do exist. The DSM is presented as a more complete, generic and therefore appropriate model for developing nations.

14.4 KEY FINDINGS FOR IRANIAN POLICY DEVELOPMENT

A generic model of university-industry-government interrelations was developed to aid a systematic understanding of the mechanisms (primary barriers and drivers) for productive collaboration. This systems model was used in the formation of policy instruments designed to improve university-industry collaboration (UIC), and thereby the means of regional economic development. These policy experiments are applied to the case of Iran. However, since the future of Iran in this context is highly uncertain due to cultural, political and economic factors there were few assumptions to approach the problem with current innovation management practice. Instead, the DSM was employed to analyze scenarios for policy instrument impact on the UIC associated with two major Iranian industries (Automotive and Biotechnology).

The Iranian case does not seem inclined to radical change. Therefore, understanding the full range of factors available was critical in generating scenarios for feasible UIC systems developments. A sustainable and effective Iranian UIC system must involve a series of cultural shifting economic policies and administrative structures designed to evolve actor behaviour in a gradual but consistent way. Unfortunately, short-term, start-stop, incoherent government initiatives have compound the current entrepreneurial cultural malaise.

It was concluded that some of the forces in the DSM were considered as critical infrastructural forces necessary to manage the effective transition of the Iranian system from its current state. These are therefore important key forces based on scale of impact on many other (three or more) elements of the system, or their necessity in creating a cascade of events (e.g. IPR policy). The main difference between the developed scenarios was due to the variation in direction and strength of these critical infrastructural forces. The major policy findings from these scenario experiments for Iran are presented in Tables (13.1 and 13.2) and highlighted below:

<u>National and institutional policy on IPR and enforcement laws</u>

The current state of IPR policies in Iran form structural barriers to collaboration by demotivating the key system actors. Overcoming these barriers is a long-term and complex process involving many mechanisms for collaboration enhancement including research consortia and other similar mechanisms and intermediary agents, in addition to government initiative for creating an effective national IPR framework and enforcement commitment.

Government financial support and Venture Capital

The current state of government financial support is inefficient but coupled to the lack of VC industry in Iran. Results in a poor environments for entrepreneurial activities. Availability of efficient VC (especially international companies) depends heavily on the political relations with other countries. Although the second and third scenario assumed that the level of embargoes reduces, in reality this issue may take longer than proposed for these scenarios.

Stability of government regulations

It was found that increasing stability of government regulations (second scenario), improved the mechanisms for collaboration. The relatively simple act of government regulation stability at all levels including national and regional policies to encourage collaboration will result in trust between government and entrepreneurs increasing significantly.

Autonomy of universities from government

The low degree of university autonomy is a barrier for collaboration which increase bureaucracy in the UIC process and decreases the likelihood that universities will design their own policies (compatible with their structure and capabilities) in order to attract industry. The MSRT is therefore recommended to design policies to increase university autonomy, while still maintains a monitoring role.

Intermediary agents and research consortia

Performance of these mechanisms for collaboration is currently weak. Improving these mechanisms not only requires an efficient and well equipped physical infrastructure, but also requires a comprehensive IPR policy and enforcement laws, high levels of government support and more proactive management in these mechanisms for collaboration. Furthermore, availability of VC is another criterion which defines the likely degree of success of these intermediary agents.

Political environment and Embargoes

Currently, the low probability of Iranian entry to the WTO, and the high degree of embargoes imposed by Western Governments are barriers for UIC activities, and lower the likelihood of developing an entrepreneurial environment. Improvement of the current situation depends on government future political plan which is a highly uncertain topic.

Corruption, Monopolies, and Privatisation process

In the current state, high levels of corruption in government for allocating resources to entrepreneurs adversely affect trust formation between government and entrepreneurs, and consequentially the motivation for collaboration. Likewise, the extent of state monopolies depresses the entrepreneurial environment nationally. Joining the WTO and increasing government transparency are the major policy shifts required to change this status.

Cluster activities

The status of cluster formation is currently weak since it depends on the efficiency of many other policies. Cluster performance is likely to be the main beneficiary of a successful application of this system-informed policy framework for UIC development.

14.5 LIMITATIONS

Although every effort was made to ensure the accuracy of the conceptual and methodological approaches, it has nonetheless been bound by certain constraints and limitations. These were more or less unavoidable and it is suggested that they do not negate the findings of the study. They are perhaps better understood as practical guidelines for future research.

In semi-structured interviews, establishing contact with both universities and industry was straight forward. However, in government ministries the process of establishing contact and arranging interviews was long and in some cases the appointment was cancelled or it was rescheduled three or four times. In some cases the procedure to access the person was very bureaucratic and required passing through a series of administrative filters. Nonetheless, interview respondents were carefully selected to cater for the needs of the study. It should be noted that the methods in selecting the respondents were focused on finding those individuals at universities, industry and Governmental Ministries who through their experience had a deep knowledge of the UIC activities.

As regards the quality of the interview data, the respondents particularly from the government seemed to be very careful when express their opinions. They appeared to be cautious about revealing information especially if it was related to government policies. However, the data for 32 interviewees were not analyzed in isolation. There was a degree of consensus observed across the interviews and between their perceptions and the survey data.

Another limitation of this study was a lack of information and data about the position of the country compared to other countries in the same stage or later stage of development e.g. no sufficient information in World Economic Forum- Global competitiveness index report (2008) or other similar cases. Nonetheless, for the purposes of this research the limited information from international databases was accessed. This situation was rectified too late for the current work, with the Nov 2010 publication of World Economic Forum- Global competitiveness index report.

The ideal situation in semi-structured interviews in order to develop scenarios was to conduct an interview in two separate sessions for each individual. One to construct the DSM and the other one to ask “what if” questions in order to develop scenario scripts. Although this process happened in around half of the cases, because of time and access limitations the rest of interviewees were sent the list of critical forces in advance and were asked to consider the relationship among them; and after that the model was calibrated at the start of the session and “what if” questions was asked.

14.6 PROPOSALS FOR FUTURE RESEARCH

Central to the research question in this thesis, are considerations of what institutions, interactions and driving forces are associated with the structure of UIC in Iran and how can these be modelled through a series of influence diagrams. Although it is also possible to analyze the effect of changing the rates of interaction of some key variables for UIC collaboration, such a quantitative modelling approach was not considered suited to the behavioural nature of many of the system elements e.g. trust and culture.

For future research, it also might be useful to monitor the actual situation of Iran in the future and compare it with the suggested policies and outcomes from the second and third scenarios to observe differences.

Another suggestion for future research would be considering the DSM in other countries to observe what would be the impact of changing policies in these countries.

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Appendix A:

1- Structure of the Global Competitiveness Index (GCI) 2008–2009

Source: World Economic Forum, (2008), The Global Competitiveness Index: Prioritizing the Economic Policy Agenda.
http://www.weforum.org/pdf/GCR08/Chapter 1.1.pdf

The complete details of GCI are provided in the following Table.

BASIC REQUIREMENTS **1st pillar: Institutions..25%** **A. Public institutions ....75%** 1. Property rights.........................20% 1.01 Property rights 1.02 Intellectual property protection1/2 2. Ethics and corruption..20% 1.03 Diversion of public funds 1.04 Public trust of politicians 3. Undue influence...............................20% 1.05 Judicial independence 1.06 Favouritism in decisions of government officials 4. Government inefficiency ....20% 1.07 Wastefulness of government spending 1.08 Burden of government regulation 1.09 Efficiency of legal framework 1.10 Transparency of government policymaking 5. Security..20% 1.11 Business costs of terrorism 1.12 Business costs of crime and violence 1.13 Organized crime 1.14 Reliability of police services **B. Private institutions ....25%** 1. Corporate ethics ....50% 1.15 Ethical behaviour of firms 2. Accountability......................................50% 1.16 Strength of auditing and reporting standards 1.17 Efficacy of corporate boards 1.18 Protection of minority shareholders' interests	**2nd pillar: Infrastructure..................................25%** **A. General infrastructure..50%** 2.01 Quality of overall infrastructure **B. Specific infrastructure ....50%** 2.02 Quality of roads 2.03 Quality of railroad infrastructure 2.04 Quality of port infrastructure 2.05 Quality of air transport infrastructure 2.06 Available seat kilometres (hard data) 2.07 Quality of electricity supply 2.08 Telephone lines (hard data) **3rd pillar: Macroeconomic stability......................25%** 3.01 Government surplus/deficit (hard data) 3.02 National savings rate (hard data) 3.03 Inflation (hard data)d 3.04 Interest rate spread (hard data) 3.05 Government debt (hard data) **4th pillar: Health and primary education ....25%** **A. Health...50%** 4.01 Business impact of malaria 4.02 Malaria incidence (hard data)e 4.03 Business impact of tuberculosise 4.04 Tuberculosis incidence (hard data)e 4.05 Business impact of HIV/AIDSe 4.06 HIV prevalence (hard data) 4.07 Infant mortality (hard data) 4.08 Life expectancy (hard data) **B. Primary education ....50%** 4.09 Quality of primary education 4.10 Primary enrolment (hard data) 4.11 Education expenditure (hard data)1/2

EFFICIENCY ENHANCERS

5th pillar: Higher education and training 17%

A. Quantity of education 33%
5.01 Secondary enrolment (hard data)
5.02 Tertiary enrolment (hard data)
4.11 Education expenditure (hard data)1/2

B. Quality of education 33%
5.03 Quality of the educational system
5.04 Quality of math and science education
5.05 Quality of management schools
5.06 Internet access in schools

C. On-the-job training 33%
5.07 Local availability of specialized research and training
services
5.08 Extent of staff training

6th pillar: Goods market efficiency 17%

A. Competition 67%

1. Domestic competition...
6.01 Intensity of local competition
6.02 Extent of market dominance
6.03 Effectiveness of anti-monopoly policy
6.04 Extent and effect of taxation1/2
6.05 Total tax rate (hard data)1/2
6.06 Number of procedures required to start a business
(hard data)g
6.07 Time required to start a business (hard data)
6.08 Agricultural policy costs

2. Foreign competition
6.09 Prevalence of trade barriers
6.10 Trade-weighted tariff rate (hard data)
6.11 Prevalence of foreign ownership
6.12 Business impact of rules on FDI
6.13 Burden of customs procedures
10.04 Imports as a percentage of GDP (hard data)

B. Quality of demand conditions................................33%
6.14 Degree of customer orientation
6.15 Buyer sophistication

7th pillar: Labour market efficiency....17%

A. Flexibility 50%
7.01 Cooperation in labour-employer relations
7.02 Flexibility of wage determination
7.03 Non-wage labour costs (hard data)
7.04 Rigidity of employment (hard data)
7.05 Hiring and firing practices
6.04 Extent and effect of taxation1/2
6.05 Total tax rate (hard data)1/2
7.06 Firing costs (hard data)

B. Efficient use of talent 50%
7.07 Pay and productivity
7.08 Reliance on professional management1/2
7.09 Brain drain
7.10 Female participation in labour force (hard data)

8th pillar: Financial market sophistication..17%

A. Efficiency 50%
8.01 Financial market sophistication
8.02 Financing through local equity market
8.03 Ease of access to loans
8.04 Venture capital availability
8.05 Restriction on capital flows
8.06 Strength of investor protection (hard data)

B. Trustworthiness and confidence............................50%
8.07 Soundness of banks
8.08 Regulation of securities exchanges
8.09 Legal rights index (hard data)

9th pillar: Technological readiness....17%

9.01 Availability of latest technologies
9.02 Firm-level technology absorption
9.03 Laws relating to ICT
9.04 FDI and technology transfer
9.05 Mobile telephone subscribers (hard data)
9.06 Internet users (hard data)
9.07 Personal computers (hard data)
9.08 Broadband Internet subscribers (hard data)

10th pillar: Market size 17%

A. Domestic market size.............75%
10.01 Domestic market size index (hard data)

B. Foreign market size 25%
10.02 Foreign market size index (hard data)

INNOVATION AND SOPHISTICATION FACTORS

11th pillar: Business sophistication 50%	**12th pillar: Innovation..50%**
A. Networks and supporting industries ....50% 11.01 Local supplier quantity 11.02 Local supplier quality 11.03 State of cluster development **B. Sophistication of firms' operations and strategy 50%** 11.04 Nature of competitive advantage 11.05 Value chain breadth 11.06 Control of international distribution 11.07 Production process sophistication 11.08 Extent of marketing 11.09 Willingness to delegate authority 7.08 Reliance on professional management1/2	12.01 Capacity for innovation 12.02 Quality of scientific research institutions 12.03 Company spending on R&D 12.04 University-industry research collaboration 12.05 Government procurement of advanced technology products 12.06 Availability of scientists and engineers 12.07 Utility patents (hard data) 1.02 Intellectual property protection1/2

2- Examples of countries in the different stage of transition

Factor driven economy (stage1)	Countries in transition from Stage 1 to 2	Efficiency-driven economies (stage2)	Countries in transition from Stage 2 to 3	Innovation-driven economies (stage3)
(Bangladesh, Chad, Egypt, Indonesia)	(Iran, Kuwait, Venezuela, China)	(Brazil, Malaysia, Algeria, Thailand, South Africa)	(Turkey, Taiwan, Croatia)	(United States, United Kingdom, Japan, Singapore)

Appendix B:

FOUR UNIVERSITIES CONSIDERED IN THIS STUDY

Sharif University of Technology	***Islamic Azad University***	***University of Tehran***	***Ferdowsi University of Mashhad***
This university is located in the capital city of Iran, Tehran, in which over 12 million people live and is the most important industrial city of Iran. So it's a right place for high-technical institutions such as *Sharif University*. The university has different aims; one important is to create a proper place for the students in order to instruct them in both practical and theoretical knowledge. The emphasis of this university is placed on the improvement of multi-disciplinary research. This university has 300 full-time faculty members, about 430 part-time members and about 8000 students. Several independent research centres are in this university which co-exist in the university system and have multi-disciplinary activities. This will give the researchers the opportunity and flexibility to conduct their research freely while creating the working relation between university and industry (Sharif University of Technology, 2009).	This is a non-profit, nongovernmental system of higher education which was established in 1982 to satisfy the increasing social needs for especial manpower and development. This university was approved by the Iranian parliament. It offers 66 courses of study and it has campuses in other country like England. The approximate number of the students is 650000; in this study we consider The Azad University of Mashhad which is one of the branches of Azad University. Azad university of Mashhad was established in 1982. Current students are about 20000, and have 400 academic staff. The liaison office of this university was established on 1993 and now it works under the supervision of university research department (Azad University of Mashhad, 2009).	"University of Tehran, is the oldest and largest scientific, educational and research centre of the country which is called the "Mother University" and the "Symbol of higher education of the country". This scientific centre is the entering gate of Iran into the new civilization. It is also considered as one of the pioneers of the society in important scientific, cultural, political and social affairs.....The history of the establishment of University in Iran dates back to the year 1851" (Tehran University, 2009). This university have initiated a specific division by the name of "Industry Clinic" to give support and consultation to industry completely free. This initiative was taken place by the support of Ministry of Industry and Mines (MIM). The initial evaluation about the structure of this university shows that the liaison office in this university is the subsidiary of university research department and including 4 departments which are: • Apprenticeship centre for students • Department of industrial contract • Department of development of small jobs • Department of intellectual property rights	The Ferdowsi University was founded in 1954 *in Mashhad. Mashhad* is the second biggest city in Iran with the population about 3 millions. *Ferdowsi University* is one of the biggest and most important universities in the northeast of Iran. This university has about 640 full-time faculty members and 15000 students. The initial evaluation of this university shows that the liaison office acts under the supervision of university research department. Most important departments which are mostly related to this office include (Ferdowsi University of Mashhad, 2009): • Representative of internship centres. • Department of intellectual property rights. • Apprenticeship centre for students

Sources:

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Sharif University of Technology, Available at www.sharif.ir, accessed on June 30, 2009
University of Tehran, Available at http://www.ut.ac.ir/en, accessed on June 30, 2009

Appendix C: Survey Questionnaires (University and Industry)

- **University Survey Questionnaire**

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<u>Please provide your details below:</u>
Contact Person:
University:
Faculty:
Email:

Doctoral Research on Iranian University-Industry Collaborations

Dear Contact Person,

I am currently conducting a survey on the promotion of **University-Industry collaborations** in Iran as the central part of my PhD research, if you are engaged with industry, or are part of a research group that has partnered with industry; or you may contact in the future, your participation in the survey would be greatly appreciated. All it requires is for you to complete the enclosed questionnaire. This should only take 30 minutes of your time.

Please be assured that the information you provide will remain strictly confidential. For your information, please note that all participants will be provided with a summary report and recommendations. I also enclose a letter from Dr Gerry Edgar, my principal supervisor at the University of Stirling, expressing his support for this study.

It is very important that you answer all the questions to ensure that your questionnaire can be included in the research.

Thank you very much for your time and your valuable contribution to the study.

Yours sincerely,

Omid Ali Kharazmi

PhD student, University of Stirling

University Questionnaire

University-Industry Collaboration

INSTRUCTIONS:

Please fill in the following questionnaire on the basis of the facts of your Institution and your analysis regarding the future (next 5 years) challenges of University-Enterprise-Government collaborations.

1- Please answer all questions. If no exact figures are available, please give the best estimate and make a note as a comment in the cell provided to you on the last form titled Comments and Clarifications.

2- The Questionnaire contains different type of questions and some questions allow the selection of more than one option (e.g. Q3 and Q4)

3- Please make tick mark in check boxes for selection of options.

Q1. Please indicate the ownership status of your institution.

( ) Public institution
( ) Private institution

Q2. Which discipline best represents the area of your activity?

( ) Medical Biotechnology
( ) Agricultural Biotechnology
( ) Electrical Engineering
( ) Mechanical Engineering
( ) Metallurgical engineering
( ) Molecular Biotechnology and genetic engineering
( ) Industrial Engineering

Q3. Formally, how would you describe (or characterize) your current position?

( ) Administrative
( ) Researcher
( ) Senior Researcher
( ) Member of technology liaison office

Q4. In which type or types of University-Industry technology transfer have you had an experience?

( ) Conference publication
( ) Exchange programme
( ) Consultancy and technical service provision
( ) Joint venture of R&D
( ) Cooperative R&D agreement
( ) Licensing
( ) Contract research
( ) Intermediary involvement (e.g. Science Park, Research Park, Technology Park or Incubators)
( ) Spin-off company formation
( ) None (If this is your choice then ignore Q5)

Q5.What is the impact of the following factors on increasing the likelihood that the relationship with industry will be renewed at the end of the current contract?

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	No Impact 1	2	3	4	5	6	Very High Impact 7
• Degree of satisfaction from Company's regulations	( )	( )	( )	( )	( )	( )	( )
• Gain and the usage of research	( )	( )	( )	( )	( )	( )	( )
• Trust	( )	( )	( )	( )	( )	( )	( )
• Accessibility of industry funding	( )	( )	( )	( )	( )	( )	( )
• Commitment	( )	( )	( )	( )	( )	( )	( )
• Overall financial return for university	( )	( )	( )	( )	( )	( )	( )

Q6. Please specify the likely impact the following factors may have on motivating the individuals within universities to collaborate with industry.

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	No Impact 1	2	3	4	5	6	Very High Impact 7
• Existence of an efficient institutional policy on Intellectual Property Rights (IPR) for universities that consider issues relating to IP ownership with collaborative research programme and/or other contractual agreements with various partners	( )	( )	( )	( )	( )	( )	( )
• Clear institutional policy on royalty-sharing and the inclusion of any benefits to the inventor/researcher or his/her department	( )	( )	( )	( )	( )	( )	( )
• Evaluating faculty members according to the extent of their contributions to the university-industry collaboration processes	( )	( )	( )	( )	( )	( )	( )
• Enhance researcher's practical knowledge	( )	( )	( )	( )	( )	( )	( )
• Feeling a sense of accomplishment when working with industry	( )	( )	( )	( )	( )	( )	( )
• Funding for future research	( )	( )	( )	( )	( )	( )	( )
• Taking new knowledge to practical application	( )	( )	( )	( )	( )	( )	( )
• Trust	( )	( )	( )	( )	( )	( )	( )
• Modify reward systems to reward technology transfer activities (e.g. when it shifts based on academic favour in royalty and equity distribution formula)	( )	( )	( )	( )	( )	( )	( )

Q7. Please specify the likely impact the following factors may have on motivating universities to collaborate with industry.

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	No Impact 1	2	3	4	5	6	Very High Impact 7
• Increasing budget limitations for the academia, which leads to continues search for alternative funds, including research and development for and with industry	( )	( )	( )	( )	( )	( )	( )
• Integration into the labour market for graduates	( )	( )	( )	( )	( )	( )	( )
• Recruitment and retention of qualified staff from industry	( )	( )	( )	( )	( )	( )	( )
• Access to updated technical knowledge and good practices	( )	( )	( )	( )	( )	( )	( )
• Access to industrial information	( )	( )	( )	( )	( )	( )	( )
• Access to networks of knowledge creation and utilization	( )	( )	( )	( )	( )	( )	( )
• Access to applied knowledge, with positive effect on the academic research and teaching	( )	( )	( )	( )	( )	( )	( )
• Scope of university-industry collaboration which upgrades university ranking among other universities	( )	( )	( )	( )	( )	( )	( )
• Higher access to government funding if cooperating more with industry (e.g. increasing allocated budget by government or availability of government schemes for collaboration)	( )	( )	( )	( )	( )	( )	( )
• Royalty payments to universities	( )	( )	( )	( )	( )	( )	( )
• Creating entrepreneurial culture in universities	( )	( )	( )	( )	( )	( )	( )

Q8. Please indicate the potential impact the following factors may have to enhance (Promote) university-industry collaboration.

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	No Impact 1	2	3	4	5	6	Very High Impact 7
• The existence of an efficient national policy framework with a clear set of rules concerning the ownership of IP rights and enforcement laws	( )	( )	( )	( )	( )	( )	( )
• Having an efficient programme which includes the mobility of people in University-Industry collaboration	( )	( )	( )	( )	( )	( )	( )
• Having a specific patent ownership and royalty-sharing formulas between researchers, the researchers' department, the technology licensing offices and the university itself	( )	( )	( )	( )	( )	( )	( )
• The existence of an efficient venture capital	( )	( )	( )	( )	( )	( )	( )
• Efficient cluster formation	( )	( )	( )	( )	( )	( )	( )
• Higher degree of intermediary involvement(e.g. technology and science parks, incubator facilities)	( )	( )	( )	( )	( )	( )	( )
• Efficient government programme to enhance awareness/training for entrepreneurial activities	( )	( )	( )	( )	( )	( )	( )
• Existence of efficient methods for conveying knowledge between universities and industry which enables industry to use the technology completely (e.g. availability of written reports, site visits by industry, plant visits by researcher)	( )	( )	( )	( )	( )	( )	( )
• Availability of active research consortia	( )	( )	( )	( )	( )	( )	( )

Q9. Please specify the likely impact the following factors may have on impeding university-industry collaboration.

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	No Impact 1	2	3	4	5	6	Very High Impact 7
• An industrial culture which is based on profit maximization	( )	( )	( )	( )	( )	( )	( )
• Cultural differences in terms of secrecy and search for competitive advantage in industry side vs. dissemination of knowledge and sharing of results	( )	( )	( )	( )	( )	( )	( )
• Working with industry is challenging (time orientation differences)	( )	( )	( )	( )	( )	( )	( )
• Difficulties in agreeing a technology transfer deal	( )	( )	( )	( )	( )	( )	( )
• Speed of negotiation of technology transfer	( )	( )	( )	( )	( )	( )	( )
• Financing the technology transfer deal	( )	( )	( )	( )	( )	( )	( )
• Poor marketing/technical/negotiation skills of people in Technology Transfer Offices (TTOs)	( )	( )	( )	( )	( )	( )	( )
• Bureaucracy and inflexibility of university administrators	( )	( )	( )	( )	( )	( )	( )
• Insufficient resources devoted to technology transfer by universities (e.g. weak R&D facilities)	( )	( )	( )	( )	( )	( )	( )
• Lack of understanding of industry norms and environment by university people	( )	( )	( )	( )	( )	( )	( )
• Lack of understanding of university norms and environment by industrial people	( )	( )	( )	( )	( )	( )	( )
• Low degree of firms absorptive capacity on knowledge transfer	( )	( )	( )	( )	( )	( )	( )
• Brain drain	( )	( )	( )	( )	( )	( )	( )
• Instability of government regulations regarding university-industry collaborations	( )	( )	( )	( )	( )	( )	( )

Q10. Please indicate the potential impact the following TTOs' activities may have to promote university-industry collaboration.

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	No Impact 1	2	3	4	5	6	Very High Impact 7
• Identifying technologies with a commercial potential	( )	( )	( )	( )	( )	( )	( )
• Assisting researchers to patent their inventions	( )	( )	( )	( )	( )	( )	( )
• Packaging the technology appropriately so as to attract industry	( )	( )	( )	( )	( )	( )	( )
• Developing a strategy to market technology	( )	( )	( )	( )	( )	( )	( )
• Leading the license negotiations with potential licensees	( )	( )	( )	( )	( )	( )	( )
• Sensitizing researchers and students on the existence of the office	( )	( )	( )	( )	( )	( )	( )
• Managing apprenticeship programme with industry	( )	( )	( )	( )	( )	( )	( )
• Recruiting mixture of scientific, lawyers and businessmen in the office	( )	( )	( )	( )	( )	( )	( )
• Support for the creation of spin off companies or other forms of commercialization	( )	( )	( )	( )	( )	( )	( )

Q11. Please specify confident you feel about the direction, pace or likelihood of occurrence of the future course of the following factors. (Please consider the next 5 years):
1=Certain, 2=Fairly Certain, 3=Somewhat Certain, 4=Unsure, 5=Somewhat Uncertain, 6=Fairly Uncertain, 7=Uncertain

	Certain 1	2	3	4	5	6	Uncertain 7
• Existence of an efficient national policy framework with a clear set of rules concerning the ownership of IP rights and enforcement laws	( )	( )	( )	( )	( )	( )	( )
• Existence of efficient institutional policy regarding IP issues	( )	( )	( )	( )	( )	( )	( )
• Existence of an efficient programme which includes mobility of people in U-I collaboration	( )	( )	( )	( )	( )	( )	( )
• Availability of an efficient reward systems for inventor/researcher	( )	( )	( )	( )	( )	( )	( )
• Existence of an efficient institutional policy on royalty-sharing and patent ownership for researcher	( )	( )	( )	( )	( )	( )	( )
• Availability of additional government funding for universities which collaborate with companies in innovative activities (e.g. increasing allocated budget by government or availability of government schemes for collaboration)	( )	( )	( )	( )	( )	( )	( )
• Increasing amount of royalty payments to universities	( )	( )	( )	( )	( )	( )	( )
• Efficient cluster formation	( )	( )	( )	( )	( )	( )	( )
• Proactive intermediary organization involvement (e.g. Technology Park) in University-Industry collaboration	( )	( )	( )	( )	( )	( )	( )
• Existence of appropriate mixture of marketing/technical/negotiation skills in Technology Transfer Offices	( )	( )	( )	( )	( )	( )	( )
• Decreasing degree of bureaucracy and inflexibility of university administrators	( )	( )	( )	( )	( )	( )	( )
• Commitment	( )	( )	( )	( )	( )	( )	( )
• Enhancing level of trust	( )	( )	( )	( )	( )	( )	( )
• Higher accessibility of industry funding	( )	( )	( )	( )	( )	( )	( )

	Certain						Uncertain
	1	2	3	4	5	6	7
• Availability of highly qualified personnel in industry for universities	( )	( )	( )	( )	( )	( )	( )
• Availability of efficient methods for evaluating faculty members according to the extent of their contribution in university-industry collaboration process	( )	( )	( )	( )	( )	( )	( )
• Integration into the labour market for graduated students	( )	( )	( )	( )	( )	( )	( )
• Equipped universities and availability of R&D facilities	( )	( )	( )	( )	( )	( )	( )
• Enhancing firms absorptive capacity on knowledge transfer	( )	( )	( )	( )	( )	( )	( )
• Decreasing cultural differences between universities and industry	( )	( )	( )	( )	( )	( )	( )
• Existence of efficient venture capital and investors	( )	( )	( )	( )	( )	( )	( )
• High support of Technology Transfer Office for the creation of Spin-off from universities	( )	( )	( )	( )	( )	( )	( )
• Efficient policy toward brain drain	( )	( )	( )	( )	( )	( )	( )
• Efficient government programme to enhance awareness/training for entrepreneurial activities	( )	( )	( )	( )	( )	( )	( )
• Availability of active research consortia	( )	( )	( )	( )	( )	( )	( )
• Existence of efficient methods for conveying knowledge between universities and industry which enables industry to use the technology completely	( )	( )	( )	( )	( )	( )	( )
• Availability of appropriate mixture of scientific, lawyers and businessmen in the university technology transfer offices	( )	( )	( )	( )	( )	( )	( )
• Stability of government regulations regarding university-industry collaborations	( )	( )	( )	( )	( )	( )	( )

<u>Comments and clarifications by the respondent:</u>

Please feel free to give your opinions about the ways that these three organizations (University, Industry and government) can collaborate with each other more.

Industry Questionnaire

University-Industry Collaboration

INSTRUCTIONS:
Please fill in the following questionnaire on the basis of the facts of your Institution and your analysis regarding the future (next 5 years) challenges of University-Enterprise-Government collaboration.
1- Please answer all questions. If no exact figures are available, please give the best estimate and make a note as a comment in the cell provided to you on the last form titled Comments and Clarifications.
2- The Questionnaire contains different type of questions and some questions allow the selection of more than one option (e.g. Q6)
3- Please make tick mark in check boxes for selection of options.

Q1. Please indicate the ownership status of your company.

( ) National Public company
( ) National Private company
( ) National Public/Private company

Q2. Please indicate the number of Employees working in your company.

( ) < 50 Employees
( ) Between 50 and 250 employees
( ) > 250 employees

Q3. Which industrial category best describes your area of your activity?

() Automotive related
() Biotechnology related

Q4. Formally, how would you describe (or characterize) your current position?

( ) Senior Management
( ) R&D Manager

Q5. Amount of R&D expenditures financed by your company as a percentage of Income.

( ) Up to 0.2 %
( ) 0.21% to 0.4%
( ) 0.41% to 0.6%
( ) 0.61% to 0.8%
( ) 0.81% to 1%
( ) More than 1%
( ) Not sure

Q6. In which type or types of University-Industry technology transfer have you had an experience?

( ) Conference publication
( ) Exchange programme
( ) Consultancy and technical service provision
( ) Joint venture of R&D
( ) Cooperative R&D agreement
( ) Licensing
( ) Contract research
( ) Intermediary involvement (e.g. Science park, Research park, Technology Park or Incubators)
( ) Spin-off company formation
( ) None (If this is your choice then ignore Q7)

Q7. What is the impact of the following factors on increasing the likelihood that the relationship with university will be renewed at the end of the current contract?

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	No Impact 1	2	3	4	5	6	Very High Impact 7
• Degree of satisfaction from university's regulations	( )	( )	( )	( )	( )	( )	( )
• Gain and the usage of research	( )	( )	( )	( )	( )	( )	( )
• Trust	( )	( )	( )	( )	( )	( )	( )
• Accessibility of university technology	( )	( )	( )	( )	( )	( )	( )
• Commitment	( )	( )	( )	( )	( )	( )	( )
• Impact on sales	( )	( )	( )	( )	( )	( )	( )

Q8. Please specify the likely impact the following factors may have on motivating your company to collaborate with universities.

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	No Impact 1	2	3	4	5	6	**Very High Impact** 7
• Increasing your general technical awareness and/or capabilities in the research and development area	( )	( )	( )	( )	( )	( )	( )
• Accelerate or improve your existing research project	( )	( )	( )	( )	( )	( )	( )
• Improving your public image in the society in which you operate	( )	( )	( )	( )	( )	( )	( )
• Increasing the qualification level of our employees	( )	( )	( )	( )	( )	( )	( )
• To improve sales and profitability	( )	( )	( )	( )	( )	( )	( )
• To access and recruit highly qualified personnel from universities	( )	( )	( )	( )	( )	( )	( )
• Existence of an efficient institutional policy on Intellectual Property Rights (IPR) for universities that consider issues relating to IP ownership with collaborative research programme and/or other contractual agreements with various partner	( )	( )	( )	( )	( )	( )	( )
• Access to new technologies and process that allow achievement of competitive advantages	( )	( )	( )	( )	( )	( )	( )
• Access to the equipped university physical facilities	( )	( )	( )	( )	( )	( )	( )
• higher access to government funding When collaborate with universities (e.g. availability of government schemes for collaboration)	( )	( )	( )	( )	( )	( )	( )
• Creation of innovation culture in your company which increase your firm's technical capability	( )	( )	( )	( )	( )	( )	( )
• Ability to recruit talented students	( )	( )	( )	( )	( )	( )	( )
• Availability of tax credit if cooperating with universities	( )	( )	( )	( )	( )	( )	( )
• Increasing embargo imposed by West which limits the accessibility of technology from abroad	( )	( )	( )	( )	( )	( )	( )
• Improving political situation and Iranian entry to the WTO which requires adapting new technologies in order to survive	( )	( )	( )	( )	( )	( )	( )
• Trust	( )	( )	( )	( )	( )	( )	( )

Q9. Please indicate the potential impact the following factors may have to enhance (Promote) university-industry collaboration.

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	No Impact						**Very High Impact**
	1	**2**	**3**	**4**	**5**	**6**	**7**
• The existence of an efficient national policy framework with a clear set of rules concerning the ownership of IP rights and enforcement laws	( )	( )	( )	( )	( )	( )	( )
• Efficient programme which include mobility of people in University-Industry collaboration	( )	( )	( )	( )	( )	( )	( )
• The existence of an efficient venture capital	( )	( )	( )	( )	( )	( )	( )
• Efficient cluster formation	( )	( )	( )	( )	( )	( )	( )
• Higher degree of intermediary involvement (e.g. Technology and Science Parks, Incubator facilities)	( )	( )	( )	( )	( )	( )	( )
• Efficient government programme to enhance awareness/training for entrepreneurial activity	( )	( )	( )	( )	( )	( )	( )
• Effective privatisation and smaller role for the government in the economy	( )	( )	( )	( )	( )	( )	( )
• Existence of efficient methods for conveying knowledge between universities and industry which enables industry to use the technology completely (e.g. availability of written reports, site visits by industry, plant visits by researcher)	( )	( )	( )	( )	( )	( )	( )
• Availability of active research consortia	( )	( )	( )	( )	( )	( )	( )

Q10. Please specify the likely impact the following factors may have on impeding university-industry collaboration.

1=No Impact, 2=Slightly Low Impact, 3=Low Impact, 4= Medium Impact, 5=Slightly High Impact, 6= High Impact, 7=Very High Impact

	1 (No Impact)	2	3	4	5	6	7 (Very High Impact)
• An industrial culture which is based on profit maximization	( )	( )	( )	( )	( )	( )	( )
• Cultural differences in terms of secrecy and search for competitive advantage in industry side vs. dissemination of knowledge and sharing of results	( )	( )	( )	( )	( )	( )	( )
• Working with university is challenging (Time orientation differences)	( )	( )	( )	( )	( )	( )	( )
• Difficulties in agreeing a technology transfer deal	( )	( )	( )	( )	( )	( )	( )
• Speed of negotiation of technology transfer	( )	( )	( )	( )	( )	( )	( )
• Financing the technology transfer deal	( )	( )	( )	( )	( )	( )	( )
• Poor marketing/technical/negotiation skills of people in Technology Transfer offices (TTOs)	( )	( )	( )	( )	( )	( )	( )
• Bureaucracy and inflexibility of university administrators	( )	( )	( )	( )	( )	( )	( )
• Insufficient resources devoted to technology transfer by universities (e.g. weak R&D facilities)	( )	( )	( )	( )	( )	( )	( )
• Lack of understanding of industry norms and environment by university people	( )	( )	( )	( )	( )	( )	( )
• Lack of understanding of university norms and environment by industrial people	( )	( )	( )	( )	( )	( )	( )
• Low degree of firms absorptive capacity on knowledge transfer	( )	( )	( )	( )	( )	( )	( )
• Brain drain	( )	( )	( )	( )	( )	( )	( )
• Instability of government regulations regarding university-industry collaboration	( )	( )	( )	( )	( )	( )	( )

Q11. Please specify confident you feel about the direction, pace or likelihood of occurrence of the future course of the following factors. (Please consider the next 5 years):

1=Certain, 2=Fairly Certain, 3=Somewhat Certain, 4=Unsure, 5=Somewhat Uncertain, 6=Fairly Uncertain, 7=Uncertain

	Certain 1	2	3	4	5	6	Uncertain 7
• Existence of an efficient national policy framework with a clear set of rules concerning the ownership of IP rights and enforcement laws	( )	( )	( )	( )	( )	( )	( )
• Existence of an efficient institutional policy regarding IP issues	( )	( )	( )	( )	( )	( )	( )
• Availability of additional government funding for companies which collaborate with universities in innovative activities (e.g. availability government schemes for collaboration)	( )	( )	( )	( )	( )	( )	( )
• Effective government policy which encourages university-industry cooperation (e.g. Tax credit)	( )	( )	( )	( )	( )	( )	( )
• Efficient cluster formation	( )	( )	( )	( )	( )	( )	( )
• Proactive intermediary organization involvement (e.g. Technology Park) in university-industry collaboration	( )	( )	( )	( )	( )	( )	( )
• Existence of appropriate mixture of marketing/technical/negotiation skills in Technology Transfer Offices	( )	( )	( )	( )	( )	( )	( )
• Decreasing degree of bureaucracy and inflexibility of university administrators	( )	( )	( )	( )	( )	( )	( )
• Commitment	( )	( )	( )	( )	( )	( )	( )
• Enhancing level of trust	( )	( )	( )	( )	( )	( )	( )
• Higher accessibility of university technology	( )	( )	( )	( )	( )	( )	( )
• Availability of highly qualified personnel in universities for industry	( )	( )	( )	( )	( )	( )	( )
• Ability of universities to provide innovative technologies for companies and create innovation culture	( )	( )	( )	( )	( )	( )	( )
• Integration into the labour market for graduated students	( )	( )	( )	( )	( )	( )	( )

	Certain 1	2	3	4	5	6	Uncertain 7
• Equipped universities and availability of R&D facilities	( )	( )	( )	( )	( )	( )	( )
• Political stability and decreasing embargo imposed by Western Governments	( )	( )	( )	( )	( )	( )	( )
• Enhancing firms absorptive capacity on knowledge transfer	( )	( )	( )	( )	( )	( )	( )
• Iranian entry to the WTO, improving political situation and the importance of adapting new technologies by companies	( )	( )	( )	( )	( )	( )	( )
• Existence of active research consortia	( )	( )	( )	( )	( )	( )	( )
• Effective privatisation strategy and a smaller role for the government in the economy	( )	( )	( )	( )	( )	( )	( )
• Efficient policy toward Brain drain	( )	( )	( )	( )	( )	( )	( )
• Efficient government programme to enhance awareness/training for entrepreneurial activities	( )	( )	( )	( )	( )	( )	( )
• Decreasing cultural differences between universities and industry	( )	( )	( )	( )	( )	( )	( )
• Existence of efficient venture capital and investors	( )	( )	( )	( )	( )	( )	( )
• Ability of universities in providing technologies that give your company a competitive advantage	( )	( )	( )	( )	( )	( )	( )
• Existence of efficient methods for conveying knowledge between universities and industry which enables industry to use the technology completely	( )	( )	( )	( )	( )	( )	( )
• Efficient programme which includes mobility of people in U-I collaboration	( )	( )	( )	( )	( )	( )	( )
• Stability of government regulations regarding university-industry collaboration	( )	( )	( )	( )	( )	( )	( )
• Ability of universities to increase your general technical awareness in R&D	( )	( )	( )	( )	( )	( )	( )

<u>**Comments and clarifications by the respondent:**</u>

Please feel free to give your opinions about the ways that these three organizations (University, Industry and Government) can collaborate with each other more.

Appendix D: Interview Instruments (University, Industry, Government)

Omid Ali Kharazmi
Room 3A49, Department of Management
University of Stirling, UK
Post Code: FK9 4LA
Email: o.a.kharazmi@stir.ac.uk
Tel: 0044- 7927402721

Please provide your details below:
Contact Person:
University:
Faculty:
Email:

Doctoral Research on Iranian University-Industry Collaborations

Dear Contact Person,

I am currently conducting a survey on the promotion of **University-Industry collaborations** in Iran as the central part of my PhD research, if you are engaged with industry, or are part of a research group that has partnered with industry; your participation in the survey would be greatly appreciated. All it requires is for you to review the enclosed instructions. This should take 45 minutes of your time.

Please be assured that the information you provide will remain strictly confidential. For your information, please note that all participants will be provided with a summary report and recommendations. I also enclose a letter from Dr Gerry Edgar, my principal supervisor at the University of Stirling, expressing his support for this study.

It is very important that you identify all the possible connections among these forces to ensure that your model can be included in the research.

Thank you very much for your time and your valuable contribution to the study.

Yours sincerely,

Omid Ali Kharazmi

PhD student, University of Stirling

- **INSTRUCTIONS:**

<u>Part 1: Constructing Dynamic Systems Model (DSM):</u>

This section was common for universities, industry and government's interview instrument. Forces which were included in relevant interview instrument for each of these organizations are shown in parentheses.

Constructing the DSM
The following categories are the list of subsystems for constructing a model which will be used as a platform for developing three scenarios for the future of university-industry collaboration (UIC) in Iran. Please identify the possible relationship between the forces in each specific category and also among categories. On the day of interview a model based on these connections will be constructed and after that a series of "what if" questions will be asked to identify possible effect of changing a direction of series of forces on the whole system. Please feel free to add any factor to each of these five sub-categories that you may find crucial and explain a possible effect of identified factors on the whole system. Furthermore, please (wherever applicable) indicate a likely impact of national culture on UIC performance by giving an example and highlighting the importance of this factor.

A- Organizational Structures to Coordinate and Support Partnerships
B- Asset Management
C- Leadership and Culture
D- Organizational Capabilities
E- Creation of an Enabling Environment by Government

From different organizational perspective (university, industry and government) these component factors include:

A- Organizational structures to coordinate and support partnerships:

- Efficiency of institutional policy on IP rights in universities that consider issues relating to IP ownership with collaborative research programme and/or other contractual agreements with various partners (please specify the likely impact of this factor on motivation of individual within universities to collaborate with industry) (university, government)
- Efficiency of institutional policy on IP rights in universities that consider issues relating to IP ownership with collaborative research programme and/or other contractual agreements with various partners (please specify the likely impact of this factor on motivation of industry to collaborate with universities) (industry, government)
- Efficiency of institutional policy on royalty sharing (likely impact on motivation of individual within universities to collaborate with industry) (university, government)
- Efficiency of methods for conveying knowledge between universities and industry (e.g. availability of written reports, site visits by industry, plant visits by researcher) (Likely impact on UIC performance) (university, industry)

- Availability of programme which evaluate faculty members based on their extent of relations with industry (likely impact on motivation of individual within universities to collaborate with industry) (university, government)
- The structure of technology transfer offices in universities; recruiting mixture of skills including scientific, lawyers and businessmen in the office (Likely impact on UIC performance) (university, government)
- Degree of bureaucracy and inflexibility of university administrators (Likely impact on UIC performance) (university, industry)
- Efficiency of programmes which includes mobility of people between partners (Likely impact on UIC performance) (university, industry, government)

B- Asset management:

- Status of reward system to reward technology transfer activities e.g. degree that it shifts based on academic favour in royalty and equity distribution formula (likely impact on motivation of individual within universities to collaborate with industry) (university)
- Availability of various skills of the people in technology transfer offices (TTOs) e.g. marketing and negotiation experts (Likely impact on UIC performance) (university, industry, government)
- TTOs' Spin-off creation support strategy (Likely impact on UIC performance) (university)
- Strategy of TTOs to market the technology (Likely impact on UIC performance) (university)
- TTOs activities to identify technology with commercial potential (Likely impact on UIC performance) (university)
- Appropriateness of TTOs' activities to package the technology (Likely impact on UIC performance) (university)
- Ability to recruit talented students (Likely impact on motivation of companies to collaborate with universities) (industry, government)
- Integration into the labour market for graduated students (Likely impact on motivation of universities to collaborate with industry) (university. government)
- Amount of royalty payments to universities (Likely impact on the degree of motivation of university to collaborate with industry) (university, government)
- Amount of additional funding for individual future research (Likely impact on the degree of motivation of individual within universities to collaborate with industry) (university, government)

C- Leadership and culture:

- Degree of trust formation between partners (Likely impact on the motivation of individual within universities to collaborate with industry) (university, government)
- Degree of trust formation between partners (Likely impact on the motivation of industry to collaborate with universities) (industry, government)
- Degree of trust formation between partners (likely impact on the probability of renewing contract in the future) (university, industry)
- Degree of commitment between partners (likely impact on the probability of renewing contract in the future) (university, industry)

- Degree of cultural differences in university-industry collaboration (time orientation differences) (Likely impact on UIC performance) (university, industry, government)
- Degree of cultural differences in university-industry collaboration (secrecy vs. dissemination) (Likely impact on UIC performance) (university, industry, government)
- Degree of cultural differences in university-industry collaboration (profit maximization) (Likely impact on UIC performance) (university, government)
- Degree of lack of understanding of industry norms by university people (Likely impact on UIC performance) (industry, university, government)
- Degree of lack of understanding of university norms by industrial people (likely impact on UIC performance) (university, government)
- Please specify the likely impact of the degree of cultural differences between partners on the degree of trust formation between partners (university, industry, government)
- Please specify the likely impact of the degree of understanding of partner norms on the degree of trust formation between partners (university, industry, government)
- Please specify the likely impact of regulations and rules regarding UIC on trust formation (by giving an example) (university, industry, government)

D- Organizational capabilities:

- Level of university access to applied knowledge with positive impact on research and teaching (Likely impact on motivation of universities to collaborate with industry) (university)
- Probability of generating entrepreneurial culture in universities (Likely impact on motivation of universities to collaborate with industry) (university)
- Level of firm's capabilities in R&D (Likely impact on motivation of companies to collaborate with universities) (industry)
- Status of qualification level of employees in companies (Likely impact on motivation of companies to collaborate with universities) (industry)
- Degree of generating innovation culture in companies (Likely impact on motivation of companies to collaborate with universities) (industry)
- Degree of firms' absorptive capacity on knowledge transfer (Likely impact on UIC performance) (industry, university, government)
- Degree of achieving competitive advantage for companies (Likely impact on motivation of companies to collaborate with universities) (industry)
- Ability of university to improve sales and profitability of industry (Likely impact on motivation of companies to collaborate with universities) (industry)
- Performance of research consortia and other similar kind of mechanisms for collaboration which require higher level of interaction between partners e.g. R&D contract or joint activities (Likely impact on UIC performance) (university, industry, government)
- Please specify the likely impact of the level of performance of research consortia and other similar kind of mechanisms for collaboration on previous factors in this sub-system. (university, industry, government)

E- Creation of an enabling environment by government:

- Degree of access to government funding when collaborate with industry (Likely impact on motivation of universities to collaborate with industrial partner) (university, government) (e.g. by changing university allocated budget by government)
- Degree of access to government funding when collaborate with the other partner (Likely impact on motivation of universities and industry to collaborate with each other) (university, industry, government) (e.g. availability of government schemes for collaboration)

- Efficiency of reward and incentive systems for innovative firms (Likely impact on motivation of companies to collaborate with universities) (industry, government)
- Degree of stability of government regulations regarding U-I collaborations (Likely impact on UIC performance and related activities) (university, industry, government)
- Efficiency of national policy on IP rights and enforcement laws (Likely impact on UIC performance) (university, industry, government)
- Efficiency of venture capital (Likely impact on UIC performance; status of cluster formation and favourability of entrepreneurial environment) (university, industry, government)
- Performance of intermediary agents like science and technology parks and incubators (Likely impact on UIC performance) (university, industry, government)
- Status of cluster formation and favourability of entrepreneurial environment (Likely impact on UIC performance) (university, industry, government)
- UIC performance (Likely impact on Status of cluster formation and favourability of entrepreneurial environment (university, industry, government)
- Status of brain drain (Likely impact on UIC performance) (university, industry, government)
- Degree of efficiency of privatisation policy (Likely impact on UIC performance) (industry, government)
- Degree of government monopolies in market (Likely impact on degree of efficiency of privatisation policy) (industry, government)
- Degree of government monopolies in market and degree of efficiency of privatisation policy (Likely impact on degree of competition in the country) (industry, government)
- Degree of competition (Likely impact on status of cluster formation and favourability of entrepreneurial environment) (industry, government)
- Degree of embargos imposed (Likely impact on motivation of companies to collaborate with universities) (industry, government)
- Political situation status and probability of entry to the WTO (Likely impact on motivation of companies to collaborate with universities) (industry, government)
- Efficiency of government programmes to enhance awareness/training for entrepreneurial activities (Likely impact on UIC performance) (university, industry, government)
- Degree of university autonomy from the government (Likely impact on UIC performance) (university, government)
- Please specify the likely impact of status of cluster formation and favourability of entrepreneurial environment on the status of brain drain (university, industry, government)
- Please specify the likely impact of level of performance of intermediary agents on status of cluster formation and favourability of entrepreneurial environment (university, industry, government)
- Please specify the likely impact of effectiveness of IPR policy and enforcement laws on favourability of entrepreneurial environment and status of cluster formation (university, industry, government)

Connection between sub-systems:

- Please specify the likely impact of level of performance of research consortia and other similar kind of mechanisms for collaboration on the degree of trust between partners (university, industry, government)
- Please specify the likely impact of level of performance of intermediary agents on the degree of trust between partners (university, industry, government)
- Please specify the likely impact of level of performance of research consortia and other similar kind of mechanisms for collaboration on the amount of royalty payments to university, integration into the labour market for graduated students, amount of additional funding for individual's future research (university, government) and ability to recruit talented students (industry, government)

Part 2: Interview Questions (What-if questions)

University's Interview Instrument

University-Industry Collaborations

Section 1: Background of your Institution:

Q1. Please indicate the ownership status of your institution.

( ) Public institution
( ) Private institution

Section 2: Respondent Background

Q2. Which discipline best represents the area of your activity?

Q3. Formally, how would you describe (or characterize) your current position?

( ) Administrative
( ) Researcher
( ) Senior Researcher
( ) Member of technology transfer office

Section 3: Constructing Dynamic Systems Model (DSM) and developing first scenario scripts

1- **Developing first scenario scripts by asking respondents the current status of each force in the DSM and assuming that the current situation remains unchanged for the next 15 years.**

Section 4: Scenario-related Questionnaire

INSTRUCTIONS:

Please answer the following questions on the basis of the facts of your Institution and your analysis regarding the future (next 15 years) challenges of University-Enterprise-Government collaborations.
(**S2**= To be asked for the second scenario); (**S3**= To be asked for the third scenario)

In order to develop the second and third scenarios, please assume that in scenario 2, apart from its new direction of forces, the systems model will have all features of the current state. Furthermore please assume that in scenario 3, apart from its new direction of forces, this scenario includes all other changes in direction of forces proposed for scenario 2.

A- Organizational structures to coordinate and support partnerships:

1- What do you think will happen if a programme which includes mobility of people in university-industry collaboration is encouraged? **(University, Industry, Government) (S3)**

- Mobility of star scientists from universities to the industry
- University researchers have part-time jobs in industry in order to learn, experience and observe
- Industry people work in universities as lecturers
- Joint research activities
- Spin-off companies from universities

2- What will happen if universities do the followings: **(University, Industry, Government) (S2)**

- develops efficient guidelines for the management and exploitation of intellectual property rights in universities that consider issues relating to IP ownership with collaborative research programme and/or other contractual agreement with various partners?
- design clear institutional policy on royalty-sharing and the inclusion of benefits for researcher/inventor or his/her department

3- If universities and industry design efficient methods for conveying knowledge (tacit and explicit) between universities and industry, what will be the impact of this on the usage of the technology by industry? (E.g. increasing Joint research activities, availability of written reports, site visits by industry, plant visits by researchers). **(University, Industry) (S3)**

4- If universities decrease the high degree of bureaucracy and inflexible procedures, what will happen? **(University, Industry) (S3)**

5- What if universities change promotion and tenure decisions (which previously was based on publications and research grants) and considers degree of academics involvement in university- industry collaboration, as a score for promotion? **(University, Government) (S3)**

6- What if technology transfer offices change their structure and recruit multidisciplinary team including (legal, IP, business development, financial experts) in order to promote UIC? **(University, Government) (S2)**

B- Asset management:

7- If technology transfer offices gather all the necessary skills (marketing, technical, negotiation) and operate on an appropriate scale what do you think will happen? **(University, Industry, Government) (S2)**

8- What if universities and especially technology transfer offices increase their support for creation of spin-off companies from universities? **(University) (S3)**

9- What if TTOs do the following activities? **(University) (S2)**

- Develop a strategy to market the technology
- Identifying technologies with a commercial potential

- Packaging the technology appropriately to attract industry

10- What if universities change their financial reward system to reward technology transfer activities which is shifted based on academic favour in the royalty and equity distribution formula. (This refers to the split in licensing or equity income among stakeholders within universities). Please specify the likely impact on motivating individual within universities to collaborate with industry partners **(University) (S2)**.

C- Leadership and culture:

11- What will be the effect of the following science and technology policy on trust formation (contractual trust- competence trust and goodwill trust) if government employs instruments that involve an intermediary institution to bring together universities and firms?
(Government will provide financial and developmental assistance for firms to undertake R&D projects in collaboration with a university and encourage them for repeating relationships between the same partners) (CCG programme) **(University, Industry, Government) (S3)**

12- What if universities and industry design specific programmes to enhance level of their commitment when collaborating with other partners? E.g. increase senior management involvement in the corporate-university partnerships **(University, Industry) (S3)**.

D- Organizational capabilities:

13- What if universities in Iran create active research consortia to help fund research? (companies pay membership fees to join these consortia and they expect benefits in terms of access to research)
(University, Industry, Government) (S3)

E- Creation of an enabling environment by government:

14- What will happen if the Government promotes programme for transferring knowledge between university and industry?

Government programme which is funded by the number of public sectors agencies (the sponsors) with the policy and administrative arrangements led by the Department of Trade and Industry, which provides 75% of the total funding for partnerships. This programme is designed to help companies get access to universities' professionals and bring them into the business by working in partnership with academics or research teams **(University, Industry, Government) (S3)**.

15- What if intermediary organizations have higher degree of involvement in university-industry collaboration and the Government increase its support and decrease level of intervention? **(University, Industry, Government) (S3)**

16- If the Government introduces policies and actions to stem the flow of human capital, particularly expensive trained scientific and technical human capital in two different phases, what do you think will happen to the level of UIC activities? **(University, Industry, Government)**

- A control phase which force and regulate return and stay of human capital **(S2)**
- A stimulation phase which make a favourable environment for their activities **(S3)**

17- What will happen if the Government do the followings: **(University, Industry, Government) (S2)**

- Designing an efficient policy framework for IP at the national level
- Sill retains ineffectiveness in enforcement of IPR
- Still retains weakness in IPR policy due to inconsistency with international obligations

18- What will happen if the Government do the followings: **(University, Industry, Government) (S3)**

- Designing efficient policy framework for IP in national level
- Consider enforcement of IPR
- Formulating an IPR policy compatible with Iranian production structure, consistent with the international obligation

19- What if the Government introduces an efficient programme to enhance entrepreneurial activities? E.g. by enhancing awareness/training for entrepreneurial activities? **(University, Industry, Government) (S2)**

20- What if Iranian Government shifts their policy for supporting technology-based companies (with risky nature of their activities) from traditional financing mechanism (that need real asset to secure loans) to Risk Capital (that do not require security and implies that return for investors depend on the growth and profitability of the company)? (still VC is not available in a broad scope)
(University, Industry, Government) (S2)

21- What if the Government establishes association for venture capital which can supervise and support private and public venture capitals? **(University, Industry, Government) (S3)**

22- What if the Government develops policies for cluster enhancement which focuses on specialization (Economies of specialization as well as geographical concentration)? This focus is on high concentrate of SMEs, both from the supply and demand side as well as cluster support institution like universities **(University, Industry, Government) (S3)**

23- What if the Government legislates to grant the national universities autonomy from the Government supervision in order to freely develop their research policy and relations with companies? **(University, Government) (S2)**

24- What if the Government increase university access to the Government funding (increasing their allocated budget) based on extent of collaboration with companies? **(University, Government) (S3)**

25- What if the Government regulations regarding UIC become more stable?

(University, Industry, Government) (S2)

- **Part 2: Interview Questions (What-if questions)**

Industry Interview Instrument

University-Industry Collaborations

Section 1: Background of your Institution

Q1. Please indicate the ownership status of your company.

( ) National Public company
( ) National Private company
( ) National Public/Private company
( ) Multinational company

Q2. Please indicate the number of Employees working in your company.

( ) < 50 Employees
( ) Between 50 and 250 employees
( ) > 250 employees

Section 2: Respondent Background

Q3. Formally, how would you describe (or characterize) your current position?

( ) Senior Management
( ) Middle Management
( ) Researcher/staff

<u>Section 3:</u> Constructing DSM and developing first scenario scripts

1- **Developing first scenario scripts by asking respondents the current status of each force in the DSM and assuming that the current situation remains unchanged for the next 15 years..**

<u>Section 4:</u> Scenario-related Questionnaire

INSTRUCTIONS:

Please answer the following questions on the basis of the facts of your Institution and your analysis regarding the future (next 15 years) challenges of University-Enterprise-Government collaborations.
(**S2**= To be asked for the second scenario); (**S3**= To be asked for the third scenario)

In order to develop the second and third scenarios, please assume that in scenario 2, apart from its new direction of forces, the systems model will have all features of the current state. Furthermore please assume that in scenario 3, apart from its new direction of forces, this scenario includes all other changes in direction of forces proposed for scenario 2.

A- Organizational structures to coordinate and support partnerships

1- What do you think will happen if a programme which includes mobility of people in university-industry collaboration is encouraged? **(University, Industry, Government) (S3)**

- Mobility of star scientists from universities to the industry
- University researchers have part-time jobs in industry in order to learn, experience and observe
- Industry people work in universities as lecturers
- Joint research activities

2- What will happen if university do the followings: **(University, Industry, Government) (S2)**

- Develops efficient guidelines for the management and exploitation of intellectual property rights in universities that consider issues relating to IP ownership with collaborative research programme and/or other contractual agreement with various partners?

3- If universities and industry design efficient methods for conveying knowledge (tacit and explicit) between universities and industry, what will be the impact of this on the usage of the technology by industry? (E.g. increasing Joint research activities, availability of written reports, site visits by industry, plant visits by researchers). **(University, Industry) (S3)**

4- If universities decrease the high degree of bureaucracy and inflexible procedures, what will happen? **(University, Industry) (S3)**

B- Asset management

5- If technology transfer offices gathers all the necessary skills (marketing, technical, negotiation) and operate on an appropriate scale what do you think will happen? **(University, Industry, Government) (S2)**

C- Leadership and culture

6- What will be the effect of the following science and technology policy on trust formation (contractual trust- competence trust and goodwill trust) if government employs instruments that involve an intermediary institution to bring together universities and firms? (CCG programme) **(University, Industry, Government) (S3)**

(Government will provide financial and developmental assistance for firms to undertake R&D projects in collaboration with a university and encourage them for repeating relationships between the same partners)

7- What if universities and industry design specific programmes to enhance level of their commitment when collaborating with other partners? E.g. increase senior management involvement in the corporate-university partnerships. **(University, Industry) (S3)**

D- Organizational capabilities

8- What if universities in Iran create active research consortia to help fund research? (Companies pay membership fees to join these consortia and they expect benefits in terms of access to research) **(University, Industry, Government) (S3)**

9- What if companies increase their R&D compared to the current situation (medium-level expenditure on R&D)? **(Industry, Government) (S2)**

10- If R&D budgets for firms are increased e.g. by companies themselves or by the Government initiatives which give grants for those establishing research facilities, what will be the impact on the ability of firms to identify, absorb and exploit internally and externally generated knowledge? **(Industry, Government) (S3)**
Please specify the likely impact on:

- Probability of joint research project with universities

E- Creation of an enabling environment by government

11- What will happen if the Government promotes programme for transferring knowledge between universities and industry? **(University, Industry, Government) (S3)**

Government programme which is funded by the number of public sectors agencies (the sponsors) with the policy and administrative arrangements led by the Department of Trade and Industry, which provides 75% of the total funding for partnerships. This programme is designed to help companies get access to universities' professionals and bring them into the business by working in partnership with academics or research teams.

12- What if intermediary organizations have higher degree of involvement in university-industry collaboration and the Government increase its support and decrease level of intervention? **(University, Industry, Government) (S3)**

13- If the Government introduces policies and actions to stem the flow of human capital, particularly expensive trained scientific and technical human capital in two different phases, what do you think will happen to the level of UIC activities? **(University, Industry, Government)**
  - A control phase which force and regulate return and stay of human capital **(S2)**
  - A stimulation phase which make a favourable environment for their activities **(S3)**

14- What will happen if the Government do the followings: **(University, Industry, Government) (S2)**

- Designing an efficient policy framework for IP at the national level
- Sill retains ineffectiveness in enforcement of IPR
- Still retains weakness in IPR policy due to inconsistency with international obligations

15- What will happen if the Government do the followings: **(University, Industry, Government)(S3)**

- Designing efficient policy framework for IP in national level
- Consider enforcement of IPR
- Formulating an IPR policy compatible with Iranian production structure, consistent with the international obligation

16- What if the Government introduces an efficient programme to enhance entrepreneurial activities? e.g. by enhancing awareness/training for entrepreneurial activities? **(University, Industry, Government) (S2)**

17- What if Iranian Government shifts their policy for supporting technology-based companies (with risky nature of their activities) from traditional financing mechanism (that need real asset to secure loans) to Risk Capital (that do not require security and implies that return for investors depend on the growth and profitability of the company)? (still VC is not available in the broad scope) **(University, Industry, Government) (S2)**

18- What if the Government establishes associations for the national venture capital which can supervise public and private venture capital? **(University, Industry, Government) (S3)**

19- What if the Government develops policies for cluster enhancement which focuses on specialization (Economies of specialization as well as geographical concentration)? This focus is on high concentrate of SMEs, both from the supply and demand side as well as cluster support institution like universities **(University, Industry, Government) (S3)**

20- What will happen if international relations with other countries improve and pave the way for country to join the WTO? **(Industry, Government) (S2)**

21- What will happen if the country joins the WTO? **(Industry, Government) (S3)**

22- What if embargoes are decreased by Western Governments? **(Industry, Government) (S2)**

23- If the political situation improves and firms in Iran increase the proportion of foreign strategic technology alliances and/or attract FDI, what do you think will happen to? **(Industry, Government) (S2)**

- Competitiveness in the region?
- UIC performance?

24- If the Government introduce better reward and incentive systems and new forms of financial aids (e.g. increasing innovation funds and subsidies for firms or providing tax credit in case of cooperating more with universities) what do you think will happen?
(Industry, Government) (S3)

25- What will happen if the Government decreases monopoly on market- still monopoly exist- **(S2**) and also design anti-monopoly policy to encourage competitiveness **(S3)**? **(Industry, Government)**

26- What if the Government privatisation process of industries is made more efficient compared to the current situation; but some delays still exist in the process? **(Industry, Government) (S2)**

27- What happens if the Government successfully achieves the privatisation of state industries? **(Industry, Government) (S3)**

28- What if the Government regulations regarding UIC become more stable? **(University, Industry, Government) (S2)**

<u>Part 2: Interview Questions (What-if questions)</u>

Government's Interview Instrument

University-Industry Collaborations

1- **Formally, how would you describe (or characterize) your current position?**

<u>Section 1:</u> Constructing DSM and developing first scenario scripts

2- **Developing first scenario scripts by asking respondents the current status of each force in the DSM and assuming that the current situation remains unchanged for the next 15 years.**

<u>Section 2:</u> Scenario-related Questionnaire

INSTRUCTIONS: Please answer the following questions on the basis of the facts of your Institution and your analysis regarding the future (next 15 years) challenges of University-Enterprise-Government collaborations. (**S2**= To be asked for the second scenario); (**S3**= To be asked for the third scenario) In order to develop the second and third scenarios, please assume that in scenario 2, apart from its new direction of forces, the systems model will have all features of the current state. Furthermore please assume that in scenario 3, apart from its new direction of forces, this scenario includes all other changes in direction of forces proposed for scenario 2.

A- Organizational structures to coordinate and support partnerships:

1- What do you think will happen if a programme which includes mobility of people in university-industry collaboration is encouraged? **(University, Industry, Government) (S3)**
- Mobility of star scientists from universities to the industry
- University researchers have part-time jobs in industry in order to learn, experience and observe
- Industry people work in universities as lecturers
- Joint research activities

2- What will happen if university do the followings: **(University, Industry, Government) (S2)**
- Develops efficient guidelines for the management and exploitation of intellectual property rights in universities that consider issues relating to IP ownership with collaborative research programme and/or other contractual agreement with various partners?
- design clear institutional policy on royalty-sharing and the inclusion of benefits for researcher/inventor or his/her department

3- What if university change promotion and tenure decisions (which previously was based on publications and research grants) and considers degree of academics involvement in university- industry collaboration, as a score for promotion? **(University, Government) (S3)**

4- What if technology transfer offices change their structure and recruit multidisciplinary team including (legal, IP, business development, financial experts) in order to promote UIC? **(University, Government) (S2)**

B- Asset management:

5- If technology transfer offices gather all the necessary skills (marketing, technical, negotiation) and operate on an appropriate scale what do you think will happen? **(University, Industry, Government) (S2)**

C- Leadership and culture:

6- What will be the effect of the following science and technology policy on trust formation (contractual trust- competence trust and good-will trust) if government employs instruments that involve an intermediary institution to bring together universities and firms?

(Government will provide financial and developmental assistance for firms to undertake R&D projects, in collaboration with a university and encourage them for repeating relationships between the same partners) (CCG programme**)(University, Industry, Government) (S3)**

D- Organizational capabilities

7- What if universities in Iran create active research consortia to help fund research? (Companies pay membership fees to join these consortia and they expect benefits in terms of access to research) **(University, Industry, Government) (S3)**

8- What if companies increase their R&D compare to the current situation (medium-level expenditure on R&D? **(Industry, Government) (S2)**

9- If R&D budgets for firms are increased e.g. by companies themselves or by Government initiatives which give grants for those establishing research facilities, what will be the impact on the ability of firms to identify, absorb and exploit internally and externally generated knowledge? **(Industry, Government) (S3)**

Please specify the likely impact on:

- Probability of joint research project with universities

E- **Creation of an enabling environment by government**

10- What will happen if the Government promotes programme for transferring knowledge between universities and industry? **(University, Industry, Government) (S3)**

Government programme which is funded by the number of public sector agencies (the sponsors) with the policy and administrative arrangements led by the Department of

Trade and Industry, which provides 75% of the total funding for partnerships. This programme is designed to help companies get access to universities' professionals and bring them into the business by working in partnership with academics or research teams.

11- What if intermediary organizations have higher degree of involvement in university-industry collaboration and the Government increase its support and decrease level of intervention? **(University, Industry, Government) (S3)**

12- If the Government introduces policies and actions to stem the flow of human capital, particularly expensive trained scientific and technical human capital in two different phases, what do you think will happen to the level of UIC activities? **(University, Industry, Government)**

- A control phase which force and regulate return and stay of human capital **(S2)**
- A stimulation phase which make a favourable environment for their activities **(S3)**

13- What will happen if the Government do the followings: **(University, Industry, Government) (S2)**

- Designing an efficient policy framework for IP at the national level
- Sill retains ineffectiveness in enforcement of IPR
- Still retains weakness in IPR policy due to inconsistency with international obligations

14- What will happen if the Government do the followings: **(University, Industry, Government) (S3)**

- Designing efficient policy framework for IP in national level
- Consider enforcement of IPR
- Formulating an IPR policy compatible with Iranian production structure, consistent with the international obligation

15- What if the Government introduces an efficient programme to enhance entrepreneurial activities? E.g. by enhancing awareness/training for entrepreneurial activities? **(University, Industry, Government) (S2)**

16- What if Iranian Government shifts their policy for supporting technology-based companies (with risky nature of their activities) from traditional financing mechanism (that need real asset to secure loans) to Risk Capital (that do not require security and implies that return for investors depend on the growth and profitability of the company)? (still VC is not available in a broad scope) **(University, Industry, Government) (S2)**

17- What if the Government establishes association for venture capital which can supervise and support private and public venture capitals? **(University, Industry, Government) (S3)**

18- What if the Government develops policies for clusters enhancement focuses on specialization (Economies of specialization as well as geographical concentration)? This focus is on high concentrate of SMEs, both from the supply and demand side as well as cluster support institution like universities. **(University, Industry, Government) (S3)**

19- What will happen if international relations with other countries improve and pave the way for country to join the WTO? **(Industry, Government) (S2)**

20- What will happen if the country joins the WTO? **(Industry, Government) (S3)**

21- What if embargoes are decreased by Western Governments? **(Industry, Government) (S2)**

22- If the political situation improves and firms in Iran increase the proportion of foreign strategic technology alliances and/or attract FDI, what do you think will happen to? **(Industry, Government) (S2)**

- Competitiveness in the region?

- UIC performance?

23- If the Government introduce better reward and incentive systems and new forms of financial aids (e.g. increasing innovation funds and subsidies for firms or providing tax credit in case of cooperating more with universities) what do you think will happen? **(Industry, Government) (S3)**

24- What will happen if the Government decreases monopoly on market –still monopoly exist-**(S2**) and also design anti-monopoly policy to encourage competitiveness **(S3)**?
(Industry, Government)

25- What if the Government privatisation process of industries is made more efficient compared to the current situation; but some delays still exists in the process? **(Industry, Government) (S2)**

26- What happens if the Government successfully achieves the privatisation of state industries? **(Industry, Government) (S3)**

27- What if the Government legislates to grant the national universities autonomy from Government supervision in order to freely develop their research policy and relations with companies? **(University, Government) (S2)**

28- What if the Government increase university access to Government funding (increase their allocated budget) based on extent of collaboration with companies? **(University, Government) (S3)**

29- What if the Government regulations regarding UIC become more stable? **(University, Industry, Government) (S2)**

Appendix E: List of loops identified in this study

R1- Performance of research consortia and other similar kind of mechanisms for collaboration- Level of access to applied knowledge with positive impact on research and teaching when collaborate with companies- Motivation of universities to collaborate with industry- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (7U).
R2- Performance of research consortia and other similar kind of mechanisms for collaboration- Probability of generating entrepreneurial culture in universities when collaborating with companies- Motivation of universities to collaborate with industry- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (7U).
R3- Performance of research consortia and other similar kind of mechanisms for collaboration- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (23 people in the pool).
R4- Performance of research consortia and other similar kind of mechanisms for collaboration- Level of impact on firm's capabilities in R&D when cooperation with universities- Motivation of companies to collaborate with universities - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (6I).
R5- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of impact on qualification level of employees in company when collaborating with universities- Motivation of companies to collaborate with universities- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (6I).
R6- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of generating innovation culture in industry when collaborating with universities- Motivation of companies to collaborate with universities- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (6I).
R7- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of achieving competitive advantage when cooperating with universities- Motivation of companies to collaborate with universities - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (6I).
R8- Performance of research consortia and other similar kind of mechanisms for collaboration- Ability of universities to improve the level of sales and profitability of industry- Motivation of companies to collaborate with universities- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration(6I).
R9- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of firm's absorptive capacity on knowledge transfer- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (23 people in the pool).
R10- Availability of reward and incentive systems for innovative firms- Motivation of companies to collaborate with universities- UIC performance- Availability of reward and incentive systems for innovative firms (5I, 6G).
R11- Degree of trust between government and entrepreneurs- Motivation of individual within universities to collaborate with industry- UIC performance- Degree of trust between government and entrepreneurs (2U, 2G).
R12*- Degree of access to government funding by universities (changing university's allocated budget) - Motivation of universities to collaborate with industry- UIC performance- - Degree of access to government funding (7U, 3G).
R12- Degree of access to government funding- Motivation of universities to collaborate with industry - UIC performance- - Degree of access to government funding (7U, 3G).
R13- Degree of trust between government and entrepreneurs- Motivation of companies to collaborate with universities- UIC performance- Degree of trust between government and entrepreneurs (3I, 2G).
R14- Degree of access to government funding- Motivation of companies to collaborate with universities- UIC performance- Degree of access to government funding (5I, 6G).
R15- Performance of intermediary agents- UIC performance- Performance of intermediary agents (7U, 4I, 6G).
R16a- Performance of intermediary agents- Status of cluster formation and favourability of entrepreneurial environment- UIC performance- Performance of intermediary agents(7U, 4I, 6G).
R16b- Status of cluster formation and favourability of entrepreneurial environment- UIC performance- Status of cluster formation and favourability of entrepreneurial environment (7U, 4I, 6G).
R17a- Performance of intermediary agents- Status of cluster formation and favourability of entrepreneurial environment- Status of brain drain- UIC performance- Performance of intermediary agents (2U, 3I, 5G).
R17b- Status of cluster formation and favourability of entrepreneurial environment- Status of brain drain- UIC performance- Status of cluster formation and favourability of entrepreneurial environment (2U, 3I, 5G).
R18a- Performance of research consortia and other similar kind of mechanisms for collaboration- Status of cluster formation and favourability of entrepreneurial environment- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (5U, 3I, 3G).
R18b- Performance of research consortia and other similar kind of mechanisms for collaboration - Status of cluster formation and favourability of entrepreneurial environment- Status of brain drain- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (5U, 3I, 3G).
R19- Degree of cooperation and team working culture- UIC performance- Performance of intermediary agents- Status of cluster formation and favourability of entrepreneurial environment- Degree of cooperation and team working culture (2U, 4I, 2G).

R20- Degree of cooperation and team working culture- Performance of research consortia and other similar kind of mechanisms for collaboration- Status of cluster formation and favourability of entrepreneurial environment- Degree of cooperation and team working culture (2U, 3I, 2G).
R21- Degree of cooperation and team working culture- Performance of intermediary agents - Status of cluster formation and favourability of entrepreneurial environment- Degree of cooperation and team working culture (2U, 4I, 2G).
R22- Performance of research consortia and other similar kind of mechanisms for collaboration-Amount of royalty payments to universities- motivation of universities to collaborate with industry - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (7U, 3G).
R23- Performance of research consortia and other similar kind of mechanisms for collaboration-Integration into the labour market for graduated students- motivation of universities to collaborate with industry- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (7U, 3G).
R24- Performance of research consortia and other similar kind of mechanisms for collaboration-Ability to recruit talented students- motivation of companies to collaborate with universities- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (4I, 8G).
R25- Performance of research consortia and other similar kind of mechanisms for collaboration-Amount of additional funding for individual's future research- motivation of individual within universities to collaborate with industry- UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (7U, 3G).
R26a- Degree of cooperation and team working culture- UIC- Performance of research consortia and other similar kind of mechanisms for collaboration- Status of cluster formation and favourability of entrepreneurial environment- Degree of cooperation and team working culture (2U, 3I, 2G).
R26b- Degree of cooperation and team working culture- UIC- Status of cluster formation and favourability of entrepreneurial environment- Degree of cooperation and team working culture (2U, 4I, 2G).
R27- Performance of intermediary agents- Degree of cultural differences between partners- Degree of trust formation between partners- Motivation of companies to collaborate with universities- UIC performance- Performance of intermediary agents (19 people in the pool).
R28- Performance of intermediary agents- Degree of cultural differences between partners- Degree of trust formation between partners- Motivation of individual within universities to collaborate with industry- UIC performance- Performance of intermediary agents (19 people in the pool).
R29- Performance of intermediary agents- Degree of cultural differences between partners- Degree of trust formation between partners- Probability of renewing contract in the future - UIC performance- Performance of intermediary agents (19 people in the pool).
R30- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of cultural differences between partners- Degree of trust formation between partners- Motivation of companies to collaborate with universities - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (23 people in the pool).
R31- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of cultural differences between partners- Degree of trust formation between partners- Motivation of individual within universities to collaborate with industry - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (23 people in the pool).
R32- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of cultural differences between partners- Degree of trust formation between partners- Probability of renewing contract in the future - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (23 people in the pool).
R33- Performance of intermediary agents- Degree of commitment- Degree of trust formation between partners- Motivation of companies to collaborate with universities- UIC performance- Performance of intermediary agents (3U, 5I, 1G).
R34- Performance of intermediary agents- Degree of commitment- Degree of trust formation between partners- Motivation of individual within universities to collaborate with industry- UIC performance- Performance of intermediary agents (3U, 5I, 1G).
R35- Performance of intermediary agents- Degree commitment- Degree of trust formation between partners- Probability of renewing contract in the future - UIC performance- Performance of intermediary agents (3U, 5I, 1G).
R36- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of commitment- Degree of trust formation between partners- Motivation of companies to collaborate with universities - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (3U, 5I, 1G).
R37- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of commitment- Degree of trust formation between partners- Motivation of individual within universities to collaborate with industry - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (3U, 5I, 1G).

R38- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of commitment- Degree of trust formation between partners- Probability of renewing contract in the future - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (3U, 5I, 1G).
R39- Performance of intermediary agents - Degree of commitment- Probability of renewing contract in the future - UIC performance- Performance of intermediary agents (3U, 5I, 1G).
R40- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of commitment- Probability of renewing contract in the future - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (3U, 5I, 1G).
R41- Performance of intermediary agents- Degree of understanding of partners from each other- Degree of trust formation between partners- Motivation of companies to collaborate with universities- UIC performance- Performance of intermediary agents(19 people in the pool).
R42- Performance of intermediary agents- Degree of understanding of partners from each other - Degree of trust formation between partners- Motivation of individual within universities to collaborate with industry- UIC performance- Performance of intermediary agents (19 people in the pool).
R43- Performance of intermediary agents- Degree of understanding of partners from each other - Degree of trust formation between partners- Probability of renewing contract in the future - UIC performance- Performance of intermediary agents (19 people in the pool).
R44- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of understanding of partners from each other - Degree of trust formation between partners- Motivation of companies to collaborate with universities - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (23 people in the pool).
R45- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of understanding of partners from each other - Degree of trust formation between partners- Motivation of individual within universities to collaborate with industry - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (23 people in the pool).
R46- Performance of research consortia and other similar kind of mechanisms for collaboration- Degree of understanding of partners from each other - Degree of trust formation between partners- Probability of renewing contract in the future - UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration (23 people in the pool).
R47- Style of management in SMEs- UIC performance- Performance of intermediary agents- Status of cluster formation and favourability of entrepreneurial environment- Style of management in SMEs (4U, 2I, 3G).
R48- Style of management in SMEs - Performance of research consortia and other similar kind of mechanisms for collaboration- Status of cluster formation and favourability of entrepreneurial environment- Style of management in SMEs (4U, 2I, 3G).
R49- Style of management in SMEs - Performance of intermediary agents - Status of cluster formation and favourability of entrepreneurial environment- Style of management in SMEs (4U, 2I, 3G).
R50- Style of management in SMEs – UIC performance- Performance of research consortia and other similar kind of mechanisms for collaboration- Status of cluster formation and favourability of entrepreneurial environment- Style of management in SMEs (4U, 2I, 3G).
R51- Style of management in SMEs – UIC performance- Status of cluster formation and favourability of entrepreneurial environment- Style of management in SMEs (4U, 2I, 3G).
R52- UIC performance- degree of alignment of university education system to industry needs- UIC performance (2U, 4I, 1G).
R53- UIC performance- view among university people to earn money from research- UIC performance (2U).
R54- UIC performance- Degree that SMEs have a long-term plan for their research activities- UIC performance (4U, 4I, 3G).
R55- Status of Cluster formation and favourability of entrepreneurial environment- Degree that SMEs have a long-term plan for their research activities- Status of Cluster formation and favourability of entrepreneurial environment (4U, 4I, 3G).
R56- UIC performance- Degree of risk-averse culture in universities- UIC performance (3U, 1G).

Appendix F: TWO INDUSTRY (AUTOMOTIVE AND BIOTECHNOLOGY) COMPARISONS USING MANN-WHITNEY TEST.

- **Barriers to UIC**

Test Statistics[a] (Barriers to UIC)

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Industrial culture which is based on profit maximization	204.000	457.000	-.419	.675
Cultural differences in terms of secrecy vs. dissemination	182.500	392.500	-.988	.323
Time orientation differences	211.500	421.500	-.228	.820
Difficulties in agreeing a technology transfer deal	217.500	470.500	-.066	.947
Speed of negotiation of technology transfer	218.500	471.500	-.039	.969
Financing the technology transfer deal	188.000	441.000	-.845	.398
Poor skills of the people in TTOs e.g. marketing and negotiation skills	211.000	421.000	-.238	.812
Bureaucracy and inflexibility of university administrator	208.000	461.000	-.318	.751
Insufficient resources devoted to technology transfer by universities	172.000	425.000	-1.244	.213
Lack of understanding of industry norms by university people	183.000	436.000	-.967	.333
Lack of understanding of university norms by industrial people	181.500	434.500	-1.018	.309
Low degree of firms' absorptive capacity	219.500	472.500	-.013	.990
Brain Drain	201.500	454.500	-.486	.627
Instability of government regulations regarding university-industry collaborations	195.000	448.000	-.674	.500

a. Grouping Variable: Category of Industry

Ranks (Barriers to UIC)

	Category of Industry	N	Mean Rank	Sum of Ranks
Industrial culture which is based on profit maximization	Automotive Related	22	20.77	457.00
	Biotechnology Related	20	22.30	446.00
	Total	42		
Cultural differences in terms of secrecy vs. dissemination	Automotive Related	22	23.20	510.50
	Biotechnology Related	20	19.62	392.50
	Total	42		
Time orientation differences	Automotive Related	22	21.89	481.50
	Biotechnology Related	20	21.08	421.50
	Total	42		
Difficulties in agreeing a technology transfer deal	Automotive Related	22	21.39	470.50
	Biotechnology Related	20	21.62	432.50
	Total	42		
Speed of negotiation of technology transfer	Automotive Related	22	21.43	471.50
	Biotechnology Related	20	21.58	431.50
	Total	42		
Financing the technology transfer deal	Automotive Related	22	20.05	441.00
	Biotechnology Related	20	23.10	462.00
	Total	42		
Poor skills of the people in TTOs e.g. marketing and negotiation skills	Automotive Related	22	21.91	482.00
	Biotechnology Related	20	21.05	421.00
	Total	42		
Bureaucracy and inflexibility of university administrator	Automotive Related	22	20.95	461.00
	Biotechnology Related	20	22.10	442.00
	Total	42		
Insufficient resources devoted to technology transfer by universities	Automotive Related	22	19.32	425.00
	Biotechnology Related	20	23.90	478.00
	Total	42		
Lack of understanding of industry norms by university people	Automotive Related	22	19.82	436.00
	Biotechnology Related	20	23.35	467.00
	Total	42		
Lack of understanding of university norms by industrial people	Automotive Related	22	19.75	434.50
	Biotechnology Related	20	23.42	468.50
	Total	42		
Low degree of firms' absorptive capacity	Automotive Related	22	21.48	472.50
	Biotechnology Related	20	21.52	430.50
	Total	42		
Brain Drain	Automotive Related	22	20.66	454.50
	Biotechnology Related	20	22.42	448.50
	Total	42		
Instability of government regulations regarding university-industry collaborations	Automotive Related	22	20.36	448.00
	Biotechnology Related	20	22.75	455.00
	Total	42		

- **Promotion of UIC**

Ranks (Promotion of UIC)

	Category of Industry	N	Mean Rank	Sum of Ranks
The existence of an efficient national policy framework for IPR	Automotive Related	22	23.30	512.50
	Biotechnology Related	20	19.52	390.50
	Total	42		
Efficient mobility of people in U-I collaboration	Automotive Related	22	23.86	525.00
	Biotechnology Related	20	18.90	378.00
	Total	42		
The existence of an efficient venture capital	Automotive Related	22	22.95	505.00
	Biotechnology Related	20	19.90	398.00
	Total	42		
Efficient cluster formation	Automotive Related	22	23.14	509.00
	Biotechnology Related	20	19.70	394.00
	Total	42		
Higher degree of intermediary involvement	Automotive Related	22	23.66	520.50
	Biotechnology Related	20	19.12	382.50
	Total	42		
Efficient government programmes to enhance awareness/training for entrepreneurial activities	Automotive Related	22	19.50	429.00
	Biotechnology Related	20	23.70	474.00
	Total	42		
Effective privatisation and smaller role for the government in the economy	Automotive Related	22	23.75	522.50
	Biotechnology Related	20	19.02	380.50
	Total	42		
Existence of efficient method for conveying knowledge between universities and industry	Automotive Related	22	20.98	461.50
	Biotechnology Related	20	22.08	441.50
	Total	42		
Availability of active research consortia	Automotive Related	22	19.68	433.00
	Biotechnology Related	20	23.50	470.00
	Total	42		

Test Statistics[a] (Promotion of UIC)

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
The existence of an efficient national policy framework for IPR	180.500	390.500	-1.052	.293
Efficient mobility of people in U-I collaboration	168.000	378.000	-1.390	.164
The existence of an efficient venture capital	188.000	398.000	-.836	.403
Efficient cluster formation	184.000	394.000	-.953	.341
Higher degree of intermediary involvement	172.500	382.500	-1.255	.210
Efficient government programmes to enhance awareness/training for entrepreneurial activities	176.000	429.000	-1.177	.239
Effective privatisation and smaller role for the government in the economy	170.500	380.500	-1.358	.174
Existence of efficient method for conveying knowledge between universities and industry	208.500	461.500	-.320	.749
Availability of active research consortia	180.000	433.000	-1.074	.283

a. Grouping Variable: Category of Industry

- **Motivation for collaboration with universities**

Ranks (Motivation for collaboration with universities)

	Category of Industry	N	Mean Rank	Sum of Ranks
Increasing company's general technical awareness and/or capabilities in R&D	Automotive Related	22	20.36	448.00
	Biotechnology Related	20	22.75	455.00
	Total	42		
Accelerate or improve your existing research project	Automotive Related	22	21.55	474.00
	Biotechnology Related	20	21.45	429.00
	Total	42		
Improving your public image in the society in which you operate	Automotive Related	22	19.89	437.50
	Biotechnology Related	20	23.28	465.50
	Total	42		
Increasing the qualification level of employees	Automotive Related	22	23.16	509.50
	Biotechnology Related	20	19.68	393.50
	Total	42		
Improving sales and profitability	Automotive Related	22	23.23	511.00
	Biotechnology Related	20	19.60	392.00
	Total	42		
To access and recruit highly qualified personnel from universities	Automotive Related	22	19.27	424.00
	Biotechnology Related	20	23.95	479.00
	Total	42		
Existence of an efficient institutional policy on IPR	Automotive Related	22	23.84	524.50
	Biotechnology Related	20	18.92	378.50
	Total	42		
Access to new technologies that allow achievement of competitive advantages	Automotive Related	22	23.20	510.50
	Biotechnology Related	20	19.62	392.50
	Total	42		
Access to the equipped university physical facilities	Automotive Related	22	23.32	513.00
	Biotechnology Related	20	19.50	390.00
	Total	42		
Higher access to government funding when collaborating with universities	Automotive Related	22	24.30	534.50
	Biotechnology Related	20	18.42	368.50
	Total	42		
Creation of innovation culture in the company	Automotive Related	22	24.09	530.00
	Biotechnology Related	20	18.65	373.00
	Total	42		
Ability to recruit talented students	Automotive Related	22	22.59	497.00
	Biotechnology Related	20	20.30	406.00
	Total	42		
Availability of tax credit if cooperating with universities	Automotive Related	22	20.48	450.50
	Biotechnology Related	20	22.62	452.50
	Total	42		

Ranks (Motivation for collaboration with universities- continue)

	Category of Industry	N	Mean Rank	Sum of Ranks
Increasing embargo imposed by the West	Automotive Related	22	23.07	507.50
	Biotechnology Related	20	19.78	395.50
	Total	42		
Improving political situation and Iranian entry to the WTO	Automotive Related	22	23.18	510.00
	Biotechnology Related	20	19.65	393.00
	Total	42		
Trust	Automotive Related	22	21.36	470.00
	Biotechnology Related	20	21.65	433.00
	Total	42		

Test Statistics[a] (Motivation for collaboration with universities)

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Increasing company's general technical awareness and/or capabilities in R&D	195.000	448.000	-.655	.512
Accelerate or improve your existing research project	219.000	429.000	-.027	.979
Improving your public image in the society in which you operate	184.500	437.500	-.941	.347
Increasing the qualification level of employees	183.500	393.500	-.968	.333
Improve sales and profitability	182.000	392.000	-.990	.322
To access and recruit highly qualified personnel from universities	171.000	424.000	-1.320	.187
Existence of an efficient institutional policy on IPR	168.500	378.500	-1.391	.164
Access to new technologies that allow achievement of competitive advantages	182.500	392.500	-.988	.323
Access to the equipped university physical facilities	180.000	390.000	-1.063	.288
Higher access to government funding when collaborating with universities	158.500	368.500	-1.659	.097
Creation of innovation culture in the company	163.000	373.000	-1.495	.135
Ability to recruit talented students	196.000	406.000	-.642	.521
Availability of tax credit if cooperating with universities	197.500	450.500	-.599	.549
Increasing embargo imposed by the West	185.500	395.500	-.910	.363
Improving political situation and Iranian entry to the WTO	183.000	393.000	-1.010	.313
Trust	217.000	470.000	-.089	.929

a. Grouping Variable: Category of Industry

Appendix G: University and Industry comparisons (using Mann-Whitney test)

- **Barriers to UIC**

Barriers to UIC - Test Statistics[a]

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Industrial culture which is based on profit maximization	587.000	1490.000	-3.538	.000 **
Cultural differences in terms of secrecy vs. dissemination	573.500	1749.500	-3.661	.000 **
Time orientation differences	926.000	1829.000	-.692	.489
Difficulties in agreeing a technology transfer deal	612.500	1788.500	-3.340	.001 **
Speed of negotiation of technology transfer	852.000	2028.000	-1.304	.192
Financing the technology transfer deal	936.000	2112.000	-.606	.544
Poor skills of the people in TTOs e.g. marketing and negotiation skills	932.500	1835.500	-.643	.521
Bureaucracy and inflexibility of university administrator	737.000	1640.000	-2.293	.022 *
Insufficient resources devoted to technology transfer by universities	900.500	1803.500	-.901	.367
Lack of understanding of industry norms by university people	642.000	1818.000	-3.048	.002 **
Lack of understanding of university norms by industrial people	469.500	1372.500	-4.503	.000 **
Low degree of firm absorptive capacity	921.500	1824.500	-.729	.466
Brain drain	891.000	2067.000	-.984	.325
Instability of government regulations regarding UIC	940.000	1843.000	-.593	.553

a. Grouping Variable: University-Industry

*****Indicates statistical significance of the difference at the 95% confidence level; ****** at the 99% level

Barriers to UIC - Ranks

	University-Industry	N	Mean Rank	Sum of Ranks
Industrial culture which is based on profit maximization	University	48	54.27	2605.00
	Industry	42	35.48	1490.00
	Total	90		
Cultural differences in terms of secrecy vs. dissemination	University	48	36.45	1749.50
	Industry	42	55.85	2345.50
	Total	90		
Time orientation differences	University	48	47.21	2266.00
	Industry	42	43.55	1829.00
	Total	90		
Difficulties in agreeing a technology transfer deal	University	48	37.26	1788.50
	Industry	42	54.92	2306.50
	Total	90		
Speed of negotiation of technology transfer	University	48	42.25	2028.00
	Industry	42	49.21	2067.00
	Total	90		
Financing the technology transfer deal	University	48	44.00	2112.00
	Industry	42	47.21	1983.00
	Total	90		
Poor skills of the people in TTOs e.g. marketing and negotiation skills	University	48	47.07	2259.50
	Industry	42	43.70	1835.50
	Total	90		
Bureaucracy and inflexibility of university administrator	University	48	51.15	2455.00
	Industry	42	39.05	1640.00
	Total	90		
Insufficient resources devoted to technology transfer by universities	University	48	47.74	2291.50
	Industry	42	42.94	1803.50
	Total	90		
Lack of understanding of industry norms by university people	University	48	37.88	1818.00
	Industry	42	54.21	2277.00
	Total	90		
Lack of understanding of university norms by industrial people	University	48	56.72	2722.50
	Industry	42	32.68	1372.50
	Total	90		
Low degree of firm absorptive capacity	University	48	47.30	2270.50
	Industry	42	43.44	1824.50
	Total	90		
Brain drain	University	48	43.06	2067.00
	Industry	42	48.29	2028.00
	Total	90		
Instability of government regulations regarding UIC	University	48	46.92	2252.00
	Industry	42	43.88	1843.00
	Total	90		

- **Promotion of UIC**

Promotion of UIC - Ranks

	University-Industry	N	Mean Rank	Sum of Ranks
Existence of an efficient national policy framework for IPR	University	48	62.17	2984.00
	Industry	42	26.45	1111.00
	Total	90		
Efficient mobility of people in U-I collaboration	University	48	53.59	2572.50
	Industry	42	36.25	1522.50
	Total	90		
The existence of an efficient venture capital	University	48	53.21	2554.00
	Industry	42	36.69	1541.00
	Total	90		
Efficient cluster formation	University	48	34.65	1663.00
	Industry	42	57.90	2432.00
	Total	90		
Higher degree of intermediary involvement	University	48	49.33	2368.00
	Industry	42	41.12	1727.00
	Total	90		
Efficient government programme to enhance awareness/training for entrepreneurial activities	University	48	40.03	1921.50
	Industry	42	51.75	2173.50
	Total	90		
Existence of efficient methods for conveying knowledge between universities and industry	University	48	44.35	2129.00
	Industry	42	46.81	1966.00
	Total	90		
Availability of active research consortia	University	48	45.66	2191.50
	Industry	42	45.32	1903.50
	Total	90		

Promotion of UIC -Test Statistics[a]

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Existence of an efficient national policy framework for IPR	208.000	1111.000	-6.658	.000**
Efficient mobility of people in U-I collaboration	619.500	1522.500	-3.280	.001**
The existence of an efficient venture capital	638.000	1541.000	-3.110	.002**
Efficient cluster formation	487.000	1663.000	-4.348	.000**
Higher degree of intermediary involvement	824.500	1727.000	-1.567	.117
Efficient government programme to enhance awareness/training for entrepreneurial activities	745.500	1921.500	-2.217	.027*
Existence of efficient method for conveying knowledge between universities and industry	953.000	2129.000	-.481	.631
Availability of active research consortia	1000.500	1903.500	-.064	.949

a. Grouping Variable: University-Industry

Indicates statistical significance of the difference at the 95% confidence level; * at the 99% level

- ## Probability of renewing contract

Probability of renewing contract - Ranks

	University-Industry	N	Mean Rank	Sum of Ranks
Gain and the usage of research	University	44	38.85	1709.50
	Industry	38	44.57	1693.50
	Total	82		
Trust	University	44	37.36	1644.00
	Industry	38	46.29	1759.00
	Total	82		
Commitment	University	44	41.03	1805.50
	Industry	38	42.04	1597.50
	Total	82		

Probability of renewing contract - Test Statistics[a]

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Gain and the usage of research	719.500	1709.500	-1.111	.267
Trust	654.000	1644.000	-1.774	.046*
Commitment	815.500	1805.500	-.201	.841

a. Grouping Variable: University-Industry

***Indicates statistical significance of the difference at the 95% confidence level; ** at the 99% level

- ## Motivation for collaboration

Motivation for collaboration – Ranks

	University-Industry	N	Mean Rank	Sum of Ranks
Existence of an efficient institutional policy framework on IPR	University	48	58.94	2829.00
	Industry	42	30.14	1266.00
	Total	90		
Trust	University	48	40.23	1931.00
	Industry	42	51.52	2164.00
	Total	90		

Motivation for collaboration - Test Statistics[a]

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Existence of an efficient institutional policy framework on IPR	363.000	1266.000	-5.435	.000**
Trust	755.000	1931.000	-2.253	.024*

a. Grouping Variable: University-Industry

***Indicates statistical significance of the difference at the 95% confidence level; ** at the 99% level

- **Degree of uncertainty**

Degree of uncertainty - Ranks (1): Continue

	University-Industry	N	Mean Rank	Sum of Ranks
Existence of an efficient national policy framework regarding IPR	University	48	52.24	2507.50
	Industry	42	37.80	1587.50
	Total	90		
Existence of an efficient institutional policy framework regarding IPR	University	48	51.38	2466.00
	Industry	42	38.79	1629.00
	Total	90		
Existence of an efficient programme which includes mobility of people in U-I collaboration	University	48	43.91	2107.50
	Industry	42	47.32	1987.50
	Total	90		
Efficient cluster formation	University	48	51.70	2481.50
	Industry	42	38.42	1613.50
	Total	90		
Proactive intermediary organization involvement	University	48	54.29	2606.00
	Industry	42	35.45	1489.00
	Total	90		
Existence of appropriate mixture of skills in TTOs e.g. marketing and negotiation experts	University	48	54.49	2615.50
	Industry	42	35.23	1479.50
	Total	90		
Decreasing the degree of bureaucracy of universities	University	48	41.24	1979.50
	Industry	42	50.37	2115.50
	Total	90		
Commitment	University	48	49.33	2368.00
	Industry	42	41.12	1727.00
	Total	90		
Enhancing level of trust	University	48	47.97	2302.50
	Industry	42	42.68	1792.50
	Total	90		

Degree of uncertainty - Ranks (1): Continue

	University-Industry	N	Mean Rank	Sum of Ranks
Integration into the labour market for graduated students	University	48	41.40	1987.00
	Industry	42	50.19	2108.00
	Total	90		
Equipped universities and availability of R&D facilities	University	48	49.02	2353.00
	Industry	42	41.48	1742.00
	Total	90		
Enhancing Firms' absorptive capacity on knowledge transfer	University	48	52.27	2509.00
	Industry	42	37.76	11568.00
	Total	90		
Decreasing cultural differences between universities and industry	University	48	49.21	2362.00
	Industry	42	41.26	1733.00
	Total	90		
Existence of efficient venture capital and investors	University	48	53.07	2547.50
	Industry	42	36.85	1547.50
	Total	90		
Efficient policy toward brain drain	University	48	39.00	1872
	Industry	42	52.93	2223.00
	Total	90		
Efficiency of government programmes to enhance awareness/training for entrepreneurial activities	University	48	41.21	1978.00
	Industry	42	50.40	2117.00
	Total	90		
Availability of active research consortia	University	48	44.52	2137.00
	Industry	42	46.62	1958.00
	Total	90		
Existence of efficient method for conveying knowledge between universities and industry	University	48	47.46	2278.00
	Industry	42	43.26	1817.00
	Total	90		
Stability of government regulations regarding university-industry collaborations	University	48	49.83	2392.00
	Industry	42	40.55	1703.00
	Total	90		

Degree of uncertainty - Test Statistics[a]

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Existence of an efficient national policy framework regarding IPR	684.500	1587.500	-2.792	.005**
Existence of an efficient institutional policy framework regarding IPR	726.000	1629.000	-2.406	.016*
Existence of efficient programme which includes mobility of people in U-I collaboration	931.500	2107.500	-.638	.523
Efficient cluster formation	710.500	1613.500	-2.524	.012*
Proactive intermediary organization involvement	586.000	1489.000	-3.539	.000**
Existence of appropriate mixture of skills in TTOs e.g. marketing and negotiation experts	576.500	1479.500	-3.630	.000**
Decreasing the degree of bureaucracy of universities	803.500	1979.500	-1.716	.086
Commitment	824.000	1727.000	-1.543	.123
Enhancing level of trust	889.500	1792.500	-1.042	.298
Integration into the labour market for graduated students	811.000	1987.000	-1.657	.098
Equipped universities and availability of R&D facilities	839.000	1742.000	-1.404	.160
Enhancing Firms' absorptive capacity on knowledge transfer	683.000	1586.000	-2.742	.006**
Decreasing cultural differences between universities and industry	830.000	1733.500	-1.536	.125
Existence of efficient venture capital and investors	644.500	1547.500	-3.038	.002**
Efficient policy toward brain drain	696.000	1872.000	-2.632	.008**
Efficiency of government programmes to enhance awareness/training for entrepreneurial activity	802.000	1978.000	-1.734	.083
Availability of active research consortia	961.000	2137.000	-.403	.687
Existence of efficient method for conveying knowledge between universities and industry	914.000	1817.000	-.793	.428
Stability of government regulations regarding university-industry collaborations	800.000	1703.000	-1.850	.064

a. Grouping Variable: University-Industry

Indicates statistical significance of the difference at the 95% confidence level; * at the 99% level

APPENDIX H: OTHER FINDINGS (UNIVERSITY-INDUSTRY COMPARISON)

<u>Barriers to UIC</u>

The following section presents the barriers to UIC from universities and industry's point of views, the *p*-value (See Appendix G) indicates the statistical confidence in the null hypothesis, i.e. that there are no differences between university and industry respondents. The mean rank column (See Appendix G) is one of the steps used in Mann-Whitney U test, and constitutes a measure of the relative importance given to a factor by university and industry respondents. If there are no differences in importance between the university and industry, the mean rank values should be equal. As a score of "1" means that a factor has a less impact, an organisation with a lower rank mean score indicates that the item has a lower impact for that organisation than for the other one.

The results for the main barriers to UIC (See appendix G) confirmed the greater impact of "bureaucracy and inflexibility of university administrator" in university side (significant at 95% confidence level). Other differences are more emphasis on "industrial culture which is based on profit maximization" and "lack of understanding of university norms by industrial people" in university (Significant at 99% confidence level), and "lack of understanding of industry norms by university people", "cultural differences in terms of secrecy vs. dissemination" and "difficulties in agreeing a technology transfer deal" in industry (significant at 99% confidence level). Therefore, by comparing the university and industry pool the hypotheses that each of these factors has the same or similar impact on impeding UIC from both university and industry point of views, were rejected.

The differences between university and industry respondents regarding other impeding factors were not significant (see Appendix G). Therefore the null hypotheses related to these factors were accepted.

According to the results in Sections 9.4.4.5 and 9.5.5.4, "bureaucracy and inflexibility of university administrator" was considered by both university and industry respondents to be a very important barrier to collaboration. "Industrial culture which is based on profit maximization" and "lack of understanding of university norms by industrial people" were considered only by university respondents as very important barriers to collaboration. "Lack of understanding of industry norms by university people" and "cultural differences in terms of secrecy vs. dissemination" were considered only by industry respondents as very important barriers to collaboration. "Difficulties in agreeing about a technology transfer deal" was ranked by both university and industry respondents as a medium barrier to collaboration.

Promotion of UIC

Industry survey participants rated "efficient cluster formation" and "efficient government programmes to enhance awareness/training for entrepreneurial activities" as higher impact promotional factors than university participants. University participants however, ranked "existence of an efficient national policy framework for IPR", "efficient mobility of people in U-I collaboration" and "the existence of an efficient venture capital" as a higher impact promotional factors than their industrial people. These differences are statistically significant, with a confidence level ranging from 99% to 95%. Results are available in Appendix G. Therefore, by comparing the university and industry pool the hypotheses that each of these factors has the same or similar impact on promoting UIC from both university and industry point of views, were rejected.

The differences between university and industry respondents regarding other promotional factors were not significant (see Appendix G). Therefore the null hypotheses related to these factors were accepted.

According to the results in Sections 9.4.4.4 and 9.5.5.3, “existence of an efficient national policy framework for IPR” and “efficient mobility of people in U-I collaboration” were considered only by university respondents to be highly important factors for promoting UIC. “Efficient cluster formation” was considered to be important factor only in industry side. “The existence of an efficient venture capital” and “efficient government programmes to enhance awareness/training for entrepreneurial activities” were considered by both university and industry participants as very high important factors for promoting UIC.

Probability of renewing contract

The perceived greater impact of trust in order to renew the contract in the future in industry compared with the university is evident from the analysis of the results (see Appendix G). The hypothesis that the two samples come from the same populations was rejected. The important differences between the mean ranks are indicative of the difference in perception (see Appendix G).

The differences between university and industry respondents regarding other factors were not significant (see Appendix G).

Results in Sections 9.4.4.1 and 9.5.5.1 show that both university and industry survey participants agreed that “trust” is the most important factor when universities and industry wants to renew the contract with the other partner.

Motivation for collaboration

The industry participants rated “trust” as a more important motivational factor than university respondents (significant at the 95% confidence level) (see Appendix G). The “existence of an efficient institutional policy framework on IPR” was considered more important from university point of view (significant at the 99% confidence level). Therefore, by comparing the university and industry pool the hypotheses that each of these factors has the same or similar impact on motivating individuals within universities as well as companies to collaborate with the other partner were rejected.

Results in Sections 9.4.4.2 and 9.5.5.2 show that “trust” is perceived as main motivational factor for both individuals within universities and companies to collaborate with each other. While most of the respondents in university side agreed that “existence of an efficient institutional policy on IPR” has a very high impact to motivate individuals to collaborate with industry partners; industry respondents considered it as a medium impact.

Degree of uncertainty

This section is also designed in order to understand the potential differences between universities and industry views about the degree of uncertainty they perceived regarding the future course of particular factor that has an impact on the UIC process. As a score of “7” means that there would be a higher degree of uncertainty for a specific factor, an organisation with a higher rank mean score indicates that the item has a higher uncertainty for that organisation than for the other one.

The results for the major uncertainties regarding future UIC activities in Iran (see Appendix G), confirmed the greater degree of uncertainty regarding “existence of an efficient institutional policy framework regarding IPR” and “efficient cluster formation” in university side (significant at 95% confidence level) and “existence of an efficient national policy framework for IPR”, “proactive intermediary organizations involvement”, “existence of good mixture of skills in TTOs e.g. marketing and negotiation experts”, “existence of efficient venture capital and investors”, and “enhancing firm’s absorptive capacity on knowledge transfer” in university side (significant at 99% confidence level). Other difference is more emphasis on “efficient policy towards brain drain” in industry (Significant at 99% confidence level). Therefore, by comparing the university and industry pool the hypotheses that there are no differences between the university and industry’s view regarding the degree of uncertainty they perceive about the future of each of these forces that has an impact on UIC process, were rejected.

The differences between university and industry respondents regarding the degree of uncertainty of other factors were not significant (see Appendix G). Therefore the null hypotheses related to these factors were accepted.

According to the results in Sections 9.4.5.1 and 9.5.6.1 “Existence of an efficient national policy framework regarding IPR” and “existence of an efficient institutional policy framework regarding IPR” were considered by both university and industry participants as a major area of uncertainty for collaboration. While most of the respondents from university agreed that “efficient cluster formation”, “proactive intermediary organizations involvement”, “availability of good mixture of skills in the TTOs e.g. marketing and negotiation experts”, and “existence of efficient venture capital and investors” are the major area of uncertainty to the future of collaboration; respondents from industry ranked them as medium uncertainties. “Efficient policy towards brain drain” was rated by only industry people as a major area of uncertainty for collaboration. “Enhancing firms’ absorptive capacity on knowledge transfer” was also ranked medium by respondents in both groups.