CRANFIELD UNIVERSITY

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EFFECTIVENESS OF TECHNOLOGY TRANSFER IN THE SEARCH FOR SUSTAINABLE DEVELOPMENT: THE CASE OF QATAR

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Effectiveness of Technology Transfer in the Search for Sustainable Development: the Case of Qatar

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ABSTRACT

The Emir of Qatar firmly believes that security without development is not sustainable in the long run. Endorsed by Qatar’s top leadership, this conviction has spread contagiously to all corners of the public and private spheres, leading, in turn, to numerous initiatives and massive investments directed at the development of the country. Sustainable development investments in Qatar are promising, but the process is very slow amidst dynamic globalization. Technology capability is a key factor in accelerating the growth of economic, social and environmental development. Hence, the aim of this dissertation is to assess the effectiveness of technology transfer in Qatar's search for sustainable development. The scope of the dissertation is confined to an analysis of certain government agencies involved in technology transfer; the government, the industry and R&D centres. The study developed a framework of measures to assess Qatari technology transfer and sustainable development, categorized into nine themes, including sustainable development, governance and internal environment, external technology resources, internal technology resource measures, absorptive capacity, value chain, value network, research and development and competitiveness. Through exploratory, descriptive and predictive research using qualitative and quantitative field surveys, along with secondary research, the study developed a framework of measures, and used it to assess the effectiveness of sustainability and technology transfer in Qatar. The study concluded that the technology transfer environment and practices in Qatar are ineffective in advancing the search for sustainable development. The study recommends the need to establish policies and priorities to facilitate sustainable development, focusing especially on technology, science and innovation. Future research should focus on in-depth case studies of specific industrial clusters as well as deepening the understanding of thematic measures of sustainability.

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May God Bless All, Amen.

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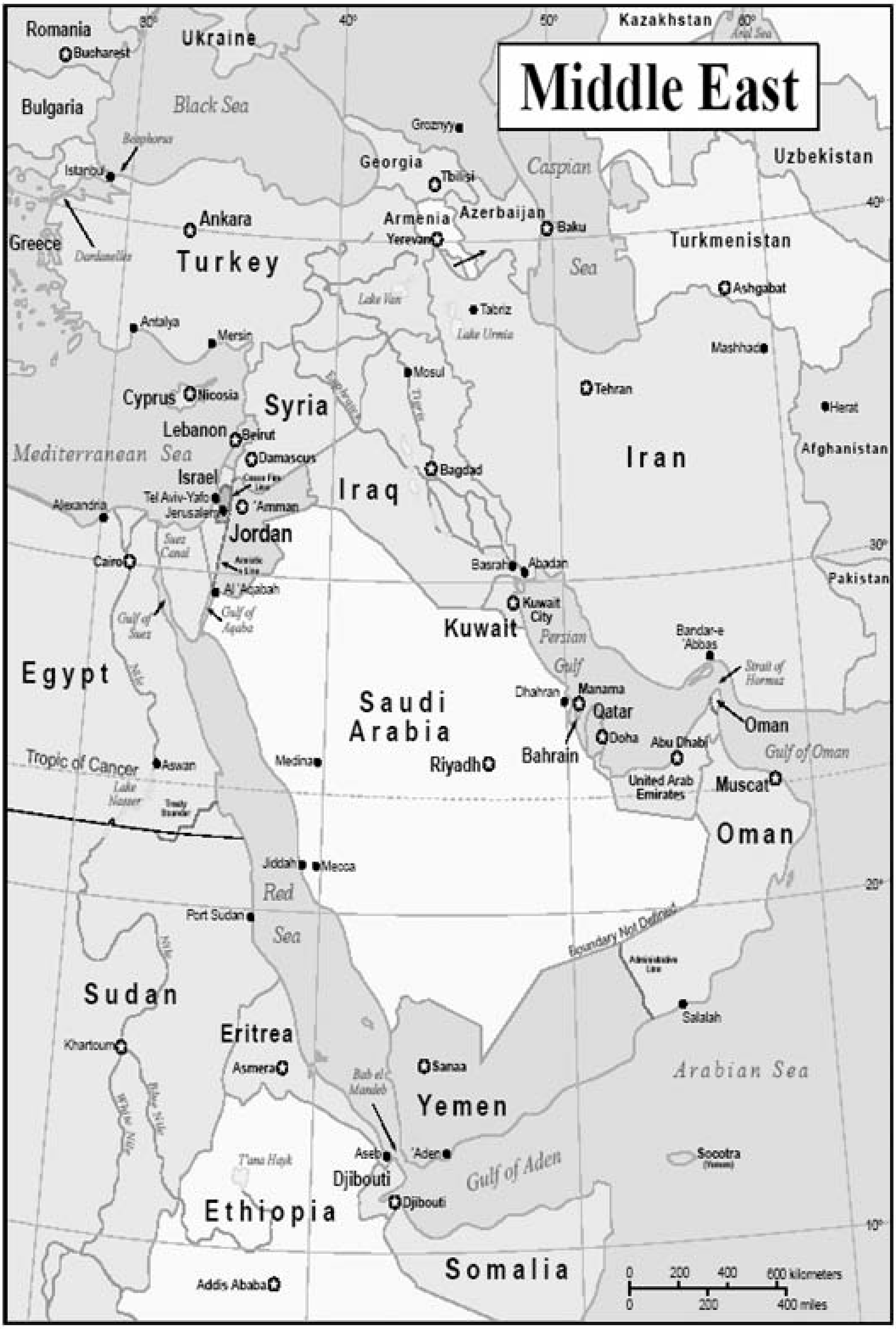
GLOSSARY

CA	-	Current Account
CPI	-	Consumer Product Index
CPM	-	Capability Poverty Measure
EF	-	Ecological Footprint
ES	-	Environmental Space
ESCWA	-	UN Economic and Social Commission for Western Asia
FDI	-	Foreign Direct Investment
GATT	-	General Agreement on Tariffs and Trade
GCC	-	Gulf Cooperation Council
GCI	-	Global Competitiveness Index
GDP	-	Gross Domestic Product
GNI	-	Gross National Income
GOIC	-	Gulf Organization for Industrial Consultancy
GPI	-	Global Peace Index
GPP	-	Gross primary production
Green NNP	-	Green Net National Product
GS	-	Genuine Savings
GSDP	-	General Secretariat for Development Planning
GSM	-	Global System for Mobile Communication
GTL	-	Gas to Liquid
GTZ	-	German Technical Cooperation
HANPP	-	Human Appropriation of NPP
HDI	-	Human Development Index
HMC	-	Hamad Medical City
HRD	-	Human Resource Development
HRM	-	Human Resource Management
ICT	-	Information and Communication Technology
ictQatar	-	Supreme Council of ICT in Qatar
IMF	-	International Monetary Fund
IPD	-	Investment Promotion Department
IPR	-	Intellectual Property Rights

ISEW	-	Index of Sustainable Economic Welfare
ITU	-	International Telecommunication Union
KPI	-	Key Performance Indicator
LLC	-	Limited Liability Companies
LNG	-	Liquid Natural Gas
MID	-	Mesaieed Industrial City
NVQ	-	National Vocational Qualifications
NPP	-	Net Primary Product
OECD	-	Organisation for Economic Cooperation and Development
PDQ	-	Petroleum Development Qatar
PC	-	Planning Council
PIRLS	-	Progress in International Reading Literacy Study
PISA	-	Programme for International Student Assessment
QAFAC	-	Qatar Fuel Additive Company
QAFCO	-	Qatar Fertilizing Company
QAPCO	-	Qatar Petrochemical Company
QASCO	-	Qatar Steel Company
QChem	-	Qatar Chemical Company
QFC	-	Qatar Financial Centre
QGPC	-	Qatar General Petroleum Company
QIDB	-	Qatar Industrial Development Bank
QIMC	-	Qatar Industrial Manufacturing Company
QMS	-	Quality Management System
QNRF	-	Qatar National Research Fund
QSTP	-	Qatar Science and Technology Park
RasGas	-	Ras Laffan Liquefied Natural Gas Company
RBV	-	Resource-Based View of the Firm Theory
R&D	-	Research and Development
ROI	-	Return on Investment
SCENR	-	Supreme Council for Environment and Natural Reserves
SEC	-	Supreme Education Council

SD	-	Sustainable Development
SMS	-	Safe Minimum Standard
TAFE	-	Technical and Further Education
TAMUQ	-	Texas A&M University at Qatar
tCO2	-	Metric tonnes of carbon dioxide
TFP	-	Total Factor Production
TIMMS	-	Trends in International Mathematics and Science Study
TRIP	-	Trade-Related Aspects of Intellectual Property Rights
TT	-	Technology Transfer
UAE	-	United Arab Emirates
UN	-	United Nations
UNCTAD	-	United Nation Conference on Trade and Development
UNFCCC	-	UN Framework Convention on Climate Change
UNDP	-	United Nation Development Programme
WEF	-	World Economic Forum
WIPO	-	World Intellectual Property Organization
WTO	-	World Trade Organization

Figure (i): Geographical Location of Qatar



Source: Qatar: 2004 Country Review. Country Watch. Http://www.countrywatch.com

Figure (ii): Map of Qatar

Source: Qatar: 2004 Country Review. Country Watch.
Http://www.countrywatch.com

CHAPTER ONE

Beyond Technology Transfer:
Making the Case for a Study of Qatari Technological Development

1.1 Obstacles to Sustainable Development in Qatar

Over the past ten years, Qatar has seen an unprecedented boom in its economy. It began producing liquefied natural gas in 1991 from reserves estimated to be nearly fifteen percent of the world's total.[1] The high value of oil and gas output relative to its population size has allowed Qatar to remain among the world's highest per capita income countries for several years, and it continues to climb toward the top of the list. However, economic growth derived exclusively from increased utilization of natural resources cannot be sustained over the long run because of impending diminishing returns. Qatar needs to diversify into non-hydrocarbon activities such as investments in education for Qatari citizens, diversification of external financial assets, and geographic diversification of real and financial assets.

Before 1985, Qatar's unspoken competition with neighboring countries prompted a great deal of unfocused major capital spending that was beyond the country's absorptive capacity. Later, Qatar took the advice of the International Monetary Fund (IMF) and the World Bank and began concentrating capital to invite foreign investment, develop the public sector, and create a financial center and a free trade zone. Would this competition serve the grand sustainable development strategy? From the perspective of the government, foreign direct investment (FDI) is not a priority because the government itself has enough capital to fund its major projects, thereby retaining complete control.

Qatar's transformation from a fishing and pearl-diving society to a country with the highest per capita in the world has shaken its political, economic and socio-cultural fabric. At the same time, government practices have created intricate obstacles to sustainable development. When Qatar invited multi-national companies and employed expatriates to develop its natural resources, Qataris became minorities in their homeland with a size less than a quarter of the population, thereby exponentially complicating political, economic and socio-cultural issues.

Other challenges to sustainable development in Qatar include political, social, technological, environmental and legal issues. On the political front, Qatar will need to work to maintain internal stability and its moderate foreign policy, promote the participation of citizens in decision making, and capitalize on its solid relationships with the West and the Far Eastern countries. In the economic sphere, Qatar must create growth through an emphasis on diversity, competitiveness, resilience and integration with global economy. It also must maintain its fiscal discipline, build a strong financial infrastructure and develop a flexible labour market that includes the private sector. On the social front, Qatar must address population planning, improve coordination between education and labour markets, and enhance its general and vocational education systems. Technologically, Qatar must select both appropriate and environmentally-friendly technology in order to conserve natural resources and promote sustainable development. Along with this, the Supreme Council for Environment and Natural Sanctuaries must reinforce its institutional capabilities and employ a network of experts to implement plans related to capacity-building, education, training and awareness-raising to protect the environment and to enhance the development of water resources. Finally, on the legal front, Qatar has to move away from financially repressive policies and implement a prudent macroeconomic policy, along with making necessary structural reforms.

The myriad of obstacles to sustainable development in Qatar summarized here cannot be meaningfully attended to in this dissertation. However, there is a common variable among these obstacles: technology. It is the common denominator of the foreseeable economic growth that the country aims to attain and sustain.

Technology can be generally defined as "the entities, both material and immaterial, created by the application of mental and physical effort in order to achieve some value."[2] The word "technology" is sometimes acknowledged as techniques which signify human skills, processes and technical methods in problem solving, resource management, achievements, and fulfillment of needs. This includes computer software and business methods.

Contemporary economic growth depends on the successful application of technology.[3] According to the Organization for Economic Co-operation and Development (OECD), "achieving sustainable development goals at a global level will strongly depend on the rapid technological development and innovation, and the widespread diffusion and application of cleaner technologies."[4] There is a need to extend our exploratory search into this domain to find the relationships between this variable and economic growth, the creation of wealth, and sustainable development.

1.2 The Importance of Technology

The importance of technology in raising productivity and improving welfare has long been a fact. Even today, scholars of economics view successful technology implementation as the major factor of long-term growth. Technology and innovation can increase production through the improvement of existing products, reduction of production costs, and the introduction of new materials. Initiatives of introducing new or improved technology means changes in organization structure, management skills, and internal processes that ultimately needed to increase productivity.

Successful technology transfer which ensues from economic activities seeks to profit from the introduction of new products[5] or the improvement of existing ones.[6] Such innovation capabilities normally reside in small number of advanced courtiers that have the right skills and infrastructure in place to invest heavily in research and development. Consequently, enterprises in these countries possess the majority of patents. Less advanced countries can benefit from absorbing technology from advanced countries and are likely to increase productivity through imitation and adaptation of advanced technologies.[7]

Historically, accumulating knowledge and expanding its use represent the main pillars of GDP growth.[8] Taiwan and South Korea have been very successful in industrial development after building the legal and institutional infrastructures with the political environment to encourage human and physical capital investment. Although scholars agree that technology must be part of economic growth model, their understanding varies.

Successful technological and industrial developments depend on the process of managing technology in an enterprise through acquiring, adapting, and innovating upon existing technologies.[9] Hence, technological capability is central to enterprise's overall capabilities. South Korea and Taiwan, and similar others countries, followed advanced countries and introduced technology by adopting and adapting processes. This is a follower's strategy. However, the difference with advanced countries is that advanced countries use the process of innovation to develop their products. This investment requires firms to incorporate advanced technologies into manufacturing processes, such as automobile manufacturing, and to train personnel to use them as these technologies are often essential components of machinery and other equipment.

This ongoing process falls within the concept of dynamic comparative advantage. In this context, dynamic comparative advantage focuses on developing production capabilities, preferably with government support, to utilize its strengths. Advanced technology will spread to every participant once a country builds its dynamic comparative advantage.[10]

In short, fast growing economies are technology intensive. In such countries, research and development (R&D) is strongly associated with growth in productivity. Innovation raises productivity and increases knowledge, collaboration with advanced countries helps to diffuse technology to developing countries, and technological capabilities are a central element of an economic centre's overall capabilities. Therefore, the real questions for Qatar are:

- Does Qatar already possess these technologies or have the capacity and the motivation to take advantage of other sophisticated technology options?
- What are Qatar's needs? And
- What barriers must be removed?"

The answers are clear. Technology must be transferred and used effectively to balance the paucity of native population in Qatar.

This dissertation will explore technology transfer in Qatar and assess its effectiveness. It will explore government agencies involved in technology transfer, the departments devoted to research and development at Qatari universities, and various Qatari industries, particularly in the energy sector. Although Qatar is one of six oil producing Gulf States countries that are experiencing the same phenomenon, Qatar has its own unstudied peculiarities. It is important to reach a full understanding of the challenges Qatar must overcome in order to select and present appropriate solutions. In order to do this, it is helpful to profile the historical development of Qatar.

1.3 Three Eras of Economic Development

In the 1950s, the production of oil led to the creation of both financial and governance structures in countries in the Middle East. Unlike other oil companies in the region, Petroleum Development Qatar (PDQ), an American, British, French and Dutch owned company, resisted involving itself in this process.

Table 1.1: Initial Formation of Qatar's Modern State

Year	Events
1950	Initial phase of financial and security development. PDQ resists participating in Qatar's development.
1952	Administrative control begins. Qatar begins to import clothing, machinery and equipment. First school built. Shell company given concessions for offshore oil exploration.
1953	Qatar's first refinery built.
1954	Public sector employees total 42.
1956	Protective nationality laws passed.
1957	Labour legislation passed.
1959	Establishment of labour department for oil industry workers. First full hospital built. Police force established.
1960	Offshore wells discovered.
1962	Labour laws passed.
1964	Commercial law 20/63 stipulates minimum 51% Qatari ownership in any commercial venture. Law grants lands to low income Qataris.
1965	Cement factory built.
1968	National Oil Distribution Company (NODCO) established.
1969	Qatar Fertilizing Company (QAFCO) established.

Source: The Author organized extracts from various books and government sites**.**

The economic playing field remained diversified. Machinery and equipment-based industries replaced the traditional commercial activity of pearling. The development of financial, security, administrative, economic and social infrastructure began transforming Qatar into a modern state, albeit very slowly. Table 1.1 summarizes this development.

When Sheikh Khalifa dethroned his predecessor Sheikh Ahmad in a peaceful coup in 1972, a period of stability and economic progress followed (Table 1.2) in which Qatar rapidly developed its infrastructure. Ahmad governed initially through a horizontal organizational structure with 33 major departments directly reporting to him. This organization was later reshuffled down to ten ministries due to the administrative difficulties of maintaining such a wide span of control. This period is also characterized by industrial development.

Table 1.2: Era of Economic Stability

Year	Events
1971	British give up control over the peninsula. Qatar becomes independent. North gas field discovered.
1972	Sheikh Khalifa resumes power. Advisory council of Qatari notables established.
1973	Oil prices skyrocket. Fertilizer production ensues.
1974	Qatar General Petroleum Company (QGPC) established. Second refinery built. Qatar Steel Company (QASCO) established. Qatar Petrochemical Company (QAPCO) established.
1975	Qatar Department of Legal Affairs established.
1976	QGPC gains total control over Qatar Petroleum Company QPC, a British Company. Gulf Organization for Industrial Consultancy (GOIC) established.
1977	QGPC’s total control over Shell begins.
1978	Steel mill production begins.

Source: The Author organized extracts from various books and government sites.

In the 1980s, falling oil production, the Iraq-Iran War, and Qatar’s territorial disputes with Bahrain over Hawar island coupled with Sheikh Khalifa’s cautious policies, resulted in a nearly complete halt to Qatar’s infrastructure development except for the Liquefied Natural Gas (LNG) sector. This trend continued into the 1990s. It was obvious that Qatar’s economic well being required the exploitation of its huge natural gas resource. Therefore, appropriate technology was needed to condense natural gas into liquid and ship it overseas to major customers in East Asia, Europe, and the United States.

Natural gas production was carried out in phases. Phase one was to serve the local industry. Phase two was dedicated to serving neighbouring countries, including Kuwait, UAE and Oman. Phase three was planned for Europe and the Far East. Qatargas was established to manage, operate, market and export LNG. Having failed to secure any long term supply contract in the 1980s, Qatar decided to develop domestic projects to utilize its gas and upgrade its oil facilities. On the oil production side, only little a success was achieved.

A new era in Qatar’s modern history started in 1995 (Table 1.3) with the rise of visionary ruler, Sheikh Hamad Bin Khalifa Al-Thani. He actively promoted public participation in decision-making, provided guidelines for the adoption of modern educational techniques and curricular development, promoted scientific planning to develop the economy, stimulated the private sector, and last but not least, promoted optimal utilization of natural resources.

In 1998, Qatar implemented a radical economic development policy. It borrowed heavily to finance the development of its natural gas reserve (the third largest in the world) and increased the export of petrochemicals. The government also invested $5 billion into the further industrialization of non-oil-and-gas-dependent sectors. This led to the development of the steel, iron, cement, besides fertilizer and petrochemical dependant industries.

Around the same time, the Ministry of Commerce and Trade (created in 2002) promoted investment in the industrial sector through international trade missions and commercial law reforms. The state-owned Qatar Industrial Development Bank was established to encourage new industrial and economic development projects and to finance small-to-medium joint venture projects.

Table 1.3: Economic Boom Era

Year	Events
1984	North Gas Field developed due to falling oil production.
1991	The North Field Alpha Project begins producing natural gas and condensate.
1993	RasGas (Ras Laffan Liquefied Natural Gas Company Limited) established by Emiri decree, a part of the creation of a Qatari liquefied Natural Gas (LNG) export industry.
1994	Qatar joins the World Trade Organization.
1995	Sheikh Hamad Bin Khalifa Al-Thani becomes ruler. Industrial law allows foreign investment up to 49%.
1996	Qatar Foundation established to promote education and R&D.
1998	Qatar borrows heavily to develop its LNG Infrastructure. Qatar Chemical Company (QCHEM) established.
1999	First Central Municipality Council elections. Production of LNG from Train 1 commences. * Qatar Fuel Additive Company (QAFAC) established to produce Methanol.
2000	Investment Law allows 100% foreign ownership. Production of LNG from Train 2 commences. Supreme Council for Economic Affairs established to advise country's economic investment.
2001	Ras Laffan Liquefied Natural Gas Company Limited (II) established to manage Trains 3, 4 and 5.
2002	Ministry of Commerce and Trade created. The World Petroleum Congress rates RasGas one of the best 30 LNG companies worldwide.
2003	Qatar Petroleum and Exxon Mobil Corporation sign agreement for RasGas (II) to supply 15.6 Mta of LNG to the United States for a period of 25 years from 2008/9. Qataris sanction a permanent constitution in a national vote.
2004	RasGas takes delivery of its first dedicated LNG carrier, the Fuwairit. The second, the Maersk Ras Laffan, is delivered in May 2004. Train 3 produces its first LNG and the first shipment leaves for India. Work on train 5 has begun. It is intended to ship to Italy and Belgium.
2005	Ras Laffan trains 6&7 begun to be commissioned in 2008 & 2009 respectively with the intention to ship to the USA. Train 4 commissioned.

Source: The Author organized extracts from various books and government sites

*** Note:** A Train is an independent unit for gas liquefaction

An investment law passed in October of 2000 contained provisions for up to 100% foreign ownership in the health, education, tourism sectors and in small-to-medium size industries. Foreign owners can currently lease land for up to 50 years.

With all of these aggressive changes, it is no wonder that Moody's rating agency gave Qatar a score of A3, a strong rating attributed to the privatization programmes, such as utility privatization, and the sale of 15% of government shares to local investors in companies like Qatar Petroleum, Qatar Fertilizer, Qatar Fuel Additives and Steel.

1.4 Analysis of the Three Eras

Political infrastructure has the potential to help maintain internal stability and positive foreign relations, slowly leading to the increased participation of citizens in decision making and the continued prosperity brought about by excellent relations with the West and the Far Eastern countries. Qatar is considered a stable state. This is extremely an important factor to develop its economy and encourage foreign investment. Internally, its government is not threatened by any militancy or viable opposition groups. Externally, there is no emerging threat to its resources from a rogue state or ruler and Qatar's own rulers command respect from the regional kings and sheikhs. Qatar has a stable, heredity-based monarchy, a moderate foreign policy, and a pro-Western orientation.

On the external front, Qatar maintains close relations with USA and the fact that Qatar hosts of a large number of US military assets on its soil makes it impossible for any foreign aggressor to eye Qatar's natural resources. Also, Qatar settled its borders disputes with Bahrain permanently through the International Court of Justice in March of 2001. This exemplary conflict resolution allowed for more stability and government attention to internal development. Also, Qatar has boldly agreed to house United States military forces in the country. Currently, over 5000 airmen and women, along with their equipment, are operating from Al-Udeid Air Base in Qatar. This action has bolstered confidence for economic development, protected Qatar from its ambitious neighbours, including Iran and Saudi Arabia, and opened the doors for direct foreign investment.

To sustain itself, Qatar must work to ensure that its political, economic, social, and environmental spheres complement and serve one another. However, Qatar has no meaningful national development plans thus far. The plans that are currently developed every five years are mostly incoherent; instead, Qatar needs to develop a set of long-term objectives. This is essential, particularly given the fact that the surplus budgets and savings are in danger of being misspent in the face of conflicting needs, which would ultimately retard Qatar's economic acceleration substantially. Political, social and environmental problems are also likely to emerge requiring the diversion of resources from the economic growth of the country toward the solution of international problems.

On the economic front, Qatar is recording one of the highest growth rates in the world.[11] Qatar's strong economy is characterized by abundant natural reserves, financial stability and sound infrastructure. Citizens enjoy excellent living standards. Economic conditions are predicted to grow steadily due to the presence of one of the largest single natural gas reservoir. According to the International Monetary Fund (IMF), Qatar's gross domestic product (GDP) increased to 9.3% in 2004, but is projected to decrease to 3.5% in 2007 due to recent investments in liquefied natural gas (LNG) infrastructure.

Though strong oil prices have allowed Qatar to achieve a number of development plans in recent years, the government has rested its future on the cultivation of LNG in the hopes that it will encourage foreign investment and technology sharing and will ensure that the country has a fixed source of income in to offset volatility in the oil market. At the same time, Qatar is also pursuing plans to expand its refining capability and downstream (petrochemical) industries even as it continues to invest in its sustainable oil production capacity. How effective are these plans to the country sustainable development and technology transfer is a question unanswered.

Other projects include the creation of new economic zones and the establishment of more non-oil based industries. Qatar advocates free foreign investment in the fields of education, medicine, tourism, and industry and Qatar Development Bank has been established to promote development of small to medium sized industries. According to the Ministry of Economy and Commerce, Qatar is expected to attract investment in excess of $130 billion in the next 10 years.[12] A large portion of the investments will enter the strategic energy sector. However, there will also be significant investments in utilities, airports, free trade zones, transportation infrastructure, sports complexes, health and other sectors. Will the technologies transferred resides in country at the end of each project? Is there a plan in place to ensure indigenous capability enhancement? These questions need to be evaluated.

To facilitate enormous volume of investments, the Ministry of Economy and Commerce has prompted the government to set up the Qatar Financial Centre (QFC), a premier financial regulatory authority. In less than a year of operations, it has received applications and expressions of interest from over 30 world class financial houses and service companies. The ministry is also in the process of drafting legislation aimed at making the Qatari private sector more competitive.

Though Qatar also has structures in place to manage the development process and to control the means of production, particularly in the industry, the private sector is still underdeveloped. Qatar has no sustainable development strategy for the private sector despite various attempts over many years to address this issue within and outside of the gas reserve development context. At the same time, Qatar’s small population has forced the country to employ expatriates to develop the economy’s infrastructure. Currently, expatriates form a ratio of eight to one with the local workforce. This ratio is expected increase as Qatar invests $130 billion to further develop the natural gas reserves. Although Qatar has the highest GDP per capita, it scores lowest in labour market employment in comparison with its neighbours.

In the future, Qatar must focus on promoting economic growth, increasing economic resilience and competitiveness, diversifying its economy, integrating with the global economy, continuing its disciplined approach to fiscal matters, continuing to build its strong public sector, and creating a flexible labour market. Qatar may not need a comprehensive sustainable development policy if the private sector is allowed to freely participate in the local economic development. However, Qatar will certainly need a more profound and comprehensive development policy for the private sector to encourage the creation of new projects and businesses so that it can maintain sustainable growth projections well into the 2020s.

On the social front, Qatari nationals are a minority in their own country, accounting for less than a quarter of the total population of 744,000. At the same time, Qatar has one of the highest population growth rates in the Middle East, averaging around three percent per annum over the past decade. Figures released by the Planning Council show Qatar's population totaled only 369,000 in 1986. It grew to around 522,000 in 1997 and the growth rate peaked in the middle of 2004. Estimates by the government-controlled Qatar National Bank put the population at around 845,000 at the end of 2005. For security reasons, official statistics do not include breakdowns of nationalities, but workforce statistics indicate that Qataris occupy 43% of the total available jobs in the market. However, they only occupy 24% in the private sector. Taken together, Qataris, other GCC citizens, and Arabs make up 64% of the total workforce with only 46% in the private sector.[13]

Like other Gulf States, Qatar is trying to reduce its foreign population by reducing its reliance on expatriate labour. The campaign to replace expatriate labourers with nationals has paid off; by the end of 2004, Qataris dominated the workforce in the public sector at around 25,000 nationals employed out of the 38,000 total civil servants in ministries, or 66%. This ratio resulted from massive layoffs of foreign workers without replacement. It indicates a masked unemployment. However, in government-owned companies, Qataris were estimated at around 8,700, which is less than a third of the total of 29,000. Qataris were also a minority in the joint public-private establishments, accounting for around 2,700 of the total workforce of nearly 13,900. In major private institutions, only 556 Qataris were employed out of the total 5,500. A breakdown showed expatriates from India, Pakistan and other South Asian countries dominating the labour force outside the ministries. They total around 12,800 in government-owned companies, 7,800 in joint public-private institutions, and over 3,000 in major private establishments.

The reason why job nationalization programmes (or Qatarisation of workforce, as it is called) in the private sector have not made any meaningful headway is because the Qataris themselves are reluctant to join the private sector. They are satisfied with the greater emoluments, shorter work periods, and better job security in the public sector. Moreover, private sector employers favour foreigners, who are generally less expensive and more skilled. The indigenous work force needs to develop its absorptive capacity to compete in the labour market.

Qatar currently imports technologies, but there is no evidence to indicate whether or not the country is capable of absorbing these technologies into the fabric of society. There is no science and technology policy or industrial policy. Qatar has invited universities from the United States to open branches in the country and has utilized research and design laboratories in Qatar Science and Technology Park to commercialize start-up projects and products that benefit national industries, especially in the gas and oil sectors. However, it is not known how successful these universities were in transferring technology. In addition, the Supreme Council for Information and Communication, a body to oversee the country's information and communication strategies, has taken both roles of legislation and execution.

The Qatari government continues to encourage investment in the country in order to bring in new technologies and to sustain development across all sectors. The natural gas reserve development requires technologies to convert gas to liquid form using environmentally clean processes. Oil reserve life extension plans are in need of increased extraction process efficiencies. The medical service industry is already privatized and open to 100% foreign investment. The health services constantly strive to increase efficiency and to decrease costs. The demand for power is increasing due to the growing power requirements from new industries, plans to expand the oil and gas industries, and increases in household consumption. The building and construction industry faces a surge in demand for infrastructure development. The industry is in need of updated construction equipment, consultancy skills, and new technologies. The transportation and communication industry is expanding ambitiously. Qatar Airways is doubling its fleet size, and Qatar Telecommunications (the monopoly provider) has plans to expand its Global System for Mobile Communication (GSM) coverage and internet services. The education sector is undergoing reforms that will reshuffle the Ministry of Education and help bring Qatar into a new era of education.

Qatar is at the centre of economic development in the Middle East. Focusing on sustainable development and appropriate use of natural resources will be critical as the country moves forward. Developed countries that have already gone through the learning curve are now focused on conservation. Therefore, the technology employed in developing countries should primarily be state of the art, low or no waste technology.[14]

The requirements for Qatar’s economic future, therefore, are evident: the country must select appropriate technology and conserve natural resources. The implementation of technological policies has to be done one step at a time for an economy in transition. Objectives must be set using the latest trends in science and technology. Qatar’s plans for the promotion of technologies in the future should be linked to international databases and should encourage local colleges and universities to conduct research and development projects through these mediums. Finally, just as the economic benefits are distributed among the State, local bodies, industries, and individuals, so must the objective of sustainable development be met through collective effort of all these entities. All must work together to create policies and practices that promote economic and social development in order to hand down a clean technology to future generations.[15]

In summary, sustainable development and technology transfer activities are necessary to the development of Qatar’s political, economic, social, technological, environmental and legal realms. Qatar needs to take stock, to establish how effective it has been, and to place greater emphasis on indigenous technology development. This dissertation will explore sustainable development and technology transfer activities in Qatar and assess their effectiveness.

1.5 Aim

The purpose of this study is to:

> **Assess the effectiveness of technology transfer in Qatar's search for sustainable development.**

The scope of the dissertation is confined to an analysis of government agencies involved in technology transfer such as the Planning Council, the Ministry of Economy and Commerce, the Ministry of Interior, the Ministry of Defence, the

Ministry of Education, the Ministry of Industry and Energy, and the Ministry of Municipal Affairs and Agriculture. The scope will also include an examination of all research and development labs at Qatar University and at other universities operating in Qatar. Finally, it will include Qatar major industries particularly the energy industry.

1.6 Objectives

The objectives of the study are to:

- Explore recent literature on sustainable development and technology transfer
- Establish a link between sustainable development and technology transfer
- Establish measures of sustainable development
- Establish measures of technology transfer
- Provide an up-to-date assessment of technology transfer in Qatar
- Suggest policies for implementation in industries, government sectors, and R&D laboratories in Qatar related to technology transfer and sustainable development

1.7 Value of Study

This dissertation will fill a gap in the literature related to technology transfer effectiveness because few studies have measured technology transfer effectiveness and none have studied technology transfer or analyzed its effectiveness in Qatar. This study will also serve as a starting point for future research. It will be a tool for government agencies, universities and industries in the country that will facilitate the measurement and review of their technological capabilities, absorption and innovation. The policy recommendations will provide pragmatic strategies that can be adopted to develop the domain of technology transfer.

The strength of this study stems from its perspective and approach in examining technology transfer effectiveness. It sees technology transfer as a means to develop and sustain Qatar’s economy and create wealth for an affluent society characterized by complacent citizens and a benevolent government. Exploring incentives to encourage citizens to play a leading role and to build their skills within such a unique social context has yet to be done.

Perhaps the most valuable aspect of this study is its potential to build an awareness of the efficiencies and inefficiencies of Qatari organizations' initiatives in the technological arena. These organizations and their stakeholders will be able to assess their progress using benchmarks developed for either local or international entities.

1.8 Study Methodology

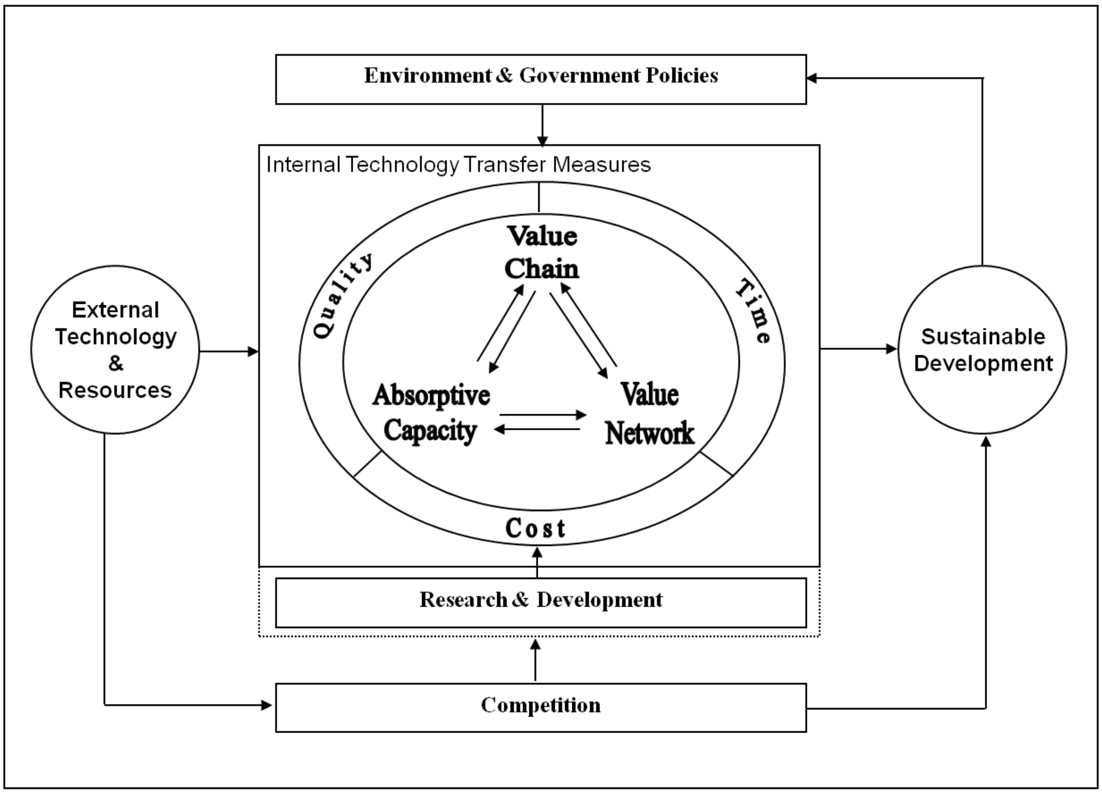
"If performance isn't being measured, it isn't being managed."[16] Measurement is the groundwork that must be done to effectively manage organizational systems. It is a primary tool for allocating resources, monitoring achievements, and communicating and envisioning improvements. The selection of measures helps to determine the organization's effectiveness. Without a defined set of measures, the desired performance cannot be achieved. With incorrect measures, the organization’s performance is sub-optimized. This study must develop total measurement systems which are relevant and productive. [16]

To develop sound measures, the most significant output must be identified. To this notion, Gilbert adds the identification of "critical dimensions" of quality, productivity, and cost.[17] He explains that a researcher must define the critical dimensions in a particular context and build measures for each.

Based on the above, it is concluded that to manage technology, its performance must be measured effectively. However, the literature review reveals only fragmented approaches to the analysis of effective technology transfer. Most of the studies focus on a particular sector or individual entity such as universities, industries, or government institutions. The literature further reveals sets of measures related to various aspects of technology transfer effectiveness, generally focusing on external and internal measures, quality and production cost measures, and characteristics of research and development, absorption capacity, innovation and training effectiveness. It also covers measures designed to assess knowledge transfer, reputation, culture, human resource management, and corporate strategies. Most indicators are classified in accordance with a particular context and are aligned with a particular author's philosophy, beliefs and approach.

In this study, the topic mandates a holistic view of technology transfer effectiveness. Therefore, the author has crafted a study methodology framework to research the technology transfer effectiveness in Qatar with respect to its contribution to the sustainable development of the country. For a more comprehensive understanding of the framework of this study, refer to Figure 1.1 below.

Figure 1.1: Technology Transfer Effectiveness Study Model



Source: the Author designed the most appropriate framework for Qatar after scrutinizing the literature

The study will provide an introduction to the concepts of sustainable development and technology transfer. To best analyze these concepts, they are first broken down into component parts that are drawn from the literature. Also addressed are a variety of related industries, institutions, and universities. The overall model is then reassembled in chapters five and six, providing a holistic understanding of the relationship between technology transfer and sustainable development.

The study has one major aim: to assess the effectiveness of technology transfer in Qatar's search for sustainable development. Technology transfer is an activity that includes, but is not limited to, evaluating invention disclosures, filing patents, marketing, protecting intellectual property, creating and promoting new business, and producing new tangible products and high-quality jobs – thereby expanding the economy. The effectiveness of these activities will be discussed in detail.

Logically, technology is transferred into a country from an external source through various means such as foreign direct investment, licenses and patents, collaboration, and joint ventures. The transfer method used influences the effectiveness of the technology sought.

At the heart of the study framework, there are three main groups of measures: value chain, absorptive capacity, and value network measures. Technology is employed in almost every value-creating activity, including inbound and outbound logistics, internal and external operations, marketing and business development and last but not least, sales and services. Any change in technology can affect competitive advantage.[3] Appropriate measures will be derived to evaluate value chain activities in relation to technological capability. The value chain is criticized as being "a linear mechanistic model" of business, inadequate to understand the complexity of value in the knowledge economy.[18] The value network concept still employs the value chain concept, but also adds the concept of intangible value exchange, thereby addressing knowledge and benefits that include strategic information, planning, process and technical knowledge, and cooperative strategies.

Absorptive capacity theory measures the manner in which incoming technology is assimilated into R&D, marketing, production, finance, and human resources.[19] Building absorptive capacity requires substantial investments in intangibles (i.e. external sources of technology, training, managerial skills and R&D), and requires more time than it requires technological capabilities. The study will focus on measures to ascertain the absorptive capacity level of the individual entities under study and will then project an overall picture of absorptive capacity in the country.

Measuring absorptive capacity creates a few challenges for this study. For one, research and development not only generates knowledge, but it also contributes to a firm's absorptive capacity. Research and development is also an activity external to a firm. The dotted line in Figure 1.1 indicates that in some organizations, R&D offices are actively involved in technology transfer. In this case, the study will treat R&D as an internal factor.

As a result of increased national and international competition, institutions are urged to generate funding for research and development,[20] use competitors' benchmarks and monitor their activities to reveal trends in the market.[21]

Environmental factors heavily influence the decision to adopt a particular technology. These factors are the events occurring in the country or the external world within which the organization operates. Such factors can impede technology diffusion and jeopardize the successful implementation of technology within the organization. Thus, a technology transfer system must be responsive to the country's environment. This study will focus on aspects of the political, economic, social, cultural and legal environments that shape, direct or affect the outcome of technology transfer activities. The study will also focus on the government's sustainable development and other policies.

In summary, following an examination of Qatar's historical development, present situation, and future challenges, this study will highlight the most pressing issues facing the country. One of the main challenges Qatar is likely to face is a question of how to transfer the technology needed for economic development, especially as oil and gas development are heavily dependent on new technologies and innovation to meet environmental standards and to be transported safely and efficiently. The research will use the study methodology framework to look closely at the disciplines of sustainable development and technology transfer in more depth. At the same time, the study will attempt to draw some conclusions regarding the effect of technology transfer on sustainable development. The literature will then focus on the criteria used to measure technology transfer effectiveness. It will discuss the appropriate measures suitable for use in Qatar, then adopt, adapt, or create criteria to be used to measure technology transfer effectiveness in selected local industries, R&D laboratories and government agencies. Data will be gathered through the research process, selected based on the criteria given in the research methodology section, analyzed and presented.

The ultimate aim, then, is to assess technology transfer in Qatar, develop a framework to measure its effectiveness with regard to sustainable development, and make policy recommendations to improve the effectiveness of technology transfer.

The following section attempts to chart the best research methodology for the dissertation.

1.9 Research Methodology

> The tension between the study of the unique and the need to generalise is necessary to reveal both the *unique* and the *universal* and the *unity* of that understanding.[22]
>
> (Simmons, 1996, p.238)

The author conducted an initial literature review to have a clear theoretical understanding of the appropriate research methods to employ in this study. Building a comprehensive collection of relevant research is indeed a complex endeavour. The journey begins with the philosophical and branches out to the more intricate, interrelated relationships of different paradigms. Table 1.4 summarizes the Author's research methodology.

Philosophy is the discipline concerned with ethical inquiry of how one should live, metaphysical inquiry of dealing with the ultimate nature of what exists, epistemological inquiry of what genuine knowledge counts, and logical inquiry of the correct principles of reasoning.[23] At an ethical level, research branches into major paradigms of meta-ethics, normative ethics, descriptive ethics, and applied ethics.[24] At a metaphysical level, all research projects must fit into the major paradigms of ontology, theology and universal science.[25] At an epistemological level, research is confined to the major paradigms of naturalism, positivism, interpretivism, constructivism and postmodernism.[26] Topics at the logical level cover syllogistic logics, predicate logics, modal logics, deduction and reasoning, mathematical logics, philosophical logic, computation logics and argumentation theory.

Table 1.4: Research Methodology for Present Study

RESEARCH METHODOLOGY			
Purpose of research	**Stage One**	**Stage Two**	**Stage Three**
	Review existing measures of technology transfer effectiveness	**Measure existing technology transfer process and activities in Qatar**	**Provide policy recommendations to develop technology transfer and present framework to measure technology transfer effectiveness**
Type of research	Exploratory	Descriptive and analytical	Predictive
Research approach	Deductive	Deductive Applied research Quantitative Induction for social context	Deductive
Philosophy	Positivistic	Positivistic and phenomenological	Positivistic
Research strategies	Survey	Survey Cross-sectional Ethnography	Survey
Data collection methods	Secondary data	Questionnaire Interview	Primary and secondary
RESEARCH METHODOLOGY			

Source: A designed methodology suitable for this study; The Author.

Exploring philosophy is important in selecting a research methodology for three reasons. It can clarify the research strategy to be used, assist the researcher in developing appropriate methods, and allow creativity in selecting and adapting the methods.[27] The researcher's experience, understanding of philosophy and personal beliefs may influence the method adopted.[28] Saunders et al support this notion and argue that research methodology mainly depends on the researcher's philosophy about the development of knowledge.[29]

Researchers must consider four areas when selecting a research method: "the philosophical model and aim of the research, the nature of the interest, the level and nature of the research questions, and any considerations related to the research setting and resources used."[30] Proctor emphasizes consistency between research aim, questions, the chosen methods, and the personal philosophy of the researcher.[31] From this, it is possible to conclude that many factors play a role in the selection of research methodology, but in essence this process must include the researcher's philosophy, the research aim and purpose, the phenomenon of interest, the availability of resources, and the research questions.

The author's research philosophy stems from the belief that philosophy disciplines are interrelated and cannot be understood in isolation. Furthermore, in research, the problem under investigation drives the method. This practical approach to the adoption of techniques across disciplinary borders in order to explore solutions requires the researcher to be aware of a variety of theoretical perspectives and various qualitative and quantitative methodologies. The author believes that a researcher should seek to find equilibrium between theory and practice. One must be clear about his or her ontological orientation to understand and justify the epistemological philosophy chosen for the research.

The field of business and management science, which is the field of this research project, contains a vast diversity of both interdisciplinary and multidisciplinary theoretical approaches.[32] This can lead to the adoption of incompatible laws or "caricatural antinomies" between different perspectives.[33] However, it can also provide insights other separate disciplines cannot achieve.[34] Saunders et al believe that business and management research can situate itself in many places along a continuum of basic research at one end and applied research at the other end because the research process can vary.[29]

Most scholars who have developed research models for the research process devise a series of stages. Some of these are too scientific in nature, others are overly simplified. Some common practices include beginning with clarifying the topic concepts, evaluating literature, choosing a strategy, collecting and analyzing data, and writing a report.

The author's passion to contribute to the development of his country, Qatar, cannot be underestimated. Throughout his thirty years of service as a citizen and his time as an officer in Qatar Armed Forces, tasks, projects, studies and research to advance the technology field and its management have been his major career focus. Throughout the course of his work in this field, he has encountered numerous obstacles – both at the government and organizational levels. Some of these have been beyond his jurisdiction, while others he has had substantial influence over. These experiences have led the author to develop the following hypotheses:

- Sustainable economic development cannot stand separate from political, social, environmental and technological developments.
- Successful technology transfer has a positive influence on the sustainable development of an organization and is a function of mission achievement.
- The absence of R&D funds and the opportunity costs associated with it contribute significantly to the underdeveloped state of certain industries.
- Organizational directions determine the success of any technology transfer scheme.
- Qualified people are the most important asset for any successful technology transfer initiative.
- The education and vocational systems in Qatar (or lack thereof) have contributed to the underdevelopment of the labour force.

These hypotheses have clear links to many theories, some well-established and others not. The application of high quality, vigorous research techniques is necessary in order to study and refine the above hypotheses. To ensure that this happens, the author will further develop his research skills through a great deal of reading and critical analysis in this subject area over the coming four years - the expected duration of his part-time PhD studies.

The end goals of the research project are achievable within the specified time of four years. However, the first two chapters (Introduction and Literature Review) must be presented in October 2007; therefore, the author has to allocate extra time in order to reach this deadline. These two chapters will be refined further before the submission of the first draft of the dissertation. As for finances, the author will fund the PhD dissertation in full. However, he will attempt to seek financial support from his organisation (the Armed Forces), the Qatar National Research Fund, or the agencies he will be investigating.

The data collection task is expected to be colossal. This study will cover many major industries, government agencies and universities. Initially, the author intends to meet face-to-face with a representative from each entity in order to establish credibility, ensure full cooperation, and make the participant aware of the mutual benefits of the study. The project also requires abundant preparation and documentation; much of this will not be a part of this dissertation, but will merely facilitate it.

It is worth noting that less effort will be required if the author succeeds in getting assistance from the Prime Minister’s office or the Planning Council to legitamize the study. This is possible, as the study will contribute to Qatar's economic development, which is the government’s top priority.

The objectives of this study have been clearly stated above and will attempt to explain the link between sustainable development and technology transfer and find whether the transfer of technology a variable affecting sustainable development. It will also test if sustainable development and technology transfer can be measured, and whether these measures are correlated. However, the main emphasis will focus on appropriate ways to measure technology transfer in Qatar and whether Qatar’s industries or the research and development initiatives are competitive compared with the international practices. The above will make for interesting research and should produce fresh insights.

Saunders et al believe that three research philosophies dominate business and management research literature: positivism, interpretivism, and realism. He claims that they are different, "if not mutually exclusive paradigms."[29] Positivism is defined as "working with an observable social reality and that the end product of such research can be law-like generalization similar to those produced by the physical and natural scientist."[35] This view emphasizes a highly structured methodology and is quantifiable.[36] The positivist philosophy embraces a particular conception of truth. Truth does not depend on abstract belief, but on tested belief in an external or independent reality. Researchers who criticize positivism, including Saunders et al, argue that the social world "is far more complex and the rich insight is lost" if we depend on laws similar to physical science theories.[29] In other words, the positivist approach is not helpful to examine individual and their behaviours in depth.

Interpretivism is "a research philosophy that requires the researcher to understand the subjective reality and meanings of the participants. Business and management situations are complex and unique, and a function of circumstances and individuals."[29] This philosophy argues that the business world is dynamic; therefore, generating a theory is not important. This concept is associated with social constructivism, where people's motives and actions can be interpreted differently depending on one's vantage point. Interpretivism recognizes the complex and delicate relationship between individual behaviour, attitudes, and cultural issues and seeks to understand a phenomenon from the participant's point of view, which is directly influenced by phenomenon under study. Therefore, this approach more often requires qualitative methods.

Johnson notes that "qualitative methods are slow."[37] Mays and Pope summarize the main criticisms as, "Firstly, that qualitative research is merely an assembly of anecdote and personal impressions, strongly subject to researcher bias. Secondly, it is argued that qualitative research lacks reproducibility – the research is so personal to the researcher that there is no guarantee that a different researcher would not come to radically different conclusions; and, finally, qualitative research is criticized for lacking generalisability."[38]

Realism is a research philosophy that shares elements of both positivism and constructivism. Realism seeks to understand reasoning and mechanisms of existing reality that influences people's actual social phenomenon or behaviours, although it may not be perceptible to them. Realism believes that people are not objects to be studied in the style of natural science.

Some scholars argue that the difference between the philosophies is exaggerated[39] and triangulation of methods presently helps avoid incorrect approaches.[40] Therefore, it is essential to first understand fully the benefits and limitations of the approaches and then use the research questions in selecting them.

1.9.1 Purpose of the Research

While the above objectives seem to be distinct, they are all guided by the author's research philosophy and are intended to meet his eventual research goal: the development of framework to measure the effectiveness of technology transfer in Qatar.

The most influential research book that the author has come across is *Research Methods for Business Students*. It provides both practical advice and interesting theory. Saunders et al introduced the concept of "the research process onion" that begins with the definition of the research philosophy (positivism, interpretivism, or realism) in the first layer and continues to consider the research approach (deductive or inductive) in the second layer. The third layer examines the research strategy - experiment, survey, case study, grounded theory, ethnography or action research. On the fourth layer, the researcher selects between a cross-sectional and a longitudinal study depending on his or her time horizons. The researcher adopts one or more types of the collection methods in the final layer. The research processes must focus on stability through building an internal coherency between these elements.

Measuring the effectiveness of technology transfer within many entities in Qatar requires the assessment of appropriate indicators. Time is also an important element in research design. Normally, longitudinal studies employ two or more waves of measurements in the research design.[41] This study is neither a repeated measure nor a time series type of design. It will measure technology transfer indicators once, except for secondary research data that has considerable impact on the result. Hence, this cross-sectional study involving different organizations will closely analyze similarities or differences between them, and will indicate whether a general theory can be concluded. Cross-sectional studies often employ survey strategies.[42] This method will be evaluated in-depth in subsequent paragraphs.

The deductive and inductive approaches are the two major logical systems used in research.[41] Deductive reasoning moves from a general theory to a more specific *hypothesis* that can be tested. This leads ultimately to the confirmation of the original hypothesis. Inductive approaches move in the opposite direction from explicit observations and measures, to detecting patterns, to forming hypotheses, and finally to developing general theories. Inductive reasoning is more open-ended and exploratory, particularly at the start. Deductive reasoning is concerned with testing or confirming hypotheses. Some studies may look like they are purely deductive, but "social research involves both inductive and deductive reasoning processes at some time in the project."[41]

This research is the first of its kind in Qatar. Although technology itself has been routinely evolving as a result of the country's economic development, for most government officials, ministries, and institutions, the subject of technology transfer has not been broached. However, many industries and establishments in the oil and gas sectors have managed to employ relatively advanced technologies transferred by their world-leading multinational partners such as Exxon Mobil and Shell. Hence, it is difficult to generalize from such inexperience since so little is known and since one must start with theory and deduce hypotheses. For this, a deductive approach will be used. The author will deduce a hypothesis, put it in operational form, test the hypothesis, examine the specific outcomes and modify his theories in light of his findings.[42]

At the same time, this deductive approach will not allow the author to explain the particular nature of the social and cultural characteristics that influence technology transfer and its outcomes. What works in another society may not necessarily work in Qatar. There is, therefore, a need for an inductive research in the form of a qualitative progressive study to systematically discover the linkages between socio-cultural factors and successful technology transfer. The research using this qualitative approach[27] will be concerned with the context in which events are taking place. Therefore, a small sample might be sufficient.[29]

The use of a mixed methods approach raises concerns about the credibility of the research. Credibility and trustworthiness in qualitative research are analogous to reliability and validity in quantitative research. Credibility is based on the study data and ensures the understanding of the theoretical background while trustworthiness ensures that the findings are worthy of belief or confidence.[43] In research, validity has two essential parts: internal and external. Internal validity is concerned with "whether the relationship between the two variables is a causal relationship?" External validity, often called "generalisability," involves the question of "whether the results given by the study are transferable to other research settings."[44] Without internal validity, external validity cannot be achieved.

A common threat to internal validity is a lack of reliability. Reliability is often at risk when assessments are made more than once, performed by different researchers, or when the assessments are highly subjective. All of these issues must be taken into account when planning a research project.

1.9.2 Reliability and Validity in Quantitative Research

Joppe defines reliability as the "extent to which results are consistent over time and an accurate representation of the total population under study." She goes on to assert that, "if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable."[45] There are three types of reliability that are referred to in quantitative research: (1) the degree to which a measurement, taken repeatedly, remains the same; (2) the stability of a measurement spread over time; and (3) the similarity of measurements within a given time period.[46]

Charles adheres to the notion that retesting can be used to test consistency. Joppe argues that this method is unreliable.[47] She explains that the test-retest method "may sensitize the respondent to the subject matter" and hence influence the responses given in the repetitive tests. This would lead to a difference in the responses provided. Likewise, Crocker and Algina reminds that the respondent's score represents only a limited sample of behaviour; therefore, the scores may change and lead to errors of measurement.[47] Such errors will reduce the accuracy and consistency among tests and scores; therefore, the researcher’s responsibility is to ensure a high level of consistency and accuracy exists.

Watling says that “reliability and validity are tools of an essentially positivist epistemology.”[48] Within the positivist context, validity exists in evidence, objectivity, truth, deduction, fact and mathematical format. Joppes explains that validity determines the extent to which research is able to accurately measure its objectives and reflects the results trustworthiness. By researching other studies and asking questions, researchers often determine validity.[45] Wainer and Braun describe one type of validity in quantitative research as “construct validity.”[49] The construct is the initial question that determines type and methods of data gathering. Wainer and Braun state that researchers reduce the validity of an investigation by influencing the interaction between construct and data in order to validate their investigation. When using quantitative methods, researchers must test for reliability and validity.

1.9.3 Reliability and Validity in Qualitative Research

There is some disagreement as to whether the term “reliability” is applicable in qualitative research. Stenbacka believes that if a qualitative study is discussed with reliability as a measure, "the study is no good.”[50] Patton, on the other hand, states that all researchers attempting qualitative investigation should be concerned with validity and reliability in their analysis. This conflict in views raises the question, “how can an investigator persuade his or her readers that the research findings are legitimate?”

To answer this question, Healy and Perry declare that “the quality of a study in each paradigm should be judged by its paradigm's terms.” This means substituting terms of “credibility,” “neutrality,” “consistency or dependability” and “transferability” for “reliability” and “validity” when discussing qualitative research.[51] This fact is also supported by Clont and Seale[52] and Lincoln and Guba who use “dependability” in qualitative research to correspond to “reliability” in quantitative research.[51]

Examinations of trustworthiness are crucial to ensure reliability in qualitative research. Seale states that the “trustworthiness of a research report lies at the heart of issues conventionally discussed as validity and reliability.”[52] In contrast, Stenbacka argues that since reliability issues concern measurements, they have no relevance in qualitative research.[50]

1.9.4 Research Validity

Like many researchers, Stenbacka argues that validity should be redefined for qualitative research. However, she talks about reliability as one of the quality concepts in qualitative research which is an essential element for a proper research.[50] Just as increased reliability and validity influence one's confidence in quantitative findings, trustworthiness increases one's confidence in qualitative findings,[51] and may lead to generalisability.[53] Therefore, generalisability depends on the trustworthiness of the qualitative data. Maxwell contrasts this view and observes that tests of generalisability look very different in quantitative and qualitative research.[54]

Patton notes that validity is used in quantitative research for very specific applications whereas in qualitative research, triangulation is used.[55] Triangulation, a method to improve validity, involves the use of two or more independent sources of data and a test of their consistency. Mathison elaborates further that "triangulation has raised an important methodological issue in naturalistic and qualitative approaches to evaluation in order to control bias and establishing valid propositions because traditional scientific techniques are incompatible with this alternate epistemology."[56] It is possible to use both quantitative and qualitative data collection when triangulating.[55] The chosen methods in triangulation to test the validity and reliability of a study depend on the research question and framework. [57]

Barbour challenges the use of two or more collection methods. She argues that the use of two or more paradigms is possible when attempting to answer a research question, but that mixing two or more methods within the same paradigm creates problems because each method has its own "theoretical framework."[58] She does not disregard triangulation as a valuable part of qualitative research, but states that using triangulation in quantitative research may lead to a “non-confirmation of the hypothesis.” In contrast, exceptions in qualitative research can be used to modify the overarching theory.

Constructivism is another paradigm in qualitative research. It views knowledge as socially constructed and circumstance-dependent. Crotty defines constructivism as "the view that all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essentially social context."[59] Johnson adds that in qualitative research, the objective is to build a more in-depth understanding of these constructions.[60] To do so, multiple research methods are needed. This requires investigator, method and data triangulations to accurately record a particular construction of reality.[53] Open-ended questions are popular in constructivist research because they allow participants to share notions and beliefs and facilitate triangulation. The use of multiple methods, such as observation and interviews, is also believed to facilitate a more valid and reliable construction of realities.

In short, reliability and validity are conceptualized as credibility and trustworthiness in qualitative paradigms. The way to achieve these in a qualitative research is to eliminate bias and increase truthfulness using triangulation.

The lack of agreement about what makes technology transfer effective might present an obstacle to this study.[61] Government laboratories, universities' research and development offices, and industries have each proposed different composite measures for the effectiveness of technology transfer. The intention of the present study is to develop a composite measure of technology transfer effectiveness that can be applied to similar sectors. In this study, reliable and generally consistent indicators of technology transfer effectiveness in Qatar will be developed through an evaluation of scholarly literature – mainly books, case studies and conferences - that takes into account socio-cultural factors similar to Qatar's. The variables selected will also have been tested for applicability in each sector: government, universities, independent laboratories and industry.

A variable is any entity that can take on different values. Variables are important in explanatory studies to test relationships. Variables can have one of three relationships with each other:

1. Dependent variables changes in response to changes in other variables

2. Independent variables cause changes in dependent variables

3. Extraneous variables might also cause changes in dependent variables

Trochin explains that "the independent variable is what you (or nature) manipulate. The dependent variable is what is affected by the independent variable."

A researcher must be aware of which variables he seeks before designing a questionnaire. Dillman specifies three types of variables that can be collected through a questionnaire: opinions, behaviours, and attributes. An attribute is a specific value on a variable like "strongly agree," "agree," "neutral," "disagree," and "strongly disagree." The wording of a question will solicit a particular variable type.

It is important to distinguish between correlations and causal relationships. Variables performing in a synchronized manner are said to be correlated. When one variable changes, the other changes as well. If an increase in one variable corresponds to an increase in the other, the relationship is said to be positive. If one variable decreases as the other increases, the relationship is said to be negative or inverse. Neither relationship necessarily means that the change in one variable causes the change in the other. It is possible that a third variable in the relationship is needed to explain the changes in the correlated variables. These are the simplest types of relationships that might typically be explored in research.

Robson believes that enquiries may be classified in terms of their purpose.[62] The researcher can employ one or more of the following strategies: exploratory, descriptive and explanatory. Exploratory studies are important in that they allow the researcher to seek new insights and to ask questions from a different perspective. This strategy can be used to review literature, conduct focus groups, or discuss a subject with experts. Adam and Schcaneveldt make the point that the flexibility in an exploratory research project does not render it unfocused, but that there is a continual shift and convergence to new and narrower foci as the research progresses.[63]

The purpose of a descriptive strategy is to create an accurate profile of a person, event, or situation. This strategy may be used to extend exploratory research. Research that is overly descriptive is often criticized for its lack of inference.

Explanatory studies, on the other hand, establish causal relationships between variables. The focus is on studying a problem or a situation to explain the relationship. While descriptive study involves the collection of data and tabulation and representation of statistical facts, explanatory study deals with the specification of causal hypotheses, estimation of causal models and testing of the validity of theses models and hypotheses.[64]

To scrutinize technology transfer effectiveness in Qatar, exploratory research is needed. Although studies of technology transfer effectiveness have been conducted for several international organizations, no previous studies have examined technology transfer effectiveness for a country, particularly with respect to sustainable development. The aim of the initial phase, then, is to look for valid effectiveness factors that can be tested. The exploratory study will use available literature to gain a broad understanding of effectiveness factors and will progressively narrow them down to those that can be applied in this particular context.

Once this phase is over, the researcher will attempt to create an accurate picture of technology transfer in many institutions in Qatar. Through the use of quantitative techniques, data will be gathered from government institutions, industries, university research laboratories, and development offices in the country. This descriptive research will help to identify and classify the characteristics of technology transfer efforts in Qatari institutions.

This phase will not be an end in itself. Through analytical research, the study needs to explain the underlying causes of the different institutions' approaches in managing technology transfer. The end result will explain the different factors involved. Since the study aims to develop policy recommendation regarding the effectiveness of technology transfer approaches, predictive research will be utilized to speculate on future opportunities available to improve and develop the transfer of technology.

1.10 Research Approach

The research questions for this particular study suggest the use of deductive analysis and a rigid methodology to facilitate replication and ensure reliability.[36] To allow for generalization, a large sample size would be encouraged. However, this methodology could be criticized for its rigidity.[29] Therefore, a slightly less structured approach may be in order in those parts of the study that attempt to explain social contexts.

The survey strategy selected – a questionnaire - will facilitate the collection of a large amount of data in a highly economical way.[29] The survey has other advantages as well: it is easily understood and gives the researcher more control over the research process. However, a considerable amount of time will be needed to design and pilot the questionnaire. Analyzing the results will also be time-consuming. The author will either create an online questionnaire linked to a database or use off-the-shelf software such as Snap. While doing so offers some measure of convenience for both the respondent and the researcher, there is also a risk that the respondent will not fill out the questionnaire in a timely fashion.

Credible research findings result from sound research design.[29] The researcher will remain focused on increasing reliability and validity. Steps will be taken to eliminate subject and participant bias and participant or observer errors to increase reliability. Furthermore, maintaining the anonymity of respondents to questionnaire, allowing respondents to choose a time to complete the questionnaire, and introducing a high degree of structure to the interview schedule will also increase reliability. The threats to validity in the study are confined to testing, maturation and history, and ambiguity about causal direction.

Survey data collected from well-known organizations and government sources are likely to be reliable. However, inaccuracies can be found in the collection methods that need to be examined to ascertain the level of precision needed. To evaluate the validity of the internet sources, UC Berkeley suggests looking for known organization names, copyright statements and related published documents.[65] However, interview sources from the internet cannot reflect and accurately record social interaction.

Reliability and validity are easier to assess if the collection methodology is clearly explained. The researcher will clearly state his sampling techniques and response rates, and he will include a copy of the questionnaire with his results.

1.10.1 Research Access

Researchers must also carefully consider access when designing studies. Burdens like limited time and resources may prevent some organizations and individuals from engaging in a study.[66] Even when access isn't hampered on the organizational level, a researcher may encounter cognitive access problems due to his lack of control over which employees are selected to participate. There are a number of strategies to overcome these issues.

The best approach is to contact an organization's manager(s) and convince them of the value of the study and the credibility of the researcher. Simultaneously, a researcher can use existing contacts, like friends, professionals and others known to the researcher, to gain access to an organization or to increase participation in the research project. In this particular case, the researcher will establish credibility either through his contacts within an organization or through the provision of a clear purpose statement. In addition, using a well-structured questionnaire will minimize the amount of time and resources requested of each participant.

Organizations are likely to be less cooperative if the research has negative implications for them. Because this research topic emphasizes organizational learning and will avoid labeling any particular entity or practice a failure, this should not prove to be a problem for the researcher. Assurances of anonymity will be repeated at all phases of the research to assuage confidentiality concerns. In fact, the organizations may find the research valuable as they face their own questions about the effectiveness of technology transfer.

The use of appropriate language in all communications with organizations and participants will convey a sense of professionalism and credibility. It may also stimulate interest in the project, thereby breaking down barriers to access.[67] For interviews, some organizations may only allow incremental access. In this case, Johnson recommends a three-stage strategy.[68] First, to the researcher requests a single interview. Then, he negotiates access to conduct further interviews. Finally, the interviewer requests permission to record interviews. Incremental access strategies rest on the principle of building positive relationships and establishing credibility. The one downside to this strategy is that it requires a significant amount of time.

1.10.2 Ethical Concerns

Ethical concerns must also be addressed when conducting research. Ethics is defined as "a code of behaviour appropriate to academics and the conduct of research."[69] The researcher is typically a student or faculty member of a university, and as such is obliged to maintain the highest ethical standards to the seven communities the university serves: students, employers, research clients, teaching staff, the academic community, the wider community, and suppliers. Professional standards must be maintained. All results are to be documented properly and evaluated critically. The contribution of others has to be attributed honestly. All results must be reported openly, taking confidentiality into consideration.

A number of ethical issues arise during the research phase. Zikmund suggests that the ethical issues related to research are privacy, deception, openness, confidentiality and objectivity.[70] Privacy a central issue in research; researchers must concern themselves with participant consent, confidentiality, reactions to the research process, and the effects of the final report on participants. Organizations involved in a research project must be fully informed about the nature of the research, the requirements for participation, the implications of that participation, the participants' rights, and the usefulness of the data collected.

During the data collection stage, the researcher must strive for accuracy while at the same time preserving the right of each participant to withdraw or decline to take part in the research. During the analysis and reporting stage, ethical issues of confidentiality and anonymity surface. Individuals can be harmed if data are attributable to a particular person. In addition, lack of objectivity could distort the reported conclusions or recommendations. If this danger exists, it is better to act as an internal consultant rather than as a researcher.[29]

In this particular project, the researcher will be guided by Cranfield University code of ethics.

1.10.3 Selecting Samples

Since the number of organizations in Qatar is small, an attempt will be made to collect data from all participants in a particular sector. However, if this is not possible due to time constraints or the unwillingness of some organizations to participate in the survey, sampling will be used. Henry recommends collecting data on the entire population if the population size is less than 50.[71] In this study, the populations will range from 10-30. Henry also warns that the influence of a single extreme case in small populations is more profound than for larger samples. The researcher will look for outliers when analyzing his data.

The population for this study is expected to be less than fifty which is considered a small population size. Data will be obtained from every member in the population. Therefore, sampling is not required and the research will not go for complex representative sampling theory or complicated result analysis.

1.10.4 Using Secondary Data

Secondary data will be used in the explanatory and descriptive phases. During the explanatory phase, the researcher will review existing measures of technology transfer effectiveness in available organizational records and websites, books, journals, and newspapers. He will also search for previously administered surveys, case studies, and censuses. Secondary data will save time and money.[72] It may also provide measures of higher quality than the researcher would have uncovered had he needed to create his own.[73]

Secondary data sources could also provide comparative and contextual data. Unfortunately, the fact that research within this subject area is often conducted by professional consultants may mean that comparative data is inaccessible or costly. For example, "Qatar: Business Forecast Report" by Business Monitor International costs around $2000. Few organizations can afford such reports. Another example of the non-availability of some resources is that of the World Bank Special Reports. The World Bank carried out a study with Qatar's Planning Council entitled "Future

Visions of Sustainable Development in Qatar." This report is not available to the public. Even so, attempts will be made to obtain these studies either through direct request or purchase.

Another disadvantage of secondary data is unsuitability. The definitions of data variables may not be appropriate for the research question at hand. Therefore, the researcher will need to carefully evaluate secondary data to ensure that it is valid and suitable.

1.10.5 Primary Data

Questionnaires can be used in descriptive or explanatory research. Descriptive research explains the variability in different organizational settings, while explanatory research examines and explains relationships between variables, including cause-effect relationships. Questionnaires can also be administered in different ways. One type is self-administered, and the other is interviewer-administered. In this study, a self-administered questionnaire will be used. Measuring technology transfer effectiveness will entail time-intensive calculations and data retrieval tasks. This is one reason that an interviewer-administered survey would not work for this study.

Both online and delivery-and-collection types will be developed for the convenience of respondents. An online questionnaire is preferred for reaching geographically dispersed respondents and will also circumvent the inefficiencies in the local postal services. Online questionnaires have low respondent answer contamination rates.

Because virtually all questionnaire data will be analyzed using computer programs, an online questionnaire will be convenient in that it can be linked to a database that can store the answers.

Explanatory research tests a hypothesis or the relationship between variables. These have to be conceptualized before designing the data collection tool.[72] Dillman lists three variables that can be solicited: opinions, behaviours and attributes.[74] He stresses the importance of distinguishing between them as the type of variable one seeks will determine the way in which the question should be worded.

Collecting appropriate data requires that questions be generated with regard to the research objectives.[75] Major research questions will be broken down into detailed investigative questions that measure specific variables. Gathering numerous specific details during the collection stage will make the analysis stage much easier. The validity and reliability of the data collected depends on the design of the questions, the structure of questionnaire, and the careful design of the pilot testing. Foddy emphasizes that "the question must be understood by the respondent in the way intended by the researcher and the answer, in turn, is understood by the researcher in the way intended by the respondent."[76]

While designing individual questions, Bourque and Clark note that researchers either tend to adopt or adapt questions used in other questionnaires or develop their own questions.[77] Adopting and adapting questions can allow the researcher to reliably compare findings with other studies. However, there are “poor questions in circulation,” so they need to be assessed carefully.

Self-administered questionnaires are normally accompanied by a cover letter explaining the purpose of the study. This letter should explain precisely why the respondent should fill out the survey - namely, to have high response rate.[74] Dillman also suggests adding a clear unbiased title and subtitle that convey the research topic, and using a neutral graphic illustration or logo to garner interest.

Before using the questionnaire, pilot testing it is important. Bell makes it clear that pilot testing is necessary to find out how long the questionnaire takes to complete, assess the clarity of the instructions, pinpoint difficult questions, find out major topic omissions, review the attractiveness of its layout, and check any other comments.[78] Michell outlines three common approaches to reliability testing.[79] The first is to administer the questionnaire twice to each respondent. Saunders debates this approach as it is difficult to persuade respondents to answer the same questionnaire twice. Instead, Saunders recommends using an alternative method. A second method is correlating the responses to each question in the questionnaire to others in the questionnaire to measure the consistency of responses across questions. A final approach is comparing responses to alternative forms of the same question or group of questions. This final approach is very tedious and should be used sparingly.[31]

1.11 Structure of the Dissertation

The dissertation started with chapter one as an introduction. The introduction covered background information that spoke to the importance of technology transfer. It was followed by the "Aim" of the study, its objectives, the study value, study methodology, research methodology, and the structure of the dissertation. The contents of “study and research methodology” were determined through consensus with the dissertation advisor. The study will attempt to develop a framework to measure technology transfer effectiveness in Qatar. In essence, the study will answer the question, “Is Qatar on a sustainable path?”

Chapter two will shed some light on sustainable development and will present criteria to measure the country's sustainable development. It will then define technology and discuss the importance of technology transfer in more detail. This chapter will build upon existing theoretical foundations and will provide a conceptual framework for analyzing the effectiveness of technology transfer. In this chapter, an attempt will be made to determine the most effective measures or criteria to test technology transfer effectiveness. The scope of literature search in this domain is nearly unlimited, but the approach taken in this chapter will be to review literature incrementally and redirect the research toward a focus on technology transfer absorption, technological capabilities, innovation and value chain.

Chapter three will focus on technology transfer in Qatar. The focus here will be on:

1. What "policy tools" are available for use?
2. What growth constraints do they present and how does the nature of available or acquired technology affect the usage of these tools?
3. How well are the policies applied and how well do they serve agencies and industries given the complexities of interdependence, economic growth and competitiveness?

In this chapter, Qatar’s sustainable development and technology transfer will be assessed.

Chapter four will use the framework in chapter one to measure sustainable development and technology transfer effectiveness. It will evaluate appropriate technology transfer indicators for Qatar against the indicators selected in chapter two after conducting a field survey. Chapter four will then present an overall framework of measures to be used in the survey.

Chapter five will analyze the effectiveness of technology transfer in Qatar. The analysis will cover absorption, innovation, technological capabilities, labour skills, value chains, local value added, job creation, and the development of local research and development capacity. This chapter will answer the question, “Where is Qatar today in the development and implementation of effective technology transfer policies?” The question will be answered with regard to all the essential governmental and non-governmental organizations in Qatar. The output of this chapter will be a summary of the common trends noted amongst the diverse sectors under scrutiny and will address the nature and extent of technology transfer operations in Qatar such as licensed production, strategic alliances, education affiliations, partnerships, and so on.

Chapter six will present an overall summary to the study and specific conclusion to every theme in the framework supported by policy recommendations. At the end, it will suggest how this study can further be explored.

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CHAPTER TWO

Gauging the Effectiveness of Technology Transfer

2.1 Introduction

In this chapter, the available literature will be scanned to focus on sustainable development and technology transfer, particularly the important indicators for measuring their effectiveness. It will also discuss the barrier to technology transfer. The dissertation will cover the scope mentioned in chapter one Figure 1.1 under "Technology Transfer Effectiveness Model" including environmental, economic, socio-political, innovation, research and development, absorptive capacity, value chain, and value network indicators. These appropriate indicators are essential to be adapted into surveys that will be used to measure the effectiveness of technology transfer of various government agencies, industries and universities to form a picture of the overall technology transfer effectiveness of the country.

2.2 Concept of Sustainable Development

In 1972, the United Nations endorsed the protection of the human environment as a crucial element in its development agenda. Since that time, the concept of sustainable development has grown and evolved. The 1987 Brundtland Report suggested that environmental considerations should be an integral part of all development policies.[1] In 1992, the Earth Summit ratified Agenda 21, a programme of action governing human activities that impact the environment. The Summit inspired the UN Climate Change Convention and the Biodiversity Convention. The UN Climate Convention and its amendment, the Kyoto Protocol, have contributed emensly to the evolution of sustainable development discourse. The Kyoto Protocol states that a "clean development mechanism is designed in part to assist participating developing countries in achieving sustainable development." Public awareness of sustainable development was a central issue at the 2002 World Summit held in Johannesburg, South Africa. The Summit was committed to implementing Agenda 21 and creating partnerships to advance sustainable development.

There are numerous definitions of the term "sustainable development." However, one of the most-often used is given in the text of the Brundtland Report:

> “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”

This implies that our economic systems should be managed in such a way that future generations can live off the "dividends of our resources."[2] Economically, this means maximizing income while maintaining a constant or increasing stock of capital. Socio-culturally, it means maintaining the stability of social and cultural systems. Ecologically, it means maintaining the resilience and robustness of biological and physical systems.[3]

Taken together, these assertions mean that sustainable development is important to the prevention of poverty, social injustice, violence, state failure, migration and the deterioration of the environment. At the same time, they promote institutional change towards sustainability through efficient utilization of physical and human capital, investment, and technology. Sustainable development is "a dynamic process of change" in which its activity is made consistent with present and future needs.[1]

Economic, environmental and social components are referred to as "the triple bottom line" of sustainable development and are used to measure the success of development projects.[4] Maurice Strong offers a definition that runs beyond the triple bottom line and enlists the change process of the “political, institutional, technological order, and the relationship between the developing and more developed countries.”[5] However, Edward Barbier, M. Redclift, Mohan Munasinghe, and Ernest Lutz observe that the three criteria most often considered are economic, social and environmental factors.[1] The bottom line, then, is that sustainable development is intended to achieve economic prosperity, environmental quality and social justice.

2.2.1 Measuring Sustainable Development and Technology Transfer

To ensure that present and future development is sustainable, some indicators are needed to monitor the progress of a country. These can be benchmarked with other countries to alert decision makers to unsustainable development paths and to help them embrace ethical economic, ecological and socio-political progress.[6] Before considering any measure, the information on which the indicators are based must be accessible. Good indicators should be measurable, easy-to-understand descriptors of important factors. They should also be measures that can be compared both locally and internationally.[6]

2.2.2 Selection Criteria for Indicators

The literature is rich with many indicators that one can tap from. However, many of these indicators are not always suitable to examine a particular situation. Normally, every indicator comes with a standard template with its own set of criteria which is useful for comparison and information exchange purposes. However, selecting indicators for a particular construct entails that a set of criteria be developed to align with a country or institutions' priorities. Sustainability criteria mandates that indicators be scientifically valid, representative of sustainability issues, demonstrate responsiveness to change, relevant, analogous to targets, can integrate social, economic and environmental factors, and cost-effective.[7]

Scientific validity is a major criterion in selecting sustainability indicator particularly when using mathematical means in aggregating indicators into indices. It is also a primary requirement when evaluating causal models. If a study involves a few indicators, the indicator must represent the subject matter in various contexts and conditions particularly environmental, social and economic issues. A criterion being representative signifies that its ability to evaluate cause and effects and clarifies changes in dependent and independent variables. Distinguishing between "normal cycles and movement away from or towards a sustainable state," points out a need to have an indicator that demonstrates responsive to change.[8] It also means that decision makers are able to understand early warning signals and respond through policy intervention. Adding to the above, the criteria should be meaningful to users. [9] This means it must be relevant and easy to grasp. Criteria should also be analogous to targets to facilitate measuring progress. This is an important feature that allows sustainability comparisons between countries, institutions, and even individuals. Yet another criterion is the ability to integrate many domains of sustainability instead of looking at individual domains like social, economic and environmental issue. However, care must be taken using this criterion as it jeopardizes scientific validity. Finally, indicators must be cost-effective but not to a limit of risking accurate assessment. Costs can be mitigated through establishing means of information sharing.

Sustainable indicators in the literature are abundant but not focused and may be misleading.[10] Attention should be directed to the number of dimensions, scale, weight, and errors associated with every indicator. On the advice of social psychologists, the number of indicators must be small to effectively manage the analysis. [11] Again, this should not compromise validity and reliability of the study.

2.2.3 Environmental Indicators of Sustainability

Environmental indicators should demonstrate impact, help decision makers to make informed judgments and ensure effective monitoring. There are many possible environmental measures of sustainable development in the literature. Most individual measures record factual observations and are not the best way to determine whether or not a system is sustainable. Instead, the researcher hopes to use sustainability indicators based on their theoretical underpinnings, intuitive appeal, and frequent use in previous studies in addition to the criteria discussed earlier.

Unfortunately, it is very difficult to find indicators that satisfy all of these criteria. Responding to this issue, trade-offs are suggested. Therefore, organizing and prioritizing the selection of indicators according to audience and objectives of the particular element of the study makes sense. In this case, what is needed is a set of indicators that can show whether environmental conditions are deteriorating or improving.

Recently, concepts like environmental space, ecological footprint, and human appropriation of net primary production have been used to assess environmental impact. Environmental space represents the minimum and maximum use of resources per capita. For example, this concept measures the amount of CO2 emitted into the atmosphere, the lifetime of reserves, and the carrying capacity of the local environment. Ecological footprint is “the total area required to maintain a given population indefinitely at an average resource per capita consumption rate and at a rate of waste production which can be assimilated without harm to the environment.”[12] Ecological footprint measures strongly suggest that renewable resources must replace fossil fuels, and that the land and water required to assimilate waste should be calculated. Lastly, net primary production (NPP) measures the total available food resources for a system. Extensive human land use results in various levels of impact on actual NPP, and end consumption by people raises the total human appropriation of net primary production.[13] This then reduces energy available to other species. The methods for measurement of primary production vary depending on type of production, scale and estimation technique.

Earlier, sustainability indicators such as the “pressure-state-response” model measured changes in environmental status only which is not a perfect method to measure sustainable development performance. [14] Later methods took economic development into consideration. The environmental Kuznets Curves linked stages of economic development with environmental development.[15] The curve shows that during the initial phases of economic development, environment conditions degrade, but then improve because using green technologies offset the increasing harmful activities on the environment. Therefore, Kuznets Curves can be used to suggest strategies on transfer green technology.

2.2.4 Economic Measures of Sustainability

It is unlikely that a competitive economy will achieve sustainable development for a country unless the government uses a set of sound indicators to monitor and intervene.[16]

Some of the best sustainable economy measures rely on the following indicators:

1. Green Net National Product (green NNP)
2. Genuine Savings
3. Natural Capital Stock
4. Safe Minimum Standards

Green NNP is a closed economy that sums consumption, net investment in physical capital and net change in human capital, net change in natural capital and current environmental damages. It measures wealth and sustainability and calculates the consumption that will not reduce wealth or indicates the maximum sustainable income. However, it does not tell whether the saving is enough to achieve sustainability. If the Green NNP is high, it indicates sustainability.[17] Dasgupta argues that, when measuring sustainability in the economy, governments should only concentrate on what is important to its citizens, which is welfare.[18] The green NNP figure measures changes in welfare accurately, but does this makes a good measure to sustainability? Aronsson et al. point out that green NNP is not a good measure to sustainability.[19] Aronsson's argument is supported by Pemberton and Ulph who state that green NNP does not show the maximum constant amount that can be consumed forever.[20]

Genuine Savings (GS) may be a better indicator than green NNP as it addresses the requirement of assessing future welfare. Genuine savings is defined as public and private saving, net of depreciation, added to current spending of education as a measure to intangible human capital minus depletion of natural exhaustible and renewable resources minus damage caused by pollution.[21] GS is a test for sustainability. If the indicator is negative development is unsustainable. This entails either a consumption reduction or investment increase.[22] However, GS is based on a neoclassical growth model that assumes perfect sustainability between natural and human capital. Cabeza Gutes argues that there may be some cases where GS show a non-negative measure over time due only to adequate man-made capital while natural capital is depleting.[23] Using a measure of natural capital alone could solve this problem.

Sustainable development calls for improving the per capita wealth. This mandates that resource rich countries convert its natural capital into wealth. To allow future generation to reach our present level of utility, it is necessary to establish a constant amount of natural capital stock. The amount can be fixed at existing level, at the critical level or some amount in between.[24] It can also be categorized into pollution, renewable resources, non-renewable resources, and assimilation capacity. Non-renewable resources like oil and gas are finite stocks and must be compensated by new discoveries to equal extraction. However, environmental sustainability is in contradiction with this economic sustainability and must be balanced. The solution is to use oil rent to invest in environment sustainability and create compensation to the depleted oil and gas resources by using renewable resources. Another consideration to natural capital stock is to set its unit in physical, monetary or energy units. Once set, then the indicator can easily be developed.

Identified with Ciriacy-Wantrup (1952) and Bishop (1993)[25], Safe Minimum Standard (SMS) originates from decision making uncertainty. Society cannot accurately determine environmental degradation. SMS rule is to prevent depletion of natural capital stock below established limit unless the social opportunity cost is beyond accepted limits.[26] Therefore, SMS can be violated. SMS can include indicator for reduced population by certain year, a reduction of CO2 to a certain level in a certain time, and a more equitable use of resources, food self sufficiency, interest rate, and standard of living.

It is obvious that there is no single macroeconomic measure of sustainability that can stand on its own.

2.2.5 Socio-Political Measures of Sustainability

Developing socio-political measures of sustainability is important for two reasons. First, researchers are not comfortable using only economic measures. Second, socio-political measures help to present the overall picture of the country. Adopting sustainable development as a goal improves performance measures and generates sustainable pathways.

The third component of sustainability is social indicators. Measures of social indicators are available in the literature but no single measure can cover the subject of social sustainability. The Human Development Index (HDI), developed by UNDP, is based on measuring life expectancy, education and living standards to provide an index used to compare progress of nations. The HDI fails to reflect a comparison between smaller groups or individuals. United Nation's recognizes this fact and provides the Capability Poverty Measure (CPM) that measures people differences of those whose health is suffering, have inadequate access to health services, or experience gender and education inequalities.[27] Neither of these measures is capable of reflecting the status of the social development of affluent nations, such as Qatar, whose average standards of living is high. Hence, there is a need to other indicators that present the level of social participation in decision making and other social processes.

The World Bank and the UN do not explicitly consider the influence of politics on sustainability. Moffatt et al. added the socio-political domain to their model of sustainable development and discussed three measures. Moffatt states that to measure the real conditions of human life, several measures need to be included. Amongst these are the Misery Index, the Living Index, the Human Development Index, and the Index of Sustainable Economic Welfare (ISEW).

The latter is an important recent measure of economic welfare focused on sustainable development.[28] However, like other socio-political indicators, the ISEW is not without limitations. It incorporates numerous variables, the data is redundant, and enormous weight is given to certain variables. The ISEW index takes on weighted personal consumption and adds nineteen new elements to them. Deduction include health and education, advertising, commuting, urbanization, auto accidents, pollution, cost associated with depletion of non-renewable resources, environmental damage and the loss of land. Additions include labour service from household, streets and highways, consumption on health and education, net capital growth, and change in net international position. The measure does not incorporate environmental damage indicators or inequalities and is expressed as a monetary measure.[6]

It is difficult to use such measures for various reasons; most importantly, data is not always available. Other accurate methods must be in place as alternative measures. The United Nation Commission on Sustainable Development created a set of indicators that were adopted in 2001 after extensive consultations and national testing programmes. These indicators are reviewed periodically and include indicators on the social, economic, environmental and institutional dimensions within a national context.[29] Therefore, such indicators could be used as an alternative to the sustainable development measures that the researcher originally adopted.

2.3 Technology Transfer

Manufacturing and selling goods is a means of creating wealth and a good standard of living. Countries not only strive to be self-sufficient by producing goods to fulfill their own needs, but also wish to expand and grow economically by exporting to other countries. In doing so, they can produce a much higher standard of living for their population. Technological innovation processes are important because they introduce dynamics that facilitate economic growth and they impact the wider society.[30]

The literal definition of the word "transfer" - to convey or shift from one person or place to another [31] - will not be useful in this study. Though Lee argues that this linear definition depicts much of what happens in technology licensing, training seminars and turnkey projects, in practice, technology transfer projects increasingly takes a non-linear form in which different resources from different organizations join together to create new technologies.[32]

The phrase “technology transfer” initially meant "transformation" and "utilization." Over time, its meaning has expanded. The definition below represents a more current version: "The technology transfer process helps a manufacturing company more effectively use its human, physical, and capital resources by providing information or assistance which leads to improvements in its facility, equipment, manufacturing method, management methods or marketing methods."[33] While this definition is more up-to-date, it does not provide an image of technology transfer. Here is another version: "Technology transfer can cover a wide spectrum of activities running the gamut from the exchange of ideas between visiting researchers to contractually structured research collaboration involving the joint use of facilities and equipment."[34] Although this National Science Board definition focuses on research activities, it has linked the term “transfer” to concepts like cooperation and collaboration.

Wilkins gives an even more recent definition of “technology transfer:” "The diffusion and adoption of new technical equipment, practices and know-how between actors (private sectors, government sectors, finance institutions, NGOs, research bodies, etc.) within region or from one region to another."[35] This definition includes all stakeholders and introduces the concepts of diffusion and adoption. It can be generalized from these definitions that this dissertation must emphasize the ideas of diffusion, knowledge and skill transfer, research and development collaboration, and cooperation, collaboration and innovation in the realm of technology.

2.3.1 Innovation and the Technology Transfer Process

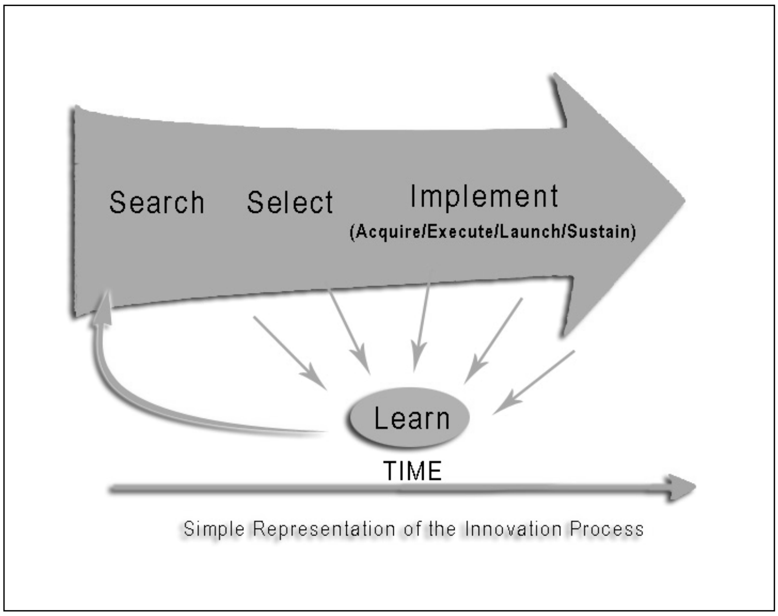
Innovation has become a core business process associated with survival and growth.[36] The process in its simplest form is shown in Figure 2.1. It involves scanning the environment for opportunities and threats (searching), then deciding how to respond (selecting). The final step is converting the idea into something of practical use in the internal and external market (implementing). This process takes place in sequential steps, including acquisition of the knowledge necessary to enable the innovation, execution of the project, launching of the innovation, and sustaining its use in the long term. During each step, however, the organization is learning and improving.

Technology transfer is a "subset" of the innovation process.[33] Westphal et al,[37] Lee et al,[38] Lall,[39] OECD,[40] Kim,[41] and Kumar[42] argue that technology transfer occurs only after a new technology has been developed and that the transfer requires three steps: firms first transfer technology from an external source, absorb the transferred technology, and finally innovate and develop their own technologies. The transferred content is either a product, such as a technological device, or information like knowledge-based, skill-based or equipment-based information.

Knowledge-based information can be conveyed through scientific journals, patents, conferences, or word of mouth. It is even delivered through courses. Skill-based information is acquired by hands-on experience, observation, and participation. Skilled personnel can be exchanged, brought in, or developed through training. Equipment-based knowledge is a matter of knowing what machines and tools are available, their capabilities, the product features in the market. This knowledge is conveyed through conventions, sales representatives and direct company contacts.

The transfer medium are forms that technology transfer could adopt, such as patents, technology alliances, technology exploitation agreements, production licenses, new firm start ups, commercial agreements, the mobilization of tacit knowledge, in-house formal R&D, contract R&D, strategic R&D partnership, reverse engineering and covert acquisition, technology absorption, purchasing, joint venture, acquisition of a company with the knowledge, and foreign direct investment.

Figure 2.1: Simple Representation of the Innovation Process



Source: Tidd J, Bessant J, Pavitt K. *Managing innovation: integrating technological, market and organizational change.* 3rd Ed. East Lothian, UK: Scotprint, Haddington; 2005. p.66.

Studies have shown that qualities of the transfer agent and recipient - the type of organization (firm, university or research centre), its characteristics, context and culture - play a critical role in the transfer process.[43] However, three situations in particular influence the transfer process considerably. First, markets do not invest in R&D because of uncertainty. Second, even when firms do invest in R&D, the deficiencies in the innovation system structure prevent knowledge flow. Third, when knowledge flow does takes place, insufficient synchronization hinders technological absorption. These hindrances deserve further consideration.

2.3.2 Common Barriers to Technology Transfer

There are several factors that hinder the process of technology transfer or cause projects to fail. They include:[44]

1. Lack of awareness: many companies are not aware of available technology.
2. Lack of knowledge: if a company is short of skills and knowledge, it may be unable to use the technology offered.
3. Lack of funds: companies may be unable to purchase or develop technology.
4. Lack of common interest: companies may exhibit a lack of motivation to reach agreement or settle differences of opinions about available options.

5. Conflict of interest: competing companies may be unwilling to collaborate.
6. Poor Coordination: individuals within a company or collaborating organizations fail to effectively coordinate about activities, processes, goals and directions of the venture.
7. Lack of resources: This can include both physical resources or loss of a key member.
8. Lack of time.
9. Lack of trust.

Hidalgo (2004) adds to the above list obstacles to technological collaboration, including such hindrances as technical problems, changes in the project structure, and organizational problems.[43] Cooks explains that organizational problems can encompass management attitudes, R&D effectiveness, short-term pressure, resistance to change, poor information flow and weak links between customers and suppliers.[23]

Because the list of obstacles is long, analysis is needed to pinpoint the areas that most considerably influence technology transfer effectiveness.

2.3.3 Technology Transfer Effectiveness

A strong research and design base, the availability of capital, a rich pool of technical talent, and a government science and technology policy designed to foster technology-based economic development are crucial to the success of technology transfer. In reality, countries often do not have this supporting infrastructure; rather, there is a wide variety in research funding, facilities, capital availability and human resource strategies. In the vacuum of information that identifies critical elements in the technology transfer infrastructure, this dissertation will develop metrics that can provide policy makers and program practitioners with a clearer picture of the conditions needed for successful technology transfer initiatives that lead to sustainable development.

2.3.4 Purpose of Measures

The literature on technology transfer effectiveness measures for particular countries is scarce, fragmented in scope, and undefined. Even looking globally, “measures of technology transfer are neither well defined nor universally accepted.” [45] Keefe and

Bozeman acknowledge that the deficient conformity on the concept of technology transfer effectiveness is a barrier to its study. However, the activity of technology transfer is a systematic process that encompasses inputs, processes and outputs. The performance measures for such processes are abundant in the literature.

In order to measure the effectiveness of a multidisciplinary subject like technology transfer, a careful selection of appropriate indicators related to technology that leads to sustainable development is required. This selection of a comprehensive and concise summary of metrics and information can help better understand how factors such as R&D expenditure, research facilities, math and science education, venture capital, and the presence of high-technology business can influence economic outcomes in a country. These metrics will be organized in accordance with Figure 1.1 in chapter one. They will be selected with regard to timeliness, credibility, and availability.

Effectiveness carry several meanings, including market or political impacts, impacts on personnel or resources available for scientific and technology. Economists like Arrow,[46] Johnson,[47] and Dosi[48] tend to focus on production and design when looking at effectiveness. Zhao and Reisman,[49] Rogers, Rogers and Shoemaker[50] tend to link technology transfer to innovation, while anthropologists Foster,[51] Service,[52] and Merrill[53] view technology transfer within the perspective of cultural changes and the way in which technology effects change. Management and business scholars differ in their areas of focus. For example, Teese[54] and Lake[55] Concentrate on stages of technology transfer, while Rabino,[56] Chiesa and Manzini[57] privilege infra-sector transfer and Laamanen, Autio,[58] Lambe and Speckman[59] examine the relation of technology transfer to strategy. Hagedoorn,[60] Niosi,[61] Kingsley and Klein[62] have focused intensively on alliances among firms and how alliances affect development and technology transfer.

There are numerous models of transfer including mathematical decision making models,[63] conceptual process models,[64] communication based models,[65] strategic marketing models,[66] economic benefit models,[67] and a model linking technology transfer, new product development and new business enterprise development.[68] None of these models represents a holistic view of technology transfer measures. Economic models focus on the macro or micro- economic measures, while decision-making models use financial measures to optimize investment and strategic models emphasize marketing.

In an effort to move toward a holistic model of technology transfer, Bozeman used four types of models: the “out-the-door,” the “market-impact,” the political, and the opportunity cost models. The “out-the-door” model assesses whether or not the technology has been transferred. The market-impact model assesses the commercial success of the transfer. The political model measures the means to political ends. Lastly, the opportunity cost model assesses the transfer activity in terms of trade-offs. Unfortunately, all four models focus on the source of the technology transfer and not the recipient. Hence, even this approach is incomplete.

The above review illustrates the fact that technology transfer has multiple goals and multiple effectiveness criteria. If considered as a process, technology transfer has multiple outcomes that must be measured at the end of each stage of the value chain. If considered from stakeholders’ point of view, a unique set of goals must be taken into account. Additionally, the actors in the organization may have different outcomes at each stage of the value chain process. Finally, the organization’s success often depends on many factors, not just technology transfer. Therefore, measures related to organizational success may give an inaccurate picture of technology transfer effectiveness.

These complications make it difficult to measure overall technology transfer effectiveness. Even the metrics themselves can complicate the matter further. For example, using the number of licenses granted may lead to inaccurate conclusions as this does not quantify the amount of improvement a particular license has enabled.

Classifying the various measures of technology transfer effectiveness will aid in the development of a comprehensive view. Spann et al developed a set of 23 measures extracted from the literature.[69] These measures included milestones as well as ultimate goals of the transfer. Said another way, they measure both the input and the output. Spann et al classifies these into “technology-push” and “technology-pull” strategies. Technology-push is based on inputs to the technology transfer process and covers “out-the-door,” political and opportunity cost models. It includes metrics such as number of licenses, technical papers, and presentations; time spent on transfer activities; and budget and expenditure tabulations. "Technology pull" is driven by economic and market-impact models. It includes measures such as number of jobs and businesses created, calculations of competitive advantage, and market share figures.

Spann et al presented a more comprehensive view of technology transfer effectiveness than was seen in other literature. However, it is difficult to apply the model developed in this study for several reasons. The snowball sampling size of 145 reached in the study presents questions about the study's validity and reliability. Furthermore, the study focused only on aerospace, defence and contractors. Moreover, the study gathered some easily collected measures without actually determining which ones are most important and most frequently used in the field.

2.4 Analysis: Building a Technology Transfer Effectiveness Framework

This dissertation organizes technology transfer effectiveness into a framework, Figure 1.1 in chapter one, which is subdivided into the following categories:

1. External environment and government policies
2. Sustainable development measures
3. External technologies and resources
4. Means of technology transfer
5. Competitors and competitiveness
6. External research and design
7. Internal research and design
8. Value chain
9. Value network
10. Absorptive capacity
11. Quality, cost and time measures associated with value chain, value network and absorptive capacity

These categories capture almost all of the imperative variables examined in studies of technology transfer effectiveness. The arrows in Figure 1.1 indicate relationships among the dimensions, whereas the broken lines show that the study will encompass both external and internal R&D.

2.4.1 External Environment and Government Policies

The barriers to technology transfer discussed earlier are applicable on both systematic and micro levels. On a governmental level, many issues need to be highlighted. Environments need to be structured in a way that facilitates successful technology transfer. Government policies, macroeconomic conditions, social organizations, national institutions for technology transfer and innovation, national legal institutions focusing on risk and intellectual property rights, standards bodies, and the means for addressing equity issues all have a role to play in the creation of transfer-enabling environments.

Governments can provide substantial help in the technology transfer process by protecting intellectual property rights, promoting competition, encouraging collaboration, and enforcing contracts. Specifically, governments can enforce the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIP). TRIP promote international trade and IPR, and ensures that IPR laws do not hinder legitimate trade.

Governments can also apply the set of measures established under the Montreal Protocol. This protocol has facilitated technology transfer of ozone friendly technologies. The Kyoto Protocol presents additional important opportunities for capacity building and technology transfer.

The United Nations' Agenda 21 also provided some recommendations for governmental public policies that would promote technology transfer.[70] These recommendations included: "(a) information networks and institutions that disseminate information and provide advice and training; (b) government policies creating favorable conditions for both public-sector and private-sector transfers; (c) institutional support and training for assessing, developing, and managing new technologies; (d) collaborative networks of technology research and demonstration centres; (e) international programmes for cooperation and assistance in R&D and capacity building; (f) technology-assessment capabilities among international organisations; and (g) long-term collaborative arrangements between private businesses for foreign direct investment and joint ventures."[71]

In addition to this, manufacturing efforts must be directed towards national priorities. Therefore, investments in research and design must address such fields. This will require cooperation and coordination between universities and industries. The government can intervene and increase these partnerships through grants that motivate them to focus on its goals. This can be achieved through a science and technology policy.

In sum, there is a need for macroeconomic and environmental policies that make the public administration system transparent, encourage the private sector to invest in new technologies, provide adequate infrastructure and human resources, facilitate education and training, and maintain and develop people in the country. Hence, government and the external environment are two important issues that need to be studied when analyzing a country's technology transfer effectiveness. This study will assess good governance with respect to accountability, participation, transparency, globalization, national priorities, international cooperation, and leadership capacity. It will also measure government performance to its system of innovation, social infrastructure, economy, legal institutions, and standards. Together, these measures will assess government policies and the external environment.

National Systems of Innovation

National Systems of Innovation (NSI) infrastructure are institutional networks that modify, import and diffuse new technologies.[72] National systems of innovation reflect the interaction between private firms, public firms, universities, government agencies, policies and social relationships. Lundvall stresses the importance of a strong social organization that binds these units in order to build the capability needed to master new technologies.[73] This mandates policy intervention to address any weakness in the social cohesion. Also, the policy should facilitate the process of technological innovation by modifying the network through such means as financing, marketing, training and competitive positioning.

National wealth (GDP per capita) and research and development intensity (global gross expenditure on R&D (GERD)/GDP) are used to compare innovation systems.[74] The GDP per capita can be extracted from government statistics or the United

Nation's Human Resource Index. The R&D Intensity is a measure of the Global Gross Expenditure on R&D as percentage of GDP. These will be used as measures of the innovation system in Qatar for this study.

It should be noted that innovation systems are complex and that measures like R&D intensity may not sufficiently reflect real innovation systems behaviour. In addition to such indicators, it is important to measure the practices of the innovation systems, such as the extent to which a particular system has secured appropriate framework conditions, built an innovation culture, enhanced technology diffusion, promoted networking and clustering, and responded to globalization. This will be done in subsequent sections since these factors resemble independent dimensions. For example, although enhancing technology diffusion is part of building an innovation system, it is also a main part of absorptive capacity.

Social Infrastructure

The Human Development Index (HDI) is a composite indicator representing three dimensions of social development: a long life in good health, level of education, and access to resources necessary for a decent standard of living. The index is in no way a comprehensive measure of human development, but it provides a glimpse at the trends in human progress and the relationship between income and well-being.[75] This measure will be used in the study to reflect the external social environment that affects technology transfer. Furthermore, it will be correlated with the Index of Sustainable Economic Welfare (ISEW) to evaluate certain hypotheses in this dissertation.

Increased community participation has been demonstrated to lead to improvements in the quality, effectiveness and sustainability of development programs. Participation also strengthens government and stakeholders' commitments.[76] It also prevents corruption.[77] Agenda 21 advocates social partnership to build environmental and economic security.

Unfortunately, there are a number of barriers to the promotion of participation. First, building the social infrastructure necessary to increase participation requires considerable time and resources that may not be available. At the policy level, it is possible that bureaucracies may resist working in an innovative way. Finally, sustaining participation mandates extending frameworks, methods and procedures.[78] Finally, participation is a complex process with costs and benefits that are difficult to measure.[79] Still, this study will attempt to measure participation.

It can be summarized that the most important measures of social infrastructures can be HDI and the degree of participation. The Human Development Index is calculated by the United Nation Development Programme. Participation can be measured through international freedom of association policy, freedom of access to public policies and information, and the number of science and technology seminars.

Macroeconomic policy is another player in creating a transfer-enabling environment.

Macroeconomic Policy

Traditionally, governments have dominated investments in large-scale technology where returns are likely to be very long term.[80] They have also been heavily involved in fields where economic development is perceived to be central to national security, such as the energy sector. Most modern investment comprises a mixture of government and private investments. Private investment is normally directed towards business that involves returns within a shorter span of time.[81]

Faced with the inadequate performance of state-funded programmes, as in the energy sector, and the associated high cost of operation, many governments have privatized these programmes.[82] Relationships between private and public sectors can create barriers to technology transfer that need to be investigated and addressed. These obstacles include lack of access to capital, lack of available capital, high inflation or interest rates, uncertainty or instability surrounding tax policies, and risk of expropriation.

The most important macroeconomic policies that encourage public-private or foreign direct investments have been found to include: [83]

- Low inflation
- Stable currency

- Free movement of private capital and profits
- Reduction of risk of expropriation
- Reduction of the role of the public sector in directly productive sectors through privatization
- Removal of mandated local ownership requirements
- Reduction of domestic fears about excessive foreign presence
- Low tax rates

Legal Institutions

Besides the macroeconomic indicators above, a range of legal institutions are needed to protect intellectual property rights (IPR), reduce regulatory risks, promote good governance, and eliminate corruption. Strong IPR protection encourages research and development by allowing innovators to a dividend of the benefits of their innovation. This, in turn, leads to innovation and higher long-term growth. The absence of an IPR policy or IPR enforcement represents a serious barrier to technology transfer. Actors will not transfer their leading technologies into countries with weak IPR regulations, though they may transfer old technologies.

IPR policies can be supplemented through international treaties like TRIPS,[84] but this alone is not enough. Governments need to mitigate risks in order to reduce costs and extensive delays associated with technology investment.[85] When IPR regulations are not enforced, obsolescing technologies will be more prevalent. Furthermore, when the law does not function properly, there are incentives to engage in corruption,[86] and to retain monopoly power. The solution to this, Johnston argues, is empowering people through education and participation.[87] This supports the notion that stakeholder participation increases the possibility of successful technology transfer.

In sum, the absence of strong legal institutions will discourage rapid international diffusion of technology. Based on the above, the related measures to be included in this study are mostly qualitative, such as clear property rights policies, clear IPRs, and the existence of anti-corruption law.

Codes, Standards and Certifications

Transaction costs and technology risks can increase when the buyer becomes responsible for evaluating the quality and performance of the technology. Here, codes and standards become important because they represent the interests of end users. Standards alleviate the need to comprehensive knowledge a customer must possess before purchasing; therefore, they can overcome information barriers. Further, Certification reasserts that the processes, products or technologies meet the specific standards that were designed at the performance audit phase.

Governments can cooperate with the private sector to establish codes, standards and certifications. To analyze this, the number of codes and standards for different categories can be measured. At the same time, qualitative measures can be used to look at international accreditation, like the ISO standards.

2.4.2 External Technology and Resources

While resources are only one dimension of performance,[88] they are an important one. Where do organizations look for resources and technology? Sources of technology can include private firms, government agencies, government laboratories, universities, nonprofit research organizations, and even entire country.

These sources sometimes serve different functions. For example, universities can not only help organizations access new technology, but they can also update organizations on new development and can teach skills. There are also certain problems unique to each source. One disadvantage of universities as technology transfer partners relates to timing. Universities do not appreciate the urgency within which industry functions. There are also different practices with respect to intellectual property rights. Universities often emphasize the production of research publications over innovations for patents. Each potential partner, then, will require careful analysis. A useful measure of research effectiveness at the university level would be the percentage of research that is classified as having some degree of commercial viability.

The government can act as a catalyst to encourage new companies to apply public research. This will create jobs, profits and wealth for the country. Forming links with universities can be done through graduate employment, industry-university research units, and forums for the exchange of information.

Where technology already exists, transfer might begin with the identification of a particular technology's existence, evaluation of its general appropriateness, and adjustments to make it suitable for a particular field or environment. The technology can then be available for use in places where it was verified that such technology will succeed.[89] However, technology sourcing might impede technology transfer efforts because of a lack of expertise needed to evaluate it, public reluctance to participate in the transfer process, a lack of availability of transfer mechanisms, anomalies in commercial regulation, or an inability to identify the appropriate source of technology. All of these challenges must be addressed.

There are three important measures related to external sources of technology that will be included in this study: policy related to technology needs, information access to policy (networks), and plans for sustainable resource development.

Methods and Means of Technology Transfer

Why are certain technology transfer strategies more effective for some countries than others?[90] Foreign direct investment worked well in China, whereas licensing was the best strategy in Malaysia. This makes it difficult to conclude that there are causal links between strategy type and technology transfer success, but it is certainly worth examining each strategy's relationship with effectiveness measures.

Technology sale or acquisition is a strategy that works best if there are problems of licensing to third parties or if the owner is unable to convert the patent to a commercial product. Once technology is transferred, comprehensive control and management is handed over to the buyer who typically pays a very high price. Usually, a buyer will only purchase technology if he is absolutely certain that the technology will be of economic value.

Licensing is another strategy that gives execution rights to the holder for a certain time period through a contract. After the period is over, rights of execution and usage return to the patent holder. Since the technology provider retains possession rights and only gives license for execution rights, execution permits can be given to other parties.

For highly advanced technologies, sales and acquisition or licensing cannot guarantee commercial success. Joint venture is a way to solve this problem. This entails technology transfer using others' management capital and know-how, equipment and competencies.

Purchase of corporations possessing technological capabilities is seen as a technology transfer as well. This kind of technology transfer strategy is chosen if the speed of technology development is very fast or the life cycle of related technology is very short. However, evaluating companies subject to acquisition is very difficult.

Other technology transfer methods include the sale of technology data, where an organization acquires a part of the particular technology information. This can be used as a method to find simple technological solutions for small projects. Technical personnel can be a medium for transferring technology as well. If the technology provider is not needed to execute the technology transfer activity, and if technology has been documented, then the in-house technical personnel can be utilized in the process. This method can be used in combination with the above mentioned methods as well.

Other strategies have been adapted from the United Nation Conference on Trade and Development (UNCTAD)[91] and Patel.[92] Methods of technology transfer can range from most to least complex as follows:

1. Total project contracting
2. Total process contracting
3. Major process contracting
4. Know-how contracts
5. Patent contracts
6. Trademark agreements
7. Franchise agreement
8. Engineering services contracts
9. Technical consultancy contracts

10. Purchasing machinery supplies
11. Employment of experts
12. Use of technical publications
13. Use of personal contacts

Barry Bozeman[93] states that strategy does make a difference. He finds that participation in a research center is the most effective strategy for technology transfer, followed by sales of patents, copyrights, and licenses, and R&D cooperation for technology transfer. He situates these strategies among others:

1. On-site seminars and conferences (seminars)
2. Fliers, newsletters, or other mailed correspondence (mail)
3. Person-to-person contacts of our scientific and technical personnel with persons in technology-recipient organizations (contacts)
4. Presentations at scientific meetings sponsored by professional organizations (professional conferences)
5. Presentations at scientific meetings sponsored by government organizations (government conferences)
6. Membership in research consortia, university, or government centers (consortium)
7. A central office with responsibility for technology transfer (office)
8. Encouraging informal, on-site visits (visits)
9. Personnel exchanges (exchange)
10. Cooperative R&D (as a technology transfer strategy, rather than other possible purposes)
11. Contractual relations for direct R&D funding between a lab and the organization receiving the technology (contract)
12. Permitting persons from other organizations access to a laboratory's equipment and facilities (equipment access)
13. Sales or gifts of patents, copyrights, or licenses (license)

Foreign Direct Investment (FDI) by multinational companies is important for international technology transfer. Through technology spillover, a country enhances its productivity and economic welfare.[94] In a study by Nakamura, it was demonstrated that if the elasticity of the foreign firm’s marginal quasi-rent is positive, then the spillover and efficiency of learning or imitation is large.[95] In the same study, it was found that an increase in spillover does not always lead to an improvement into the host country's welfare. This is in opposition with the previous findings. It can be concluded that the foreign subsidies are beneficial and can lead to a reduction in the technological gap.

Another method for international technology transfer is direct and indirect offset programmes.[96] Direct offset includes:

1. Co-production
2. Overseas production based on government-to-government or producer agreements that permit a foreign government to acquire the technical information and tooling to manufacture all or part of a contract
3. Directed sub-contracting
4. Procurement of domestic-made components for incorporating or installing in items sold to that same nation under direct commercial contracts
5. Concessions of commercial compensation practices whereby capabilities and items are given free to the buyer
6. Technology transfers/licensed production
7. Assistance in establishing industry capabilities by providing valuable technology and manufacturing know-how
8. Investments in directly related firms
9. Capital invested to establish or expand a company in the purchasing country

Indirect offsets include:

1. Procurements of parts/components from the purchasing country that are unrelated to the system being purchased
2. Investments in indirectly related firms
3. Establishing corporations in the purchasing countries to invest capital in the nation's companies
4. Trading of commodities

Based on the above, it is clear that there are many strategies for technology transfer. It is difficult to single out the best strategy. Furthermore, strategies can be combined to facilitate successful transfer. A country at the stage of selecting a method must decide the best strategy or combination of strategies for the particular initiative at hand. However, it appears that cooperative R&D and licensing are two very effective methods of transferring technology. International transfer of technology is also quite popular and effective. FDI and direct or indirect offsets are used by host countries to develop their industrial base. Any measures of the means of technology transfer must at least take these strategies into account.

As countries are forced to compete in the global economy, foreign direct investment can depend on R&D activities of other countries. A great deal of the literature has tried to explain the effects of in-house R&D capital formation and international technological spillovers on a country's productivity. Researchers reach the same conclusion that domestic R&D expenditure is important for output and productivity growth and there exists a channel through which R&D capital formation in one country affects the productivity in another.[97]

2.4.3 Research and Development

Research and development is both an investment and a major drive of value. The importance of R&D stems from its objective to position the country among the leading research and innovation countries by promoting collaboration among public and private agents and enhancing knowledge and entrepreneurship. Ultimately, research and development has the potential to help countries achieve sustainable economic development and to ensure social wellbeing and cohesion.

Too often, R&D institutes face financial constraints because they produce intangible benefits that are both more risky and more difficult to secure than physical assets. Bond et al. (1999) attribute these financial constraints to the fact that R&D programs involve significant sunk costs, mostly for the wages of R&D staff. Still, industrial expenditures on research and development are forecasted to increase of 3.5% in 2006 over the previous year. [98]

What causes R&D spending to vary from country to country and how much should a country spend? Boston Consulting Group poses three questions that may guide a company to determine the adequate amount of investment for research and development:[99]

1. What are the company's objectives?
2. How much can it invest in this area on a consistent basis?
3. How much is needed to attract internationally recognised research talent, encourage collaboration between research organisations, and leverage research strengths into market opportunities and social benefits?

Boeing's Vice President advises companies to keep a strict focus on product strategies by asking, “Is there a strategy here? Is there a capability that the strategy demands, and is there an R&D project that can provide that capability?”

Another area of importance that is related to R&D is technology protection. Various methods of technology protection are available, and understanding each one is important to this study. Intellectual property rights protect new ideas and their owners from exploitation. Patents, trademarks, copyrights, confidential information, licensing and franchising – the tools of intellectual property protection - play an important role in the innovation process.

Patents are monopoly rights that normally last twenty years. The invention must be new and capable of industrial application. The owner has the right and duty to discover whether or not someone is infringing on the patent. Therefore, it is advisable for patent holders to look at potential markets locally or abroad for infringement, and if infringement is discovered abroad, a protection file should be obtained in that country.

Trade secrets can be another means to protect innovative ideas from industrial espionage. Trade secrets are typically protected through confidentiality agreements. This means that anyone who can access the information must sign a written agreement to keep the information confidential. These are often included in employee contracts. The disadvantage here is that an innovation can disappear overnight if someone else develops the same idea or if the secret is leaked. Because employees resign or leave organizations holding the secrets, organizations must also use non-disclosure agreements.

Anti-competitive or anti-trust practices sometimes work against the preservation of intellectual property rights. These laws operate on the principle that preventing competition is against the public interest. They prevent large companies from lowering their prices to drive small business out of the market.

Copyright, trademarks and design registration are all intended to control exploitation of original literacy, dramatic, musical, artistic work, films, video, and computer programmes. If an enterprise does not have the finances or skills to produce its innovative idea, it can sell the idea, sell it with royalties included, or license it to someone capable. If it sells, then the enterprise gives up its right to the innovation, but if it licenses an innovation, it can keep its right. There are four types of licensing: exclusive licensing, where the licensee can defend his right; sole licensing, where the licenser can control the right; non-exclusive licensing, where only the owner can defend the right; and a sub-licensing, where the licensee can grant license.

Joint venture is another form of information protection where two or more independent organizations with complementary skills and expertise join together to exploit their shared opportunity. Their article of association clarifies their governance, mutual costs, profit sharing, and termination. Agreements, consortiums and disclosures are related methods of technology protection.

The theory of resource dependence points out that no organization is self-sufficient. To develop, organizations depend on external sources.[100] The triple helix regime posits that a network of resources exists that has universities, governments and industries as actors.[101] Knowledge is one resource that moves through this network. Link et al confirmed the concept of knowledge spillover, demonstrating that innovative business practices tend to occur in the proximity of research institutes.[102]

Governments can encourage university-industry cooperative projects.[103] Unfortunately, the wealth created through such cooperatives could be exploited for private interests. In other words, commercializing knowledge could deteriorate the university knowledge base. Baaken, Hoppe and Macure, and Davies believe that outsourcing research should not be approached solely from a financial and operational perspective, but that marketing principles should be considered as well.[104] Benefits of this approach include a higher number of patents, lower R&D spending per employee and increased access to knowledge. Moreover, as a result of increased competition, research institutions are encouraged to find alternatives to generate income.[105]

The resource-based view of firms suggests that a firm's competitiveness is based on its distinctive internal resources.[106] The aggregate of these resources represents the firm's capabilities. Miller and Shamsie (1996) find that knowledge-based resources contribute most to performance in a dynamic setting. Therefore, to compete and survive, Deed et al note that "firms must rely on a steady stream of innovative products."[107] This indicates that competitive advantage is mainly based on organizational and technological resources and capabilities.

Resources also include distinctive competencies.[108] There are other organizational assets such as management of information systems, trust between management and labor, accumulated knowledge, and technological or physical assets. Knowledge is considered "the most strategically significant resource of the firm."[109] Barney emphasizes that organization resources must be valuable, rare and imperfectly imitable to sustain competitive advantage.[110]

The literature in the field of university technology transfer is rich. Bercovitz and Feldman show that differences in structure may be connected to effectiveness.[111] Jensen and Thursby illustrate that faculty involvement university licensing increases the prospects of its success.[112] Thursby et al believe that inventions tend to be disclosed at an early stage of development. They also note that the elasticity of licenses related to invention disclosures is less than one and that faculty members are expected to uncover inventions.[113] In another study, Thursby and Kemp conclude that faculty quality and the number of technology transfer staff have a positive impact on licensing. They also note that private universities show more competence than public universities.[114]

Chapple et al. state that "organizational and environmental factors have considerable explanatory power" with regard to the low level of effectiveness of technology transfer offices.[115] In another study, their findings affirmed that technology transfer offices exhibit decreasing or constant returns to scale.[115] Link and Seigel claim that land grants to universities are more efficient in increasing university technology licensing and garnering more royalties for faculty members.[116]

Based on this literature, measures such as R&D expenditure, number of staff in R&D, number of invention disclosures, number of licenses, the ratio of public to private universities, return on R&D investment, land grants, and royalties paid to R&D staff should be used to assess the effectiveness of university technology transfer activities.

Seigel et al. argue that science parks are more efficient in generating new products, services, and patents.[117] Link and Scott also add that when located near a university and given enough venture capital, science parks enable universities to easily place graduates, hire top researchers and publish more patents and publications.[118] In a recent study, Link and Scott showed that there are positive associations between the numbers of university start-ups**,** the age of the park, the quality of the research environment at the university, and proximity to the university. In the same study, they said that factors associated with science park growth are proximity to the university, management through private companies, and emphasis on information technology.[119]

These studies provide measures of the effects of science parks on technology transfer, including number of science parks, number of patents generated in science parks as compared to the total number of patents, scholar distribution and qualifications, number of scientific and technical publications, number of startups, focus of parks, proximity to universities, type of management (private/public), and the information and communication technology intensity.

Zucker et al. say that collaboration between university scientists and industry scientists improves research performance. This is measured using number of patents granted, number of products in development, and number of products on the market.[120] If universities desire to begin successful startups, they should employ a combination of academic and "surrogate entrepreneurship."[121] Normally, universities with most startups tend to have clear, well-defined spinout strategies, strong marketing capabilities, and vast social networks.[122] In areas where technology is not widely available, technology transfer offices often focus on local economic development and the commercialization of university research.[123]

Powers and McDougal say that universities with most licenses and entrepreneurial policies have better technology transfer performance.[124] With respect to such entrepreneurial activity, additional measures can be included in this study, such as number of products in development, number of products in the market, the level of cooperation between scientists at universities and firms, the number of entrepreneurial surrogates in the university, and the availability of supportive licensing policy.

Technology and knowledge are intangibles and this means that measuring them is not easy. In particular, capturing the return on investment of innovative efforts is difficult. R&D expenditure can be considered a measure of the input into technology transfer activities, while patent applications are an output measure because patents are known to be the best form of protection for industrial innovations. Although R&D expenditure and patent registrations have strengths and drawbacks, patent applications have more advantages over R&D expenditure in terms of time. Developing countries benefit from the extended period of time of patent availability and reliability. The weaknesses of this measure include the considerable variation in the value of patents and the fact that many innovations are not patented.

R&D expenditure figures are often used as a measure in the literature as well, because R&D expenditures are the key input towards innovative activity. Unfortunately, this measure cannot take into account the R&D projects that are not successful or the possibility of discovering new technology by accident.

On a macro level, measures of the changes in a country's or firm's Total Factor Production (TFP) can be used as an indicator of technology change. To measure TFP, changes in major factor inputs are subtracted from changes in outputs and assigning the difference to changes in technology. Thus TFP is a derived measure of technology.[125]

2.4.4 Competition's Impact on Technology Transfer

Michael Porter identified five forces - relations with suppliers, relations with buyers, new entrants, substitute products, and rivalry among established firms - that drive industry competition and generate opportunities as well as threats. Technological change can influence all five forces.[126] Threats to new entrants can be increased through reduced economies of scale and substitute products. They can be decreased through patents and other legal protection. The power of suppliers can be increased by innovations that are more critical to the enterprise's input. They can be decreased by innovations that reduce technological reliance on suppliers. Through innovations, competitor enterprises can establish a monopoly position; and through imitation, they can destroy a monopoly position.[36] These are just a few examples of the impact of technology on industry competition.

According to Porter, firms compete by choosing from among four generic marketing strategies: overall cost leadership, product differentiation, cost focus, or differentiation focus. [36] According to him, the choice of strategy has implications for technology strategies. For example, choosing one strategy over another may lead a firm to prioritize product creation over process development. Though he asserts that firms must decide between leading the field or and imitating the leader, in practice, the distinction between the two is less clear.[127]

Competition provides the essential incentive for innovation. Technology can provide distinctive capabilities, allowing the firm to provide better goods and services than competitors. However, it is difficult to prevent knowledge from leaking to competitors. Also, competencies can be imitated unless they are constantly replaced with new ones. Competitive competencies can be sustainable only if an organization carefully analyzes competitors and market conditions.[128]

Martin Fransman thinks that Porter's model devalues the power of technological change to transform industry. He also posits that Porter overvalues the power of managers to direct innovation strategies.[129] He illustrates this through the example of mainframe and semiconductor changes. Large mainframe computer firms could not control the semiconductor's trajectory. The organizational skills were directed to promote expensive products in a focused market.

In short, several judgements can be reached relating to technology and competition. First, large firms have broad front strategies and small firms are focused. Firm-established competencies decide the range of technological fields of future competition. The nature of products and customers will influence both quality and cost. Finally, the competitive significance of a particular technology is the most important factor influencing a company decision about acquisition of that technology.

In order to understand such decisions, then, research on technology acquisition must take into account the ways in which firms evaluate their competitors. Information for these comparisons can be obtained from a variety of sources, including annual reports, reports on science and technology indicators, patent offices and sites, private consultants, conferences, trade press, and product catalogues. A large scale study of R&D managers in US firms conducted in the 1980s lists what it found to be the most effective methods of learning about competitive innovation.

Table 2.1: Methods of Learning Effectiveness about Competitors' Innovations in Large US Firms

Method of Learning	Overall sample means	
	Processes	Products
Independent R&D	4.76	5.00
Reverse engineering	4.07	4.83
Licensing	4.58	4.62
Hiring employees from innovation firms	4.02	4.08
Publications or open technical meetings	4.07	4.07
Patent disclosures	3.88	4.01
Consultation with employees of the innovative firm	3.64	3.64

Range: 1 = not at all effective; 7 = very effective

Source: Levin, R et al . "Appropriating the Returns from Industrial Research and Development." Brookings Papers on Economic Activity. 1987 ; (3): 783-820.

The above table demonstrates the importance firms place on both products and processes. Based on the above table, this study can measure competition effectiveness through the use of independent R&D, the intensity of reverse engineering, the number of licenses, the number of employees hired from competitive firms, the number of open technical meetings, the number of technical publications, the number of patent disclosures, and the level of consultation with employees of innovative firms, such as technical assistance consultation.

Developing Sustainable Competencies

Richard Hall distinguishes between intangible assets, such as IPR and reputation, and intangible competencies, including employee skills and know-how, suppliers and distributors, and organizational culture.[130] His empirical work suggested that the most important intangible resources are company reputation and employee knowledge; both are a function of organizational culture.

Sidney Winter links the idea of competencies to dynamic capabilities, which involves both the utilisation of existing competencies and the development of new ones.[131] Research suggests that variation in the performance of firms is due to differences in the ability of managers to build, integrate and reconfigure organizational competencies and resources.[132] These "dynamic marginal capabilities" are subjective to managerial decisions and actions, human and social capitals.

Dynamic performance and management capabilities are subjects of absorptive capacity that will be discussed later. It is clear that competitiveness directly correlates with absorptive capacity. This relation will be analyzed once absorptive capacity is described. In addition, dynamic marginal capabilities of managerial cognition, human capital and social capital could be used as indicators of sustainable competencies. Reputation will be measured in the “Value Chain” section. Employee know-how indicators will be illustrated in the section titled “Absorptive Capacity.”

Looking outside the firms themselves, an important mechanism for creating competition among local firms is legislation that protects local start-ups for some period of time without retarding the healthy growth of local firms. Therefore, import liberalisation and fair trade legislation may also be good indicators of competitiveness.

2.4.5 Absorptive Capacity

"The ability to exploit external knowledge is a critical component of a firm's capabilities."[133] This ability is often called "absorptive capacity." Prior studies have divided absorptive capacity into four dimensions: acquisition,[134] assimilation,[135] conversion,[136] and exploitation.[137] A broad definition of absorptive capacity, then, should represent these four dimensions. For the purpose of this study, absorptive capacity will be defined as the capabilities required to managing knowledge in order to create value. This definition integrates the views offered in the literature and also emphasizes value creation as the dependent variable of absorptive capacity.

Several terms are used to explain firms' attempts to increase absorptive capacity: capacity building, capacity development and capacity strengthening. Use of the term "capacity building" has been criticized as implying an engineering approach to the creation of new capacity.[138]

The link between absorptive capacity and R&D is in knowledge accumulation. R&D generates knowledge that accumulates over time and contributes to the enterprise's absorptive capability. Absorptive capacity is decreased in environments where it is difficult to learn as a result of either cost or availability of knowledge. These two factors resemble learning incentives. Therefore, R&D response to change can be used as an indicator to measure absorptive capacity. Learning can also be determined by the characteristics of the knowledge; therefore, complexity and relevance are also important. Less targeted knowledge requires more work from R&D. The pace at which knowledge expands in a field and the quantity of prior knowledge in that field also affects the role and efficacy of R&D.

A typical firm begins by producing its own R&D and adds knowledge from other sources. A firm's ability to capitalize on competitor spillover, then, is realized through the firm's absorptive capacity. Looking at other dimensions besides ability-based concept, Bosch et al. analyzed absorptive capacity using the dimensions of efficiency, scope and flexibility. This supplements ability-based definitions. Efficiency is defined as "the costs and economies of scale associated with a certain level of identification, assimilation, and exploitation of external knowledge."[139] Hence, absorptive capacity is a strategically valuable capability specific to each firm that is culturally oriented and lowers the costs of contracting knowledge for innovative products and services.

Cohen and Levinthal concluded that an organization's absorptive capacity has the tendency to develop cumulatively and be path dependent. They also suggested that demand, ability to capture profit from innovation, and technological opportunity are three motivators for investing in absorptive capacity. Through experimentation, they proved that R&D spending can be used as a measure of enterprise motivation to invest in absorptive capacity.[133]

Enterprises can learn from other enterprises if they share similar knowledge, organization structure, compensation policies and dominant logics Lane and Lubatkin find that the similarity in basic knowledge between partners, compensation policies, unified research centre, formal interactions, and research culture improve learning between organizations. Szulanski found that absorptive capacity is important at all stages of the adoption process.[140] The above measures are more efficient in diagnosing absorptive capacity than established measures.

Technology transfer can fail if there is no absorptive capacity within an institution, i.e. lack of capabilities in searching, selecting and negotiating for new technologies. Lack of learning and implementation capabilities may lead to failures in joint ventures or deployments of new technological systems. Moreover, at the end of equipment life, replacing a technology may need market search capabilities. Therefore, capacity is essential in all phases of the transfer technology or smart procurement cycles.[141]

In a recent study, Datta and Mohtadi concluded that a government must vigorously develop human capacity; otherwise, it will never reach a role of an innovator.[142] In discussing capacity building, the literature mainly focuses on enhancing developing countries technical capabilities as a prerequisite to a successful technical transfer.[143] This is a shortsighted vision to the greater need for skills and capabilities in marketing, finance, service, information, policy development and other fields. However, there is an agreement that capacity building may differ from one country to another and acknowledge that particular studies needed in every case.[144] Several methods of developing capabilities for the different stages of technology transfer are suggested through experience which includes formal training, knowledge and technology management and learning-by-doing. The OECD spoke to a need for diverse capacity-building policies when it stated that "technology policy has traditionally focused on the innovation end of the process ... this approach has slowly been complemented by a parallel concern for an economic environment conducive to the diffusion of innovations ... Policy needs to move towards recognizing that, rather than two distinct activities, innovation and diffusion are two facets of the same process. Developing firms' ability to absorb and use new technology effectively also improves their ability to develop innovations themselves."[145]

Acquiring innovation capacity or even skills to innovate is not easy. Generic and specific high quality training are required to infuse knowledge and experience. [146] In this context, quality training must focus on specific know-how and relate to systemic knowledge. This is an important consideration to cumulate learning and experience in order to remain competitive in the market. [147] If existing capabilities are weak in certain areas, fundamental training in technology and assessment is needed.

Many capacity building initiatives have failed.[148] The causes of failures are numerous but mostly are attributed to the lack of understanding of policy makers that the process is slow and to their inability to identify needed capacities and how to develop them. Compounding to this, advanced countries are hesitant to sell un-codified knowledge in order to preserve competitiveness.[149] These donors must deveop their understanding to the requirement of global sustainable development. Moreover, long term commitment is needed to ultimately achieve technology transfer objectives. Governments should develop independent capacities to innovate. They must select appropriate technologies aligned to their national vision, develop indigenous capacities, and strengthen institutional expertise of public and private sectors.

The resource-based view of the firm theory (RBV) may be an answer to selecting resources to develop competitive advantage. However, dynamic capability advocated criticize the RBV theory for its presumptions that factors such as surrounding resources simply exit. It does not consider the development aspect. Dynamic capability, on the other hand, is defined as “the ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments."[150] It deals with the development, integration and release of enterprise resources. It maintains enterprise competitive advantage through resource mix. A crucial success factor to dynamic capability is information system. Although information systems may not lead in a short-term to competitive advantage, they are crucial in a rapidly development environments and lead to long-term competitiveness providing they are configured to respond quickly to dynamic capability requirements.[151]

Measuring social capital is based on the relational links. Kaplan indicates that theorization in social capital and absorptive capacity, and the developments of their measures are related. Therefore, it is not surprising that research significantly stresses on improvement of theorization and measures at the same time.[152]

Kim brings up another concept of technological capability that he convincingly declares is interchangeable with absorptive capacity in the areas of knowledge absorption, assimilation and generation.[153] Technological capability has been defined as "the capability to make effective use of the technical knowledge and skills not only in an effort to improve and develop products and processes but also to improve the existing technology and to generate new technology and skills in response to the competitive business environment."[154] Lall states that technological capability has a strong role in the development of a country.[155]

Because of its layered dimensions, absorptive capacity may be the most difficult component of technology transfer to measure. This dissertation will use four types of measures in order to capture the intricate dimensions of absorptive capacity. These measures are marketing capability, breadth of knowledge, learning-by-doing and return on investment.

To estimate marketing capability, Katsikeas (1994) identified four capabilities in a firm's marketing competency. They are production capability, marketing and promotion capability, product superiority and competitive pricing.[156] The dissertation will attempt to evaluate these capabilities by placing industrial products on Ansoff's matrix, evaluating its marketing plans, and calculating the amount of sales by product. Through assessing the firm's growth strategy, whether it follows market penetration, market development, product development, or diversification growth strategy, its marketing capabilities can be evaluated as well. Market penetration occurs when a company penetrates a market with its current products to increase its market share. This is an indication to the ability of the firm’s to increase its market share and marketing promotional capabilities that secure loyalty of its customers. Product development occurs when a company develops new products for the same market. This is an indication of the firm’s ability to innovate and develop new competencies to develop successful products in new markets. Market development is the ability of the firm to sell its products in new markets. Lastly, diversification strategy is a high-risk growth strategy as it involves marketing new products in new markets.

The breadth of experience of a firm will be measured by looking at the broadness of past patenting, ICT budget, qualifications, and training expenditure. Learning by doing will be evaluated through inspecting the degree of internet access, firm’s site on the internet, rating successful team working, rating internal communication, rating staff morale and training relevance to employees’ jobs.

ROI is a standard accounting measure, and is defined as net operating income divided by net assets.

2.4.6 Value Chain and Technology Transfer

For the purposes of this study, technology includes the entire set of technologies employed in the sequence of activities that constitutes a firm's value chain.[128] Any of the technologies listed in Figure 2.2 can affect an industry's competitive advantage.

The creation of a technology strategy, then, requires a firm to answer two questions: (1): How technology can be used to gain competitive advantage at each step? and (2): Should the technology be procured or developed in-house? Five important categories influence the innovation strategies of a business:[157]

1. Availability of resources for innovation
2. Capacity to understand competitor's strategies and industry evolution
3. Capacity to understand technological development relevant to the business unit
4. Structural and cultural context of the business unit

5. Strategic management capacity to deal with internal business initiatives

Figure 2.2: Representative Technologies in a Firm's Value Chain

Transportation technology Material handling technology Storage and preservation technology Communication system technology Testing technology Information system technology	Basic product technology Material technology Machine tools technology Material handling technology Packaging technology Maintenance methods Testing technology Building design operation technology Information system technology	Transportation technology Material handling technology Packaging technology Communication system technology Information system technology	Media technology Audio and video recording technology Communication system technology Information system technology	Diagnostic and testing technology Communication system technology Information system technology
Inbound Logistics	Operations	Outbound Logistics	Marketing Sales	Service

Source: Burgelman, R., Christensen, C. and Wheelwright, S. *Strategic Management of Technology and Innovation*. (4th Ed.). NY: McGraw-Hill. 2004. P. 8.

Value chain analysis assesses the value of a firm from its input suppliers to final buyers, their relationships, industry performance, and the level and quality of support services. Because of this, value chain is a very important framework for the analysis of factors related to business innovative strategies. Performance metrics of value chain can be traced to Gopal and Cypress's customer service time and cost[158], Rolstadas's financial and efficiency metrics[159], Kaplan and Nortron's Balanced scorecards[160], and others. None was found suitable for this study that focused on sustainable value chain technologies. What this study recommends is the use of a set of KPIs indicators that can assess accurately the status of a sustainable value chain and remedies to correct any flaw in the chain.

After a thorough search, the author created the following table that summarizes measures of the values gained throughout the activities and operations of the chain.

Table 2.2: A Summary of Approaches for Measuring Value Gain from Technology Transfer

Analysis	Value Chain Metrics
Environmental analysis	Assessment of tendering regulations
Contribution analysis	Contribution made towards GDP
Product/service analysis	Cost of production
Market assumptions	Competitiveness and marketing capabilities
Financial management	Financial ratios related to profit and return on investment
Customer satisfaction	Benchmark comparison of variety of surveys towards the value chain
Sales	Sales Performance
Performance management	KPIs in-place
IT management	IT policies and infrastructure
New product development management	Measure innovation using Ansoff's Matrix

Source: Author

2.4.7 Value Network and Technology Transfer

Davidow and Malone indicated the presence of the virtual corporation in 1992, where a provisional "network of independent companies linked by information technology share skills, costs, and access to one another's markets."[161] However, employment statistics reveal that corporations are still alive. The nature of outsourcing and partnering relationships are changing so much that the center of a corporation can be anywhere. Outsourcing and alliances are being used to drive enterprise transformation. In 2002, an Accenture study found that 90% of alliance negotiations fail and only 2% survive more than four years.[162] The foundation of good business relationships is trust that is overlooked from the network.[163]

Operationally, businesses need to understand how digital technologies shape the business value chain. Tactically, businesses need to understand how social networks help technology transfer. Strategically, businesses need to understand that intangibles are important for building relationships. Finally, business leaders need to understand that ethics are important to the construction of successful networks.

The intangibles and intellectual capital in businesses need to be treated as true strategic assets. Measuring the value added from the network is not straightforward. It needs to be done at three levels: the operational, tactical and strategic levels. On the operational level, the key question is how to share knowledge of routine order. This can be done through the internet, databases and portal systems. Tools like e-learning, workflow, knowledge repositories, best practice databases, and search engines are all supporting technologies to transfer and exchange knowledge.

A firm's success depends on how it acquires knowledge and applies it more effectively than its competitor. On the tactical level, then, leaders and managers need to know how to better create, use and apply knowledge. The best methods are through knowledge networks and communities of practice utilizing collaborative tools, after-action reviews, knowledge mapping, project histories, social network analysis, storytelling, personalization tools, and group processes. It is important to build collaborative groups working towards communal learning that encompasses the whole enterprise.

The strategic level is concerned with the purpose and the creation of value. The strategic level is also concerned with both monetary and intangible value. Although thinking of intellectual capital and other intangibles of non-financial form as business assets surfaced only a decade ago, this area has garnered interest all over the world.[164] Strategic-level practices apply intangibles, scorecards, and business modeling. The supporting technology ranges from business modeling, systems mapping, values assessment, scenario building, enterprise planning tools, conscious conversation, dialogue, and learning intensives.

From another perspective, the value network concept can be expanded through a whole system view of value. Along with the economic and business models, this perspective includes social and environmental intangibles in addition to internal structures, business relationships, and human competence. See Table 2.3.

Another intangible that is entering the business literature is the social capital. The World Bank defines social capital as "the norms and social relations embedded in social structures that enable people to coordinate action to achieve desired goals." Robert Putnam describes it as "features of social organizations such as networks, norms and social trust that facilitate coordination and cooperation for mutual benefit." Recently, Don Cohen and Larry Prusak suggested that social capital is a useful concept for understanding behaviors that support or impede knowledge creation and sharing. In their view "social capital consists of the stock of active connections among people; the trust, mutual understanding, and shared values and behaviors that bind the members of human networks, communities and make cooperative action possible".[161] This description of social capital certainly encompass all of the discussions about value networks. All of the expanded definitions within the value network must become measures whose sum total resembles social capital.

Table 2.3 : **An Emerging Perspective of Wealth and Value**

Business relationships	**Internal structures**	**Human competence**
Alliances and relationships with customers, strategic partners, suppliers, investors, regulatory bodies and government groups	Systems and work processes that leverage competitiveness including IT, communication technologies, systems and software, databases, documents, images, concepts and models of how the business operates, patents, copyrights, and other codified knowledge	Individual capabilities, knowledge, skills, experience and problem solving abilities
Social citizenship	**Environmental health**	**Corporate identity**
Quality and value of the relationship with the larger society through the exercise of corporate citizenship as a member of local, regional and global communities	The value of a firm's relationship with the earth and its resources, as understood through calculation of the true costs of resources consumed by an enterprise or economy, and by determination of equitable exchange or contribution to the health and sustainability of the environment	The value of the firm's vision, purpose, values, ethical stance, and leadership, as it contributes to brand equity and economic success in business and employee relationships

Source: Extracted from Allee V. *The future of knowledge, increasing prosperity through value network*. Burlington, Massachusetts: Elsevier; 2003.

Measuring Value Networks

Form the above; this study will measure asset utilization to reflect the tangible aspect while value creation, conversion and enhancement capabilities along with social capital will reflect the intangible side. Asset utilization assess the efficiency of leveraging financial and non-financial assets in generating valuable output and is an element in the analysis of value creation. The indicator may be subjective or an in-depth quantitative method that measures financial, logistics and operation output.

The second indicator looks at the value generated from a conversion process. Converting value is achieved by:

- Converting a value input to a value output.
- Adding intangible value from own insight to another business partner.
- Extending value to be available for access by other partners.
- Converting competitive intelligence into tangible value.

The third indicator considers value enhancements or value features that make a value output distinctive. This can be done in several ways including:

- Enhancing basic input to add value.
- Extending a value gain to others.

The fourth indicator of value is perceived value from customers' point of view. It measures how the customers perceive the importance of enterprise's products or services. This value can be a subjective measure like "high, average, and low" assessment. Business value creation and investment strategies can enhance substantially once this measure is evaluated against utilization and cost results. Business vision should focus on achieving maximum perceived values.

Social value is the fifth indicator that assesses the indirect impact to receiving ends in the value network. It evaluates both qualitative and quantitative measures that impact the environment, industry and society.

2.5 Summary: Technology Transfer Measures

There are many mechanisms for transferring technology, each of which will influence the effectiveness of the technology sought. There are also many measures that can be employed to assess the performance of technology transfer. The applicability of each measure depends upon how an organization defines its goals and the outputs it uses to measure these.

Because technology transfer involves so many stakeholders and organizations with different needs, it is difficult to find universal measures of technology effectiveness. The literature reveals sets of measures related to various aspects of technology transfer effectiveness, generally focusing on external and internal measures, quality and production cost measures, and characteristics of research and development, absorption capacity, innovation and training effectiveness, knowledge transfer, reputation, culture, human resource management, and corporate strategies. Most indicators are created in accordance with a particular context and the researcher's philosophy, beliefs and approach. The literature evaluation in this dissertation has confirmed a gap in the scholarship regarding this study on measuring the performance of technology transfer in Qatar.

To develop sound measures, the most significant output must be identified. The debate on good measures for technology transfer continues with new models entering the literature from various economic settings. It is important to remember that these measures are evidence of activity in the field, but are not necessarily a sign of success. Using secondary research, chapter three will discuss current practices of sustainable development and technology transfer before tackling the issues of developing an appropriate survey approach, planning its implementation, and designing the analytical method through which the data will be evaluated.

References and Notes

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CHAPTER THREE

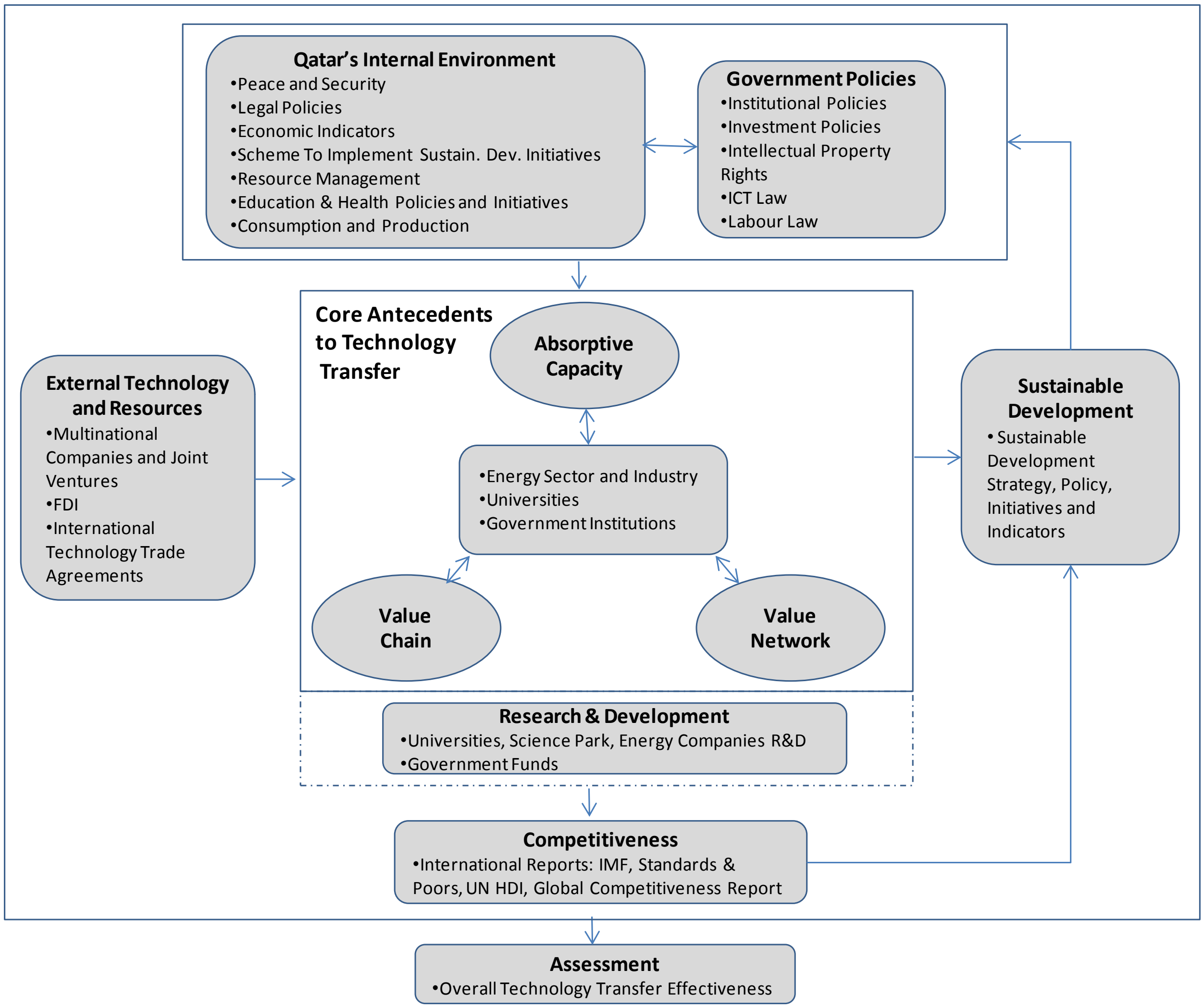
Technology Transfer in Qatar

3.1 Introduction

This chapter will assess sustainable development and focus on technology transfer in Qatar. It will discuss available policy tools, their constraints, how they are applied, and who enforces them. Qatar environment that influence technology transfer will also be evaluated. Overall, the intention of this chapter is to weigh technology transfer practices in the country's public and private sector.

The discussion and evaluation in this chapter will be congruent to the Technology Transfer Effectiveness Model in chapter one under Study Methodology (Figure 1.1). This coherence has been difficult to establish but will strengthen the thesis findings through focusing on specific aspects under scrutiny. See Figure 3.1. First, this chapter will describe the present status of sustainable development in Qatar and the various initiatives that are currently being employed to achieve its plans. Links will be drawn between the current state of sustainable development and related environmental influences and government policies. After this, the chapter will examine major industries, government institutions and universities to explore their role in Qatar's pursuit of technology transfer and sustainable development. Particular emphasis will be placed on the key concepts of research and development, absorptive capacity, value chain, and value network. Then, the thesis will use international reports and analysis, including global competitiveness reports, the UN human development index, and International Monetary Fund data, to evaluate the effectiveness and competitiveness of the country. Finally, this chapter will close with an overall assessment of the contributions of technology transfer to the achievement of Qatar’s sustainable development goals.

Figure 3.1: Influences Shaping Qatari Technology Strategy



Source: in alignment with Author's Study Methodology in chapter one Figure 1.1.

3.2 The Urgent Need to Develop a Technology Transfer Strategy

Poised to become the world's leading producer and exporter of liquefied natural gas and in the midst of an unprecedented period of development, Qatar requires the technology and capability of the developed countries to sustain its growth. Besides its strong production capacities and high income returns, Qatar needs the ability to effectively and equitably distribute and manage resources in order to build sound sustainable policies. Its dependence on oil and gas makes it vulnerable to shifts in revenues and will create complex challenges to policy makers. Hence, the present economic development is not enough to sustain a long-term development. The need to technology is crucial in achieving a sustainable level of diversification to the current economy.

In chapter one, it was shown that Qatar has no meaningful national development plans, and that the country needs to increase its economic resilience and competitiveness, diversify its economy, and integrate with the global economy. Sustainable development and technology transfer activities are necessary to the development of Qatar’s political, economic, social, technological, environmental and legal realms. Qatar could benefit immensely from joint ventures and other cooperative agreements to facilitate technology transfer; such arrangements have benefited countries like Malaysia, Brazil, India, and several others in Southeast Asia. The urgent subject that needs to be addressed is technology transfer and how to achieve it?

Unfortunately, Qatar has not been able to learn the process of technology transfer yet. This is true for a number of reasons. First, the lack of a comprehensive strategy to build a knowledge base has attributed to the deficiencies in technology transfer management. Second, the lack of professional skills prevented efficient use and exploitation of new advanced technology, in particular, information technology. Third, the lack of R&D institutions was a barrier to the absorption of new technology. Finally, the lack of awareness and commitment to acknowledge the importance of or to apply technology transfer resembled an obstacle to the integration of the concept into the development process of industry and education.

According to the literature presented in chapters one and two, there are nine key measures to judge the effectiveness of technology transfer within the context of developing sustainability: the external technology and resources, sustainable development, government policies, environmental policies, competitiveness, research and development, absorptive capacity, value chain, and value network. For Qatar, all of these measures are essential and will be explored in the following sections.

3.3 Sustainable Development in Qatar

Qatar has adopted Brundtland's definition of sustainable development, but has also added the political dimension that allows for fair economic options to all generations.[1] The Emir of Qatar, Sheikh Hamad, genuinely believes that "security without development is not sustainable in the long run."[2] This belief led to the formation of the Permanent Committee for the Protection of the Environment in 1981, which stands as a testament to the country's interest in environmental issues. Following this, several decrees and laws were promulgated for the further protection of the environment, including the formation of the Supreme Council for the Environment and Natural Reserves (SCENR).

In 2005, the Arab League Summit recommended the adoption of the 2002 Johannesburg sustainable development initiative. However, it was not until 2006 that Qatar convened its Planning Council, the SCENR and other government and non-government institutions in order to examine its achievements in this area and to build efforts to implement the initiative. Since effective sustainable development cannot be achieved without a legislative framework, instruments, and a measurable implementation plan, this section will discuss the legal, implementation and international conventions and agreements adopted by the state of Qatar.

On the legal front, the Qatari constitution has given executive powers to international conventions, including environmental agreements (Article 68).[3] The constitution delegated the authority for the protection of the environment to the state in order to achieve sustainable development (Article 33). Furthermore, decree No (30) of 2002 was aimed at protecting the environment and maintaining its balance, combating various forms of pollutions, developing the country's natural resources, safeguarding its biological diversity, protecting living creatures, and protecting the country from outside harm.[4] In addition, a number of new decrees or amendments to older decrees have been enacted to achieve sustainable development in Qatar. A summary of these decrees is shown in Table 3.1.

Table 3.1 Sustainable Development Laws

No	Decree/ Law	Year	Purpose
1	Decree (55)	1992	Ratification of the Protocol to Protect the Marine Environment from Pollution Resulting from Land-based Sources
2	Law (1)	1993	Prohibition of Arable Land Removal
3	Law (32)	1995	Prohibition of Deterioration of Plant Life and its Components
4	Law (11)	2002	Establishment of the Supreme Council for the Environment and Natural Reserves
5	Amendment of Law (4)	1983	Utilization and Protection of Biological Marine Resources in the State of Qatar
6	Law (4)	2002	Regulation of Hunting Animals, Birds and Wild Reptiles
7	Law (30)	2002	Protection of the Environment
8	Law (31)	2002	Protection from Radiation
9	Decree (19)	2003	Utilization of Water Resources
10	Law (19)	2004	Protection of Wild Life

Source: The Planning Council. Sustainable Development in the State of Qatar. February 2006.

On the implementation front, many institutions have been established to implement various integrated programmes to attain sustainable development. One of the more reputable of these institutions is the SCENR. This council, established in 2002 and headed by the Heir Apparent, was set up to implement environmental policies and to enlist all ministries’ and government institutions' resources to provide statistical data and reports relevant to Qatar’s environment and natural reserves.

The Planning Council is another important institution, which was established in 1989 to draw up the state's economic and social policies and plans. The Planning Council’s projects and studies are shown in Table 3.2.

Table 3.2: Planning Council Projects

No	The Study / Project	Objectives
1	National Project for the Development of Public Services	-develop public services with high efficiency and minimal cost -enable individuals and companies to have access to such services
2	The National Human Development Report for the State of Qatar 2005	-review human development accomplishments and the major challenges facing the State of Qatar
3	The Labor Market Strategy Project	-review all issues and problems of the labor market -make appropriate recommendations
4	The Future Vision Project of the State of Qatar: Qatar 2025	-address various sustainable development issues such as the environment, human resources and the oil and gas sector
5	The National Report on the Follow-up of the Implementation of the Copenhagen Summit Declaration 1995	-study social development and make relevant recommendations
6	The First Directory of Researches and Studies Conducted in the State of Qatar from Independence to Mid-2004	-develop and maintain a registry database of research issues in Qatar
7	A Study on Development Assistance Provided by the State of Qatar to Arab and Islamic Countries and Organizations	-demonstrate Qatar's commitment to the implementation of the World Summit's resolutions on development
8	Surveys on Family Expenditures and Income, Employment, Wages and ICT	

Source: The Planning Council. Sustainable Development in the State of Qatar. February 2006.

In 2003, the State of Qatar's Public Prosecutor established the Environmental Prosecution Circle to investigate offences and crimes related to the environment, and the Higher Judicial Council set up a specialized office to see into crimes of encroachment on the environment in accordance with current laws and regulations.

Recognizing the importance of the international and regional dimensions of the environment, the State of Qatar ratified numerous international and regional conventions and protocols. It is important to recognize, though, that many of these protocols serve to protect the environment from specific problems, such as oil pollution or the depletion of the ozone layer. It is therefore essential to evaluate the extent to which Qatar has implemented these plans and policies and, in turn, to determine whether or not their implementation has put Qatar on the path to sustainable development. Parallel to this, the study asks whether or not there will be sufficient human capacity to absorb and infuse the technologies associated with Qatar's development plans. The following section will evaluate these questions by looking at social, economical and environmental indicators of sustainable development.

3.3.1 Analysis of Qatar's Sustainable Development Indicators

Qatar has paid increasing attention to sustainable development, demonstrating efforts to achieve integration between social and economic development, and to protect the environment. Consequently, the Planning Council (PC) has selected and classified indicators of sustainable development calculated by the Johannesburg Plan of Action and the resolution of the UN Commission on Sustainable Development for use in the evaluation of Qatar’s progress. The first PC national report emphasized the progress achieved from 2000-2005. It also discussed the strengths and weaknesses of the indicators themselves.

It is possible to categorize the indicators developed by the PC and those calculated by the UNDP human development index into three broad groups: social, economic and environmental. The next section will present and analyze those social indicators that are most likely to influence technology transfer effectiveness.

3.3.2 Social Indicators

For a community to be sustainable, both individual and community resources need to be developed within an adaptable environment that is equitable, secure and socially inclusive.[5] These resources include education, skills, health, values and leadership. In addition, the social capacity (relationships and networks) that facilitates collective action toward improved quality of life must be sustained.

This study will examine the available social indicators for Qatar, including its population, social organizations, health data, education-related statistics, information and communication technology structures, and current social initiatives. Table 3.3 represents a summary of available social indicators. The table shows that the population, according to the Planning Council's official figures, increased 5.6% in 2005. The PC expects this rate decrease to 5.4% in 2006. The UN human development index figures and expectations for Qatar are similar. However, according to Qatar's General Housing and Population Census, Qatar's population reached 744,000 in 2004.[6] This figure indicates an annual increase at the rate of 5.2% over the last seven years. Because of population size concerns, the Permanent Population Committee was set up in 2004 as part of the PC with the aim of proposing a population policy and then implementing its recommendations. Four years later, Qatar's population doubled and grew to 1.5 million.[7] The economic development has contained the social aspirations and created an imbalanced development. Furthermore, in a study published in 2008, the Permanent Population Committee estimated that Qatar's population will reach 2.3 million by 2015.[8]

The above population statistics demonstrate a strong need in Qatar for an entity to formulate and pursue a national population strategy. The Population Committee, which is part of the PC, is only reacting to what appears to be happening in Qatar. There is also some question as to whether the population data that the PC is producing is valid or reliable.

Even so, it is evident that the population in Qatar is exploding unexpectedly. The effects of this can be seen in day-to-day life, the inflation rates, housing shortages, rising housing prices, reduced Qatarization and increased unemployment. The population increase is a huge challenge to handle. Qatar is likely to face overcrowding that will place a huge burden on its resources. Resources like arable land and fresh water may diminish while energy consumption increases, leading to increases in Qatar’s contribution to global warming.

It might be assumed that a natural solution would be make policies that reduce birth rates and increase education. However, the population increase in Qatar is a result of a sudden influx of expatriate labour needed to assist with economic development projects.[9] Since the development in Qatar is likely to continue in the next ten years, this influx is certainly going to continue to increase. However, it is difficult to accurately predict this rate of increase due to the absence of a sound national development strategy. This suggests that the solution may be to increase the native Qatari population to reclaim the jobs currently performed by expatriates. Here, technology transfer could play a major role in building the capacity of the local citizens to undertake the tasks needed for developing their country.

Table 3.3: Qatar Social Indicators

Measure	Planning Council	PC Expectation	UN HDI	UN Expectation
Population growth	5.6% in 2005	Decrease to 5.4% in 2015	5.1% in 2005	Decrease to 1.9% in 2015
Fertility rate	4.2% in 2005	Decrease slightly	2.9%	-
Dependency rate	30.8%	Decrease	23%	22.7% in 2015
Life expectancy at birth	76 years	Increase	75 years	-
Spread of HIV	0.001%	Remain low	Less than 0.2	-
Adult literacy	90.6%	Increase	89%	-
Rate of adults with secondary education	58%	Increase	-	-
University graduates	34%	Increase	-	-
Fixed telephone lines	26%	Remain constant	25.3%	-
Mobile telephones	90%	Increase	88%	-
Internet users	28%	Increase	27%	-

Source: Planning Council. Sustainable Development Indicators. [online]. [cited 2 March 2008]; Available at: http://www.planning.gov.qa/CDs/Performance_Evalluation_Dept/Sustainable_Develipmnt_Indicators/Intro.htm. Also, UNDP. Human Development Report 2007-2008. United Nation Development Programme. NY, USA; 2007.

Other social indicators in the table are not sufficient to evaluate the leadership effort in building social sustainability. This deficiency in the effectiveness of social indicators will be filled once the internal environment and other topics listed in Figure 3.1 have been analyzed.

3.3.3 Economic Indicators

Table 3.4 lists essential economic indicators that have a direct bearing on sustainability. Overall, Qatar enjoys an annual economic growth rate greater than virtually any other country. It is expected that the GDP per capita will soar and ultimately pass that of Luxemburg, which currently has the highest GDP per capita.[10] On the positive side, this continued economic growth has led to rising investment levels, reduced international debt, higher labour productivity, and more female participation in the economy. However, on the negative side, Qatar’s economic growth has led to inflation, higher annual energy consumption, and increased industrial solid waste. In fact, the advisor of the Emir of Qatar recently stressed that inflation can be considered a tax levied by economic development. In a newspaper article, he alluded to the fact that though reducing inflation is not Qatar's current priority; the government is trying to reduce its influence on the average citizen's quality of life.[11]

Table 3.4: Qatar Economic Indicators

Measure	Planning Council	Expectation	UN HDI, S&P	Expectation
GDP per capita	US$ 55,883,000	Increase	US$52,240,000	Increase
Investment share	35.6%	Remain high	23.3% -S&P	-
Savings	38.7%	Remain constant	67.2% -S&P	-
Inflation rate	8.8%	Decrease	4.5% -S&P	Decrease
Debt	12.1%	Decrease	18.3% - S&P	Increase
FDI	-		3.8% - S&P	-
Labour productivity in manufacturing industries	21% increase from 2001-2005	-	-	-
Female economic activity	27.1%	Increase	36.3%	-
Imports of goods and services	-	-	33%	-
Exports	-	-	68%	-
CA ratio to GDP external liquidity	25.2%	-	36-44% - S&P	-
Annual energy consumption	16,922 kw/h	-	-	-

Source: Planning Council. Sustainable Development Indicators. [online]. [cited 2 March 2008]; Available at: http://www.planning.gov.qa/CDs/Performance_Evalluation_Dept/Sustainable_Develipmnt_Indicators/Intro.htm. Also, UNDP. Human Development Report 2007-2008. United Nation Development Programme. NY, USA; 2007. Also, Standards & Poor's. Credit Research Report: Qatar. Marchand, London. 30 September 2005.

Adding to the above indicators, Qatar has introduced a cash remittance measure to its GDP (around 7.2%), which attempts to account for the amount cash transferred by expatiate workers in one year, to show the effect of labour-exporting countries foreign accounts stability.

The economic measures above fall short of explaining and offering a holistic evaluation of the economic situation in Qatar. For example, technology imports have brought about rapid changes in lifestyles. These include excessive consumption of plastics, metals, glass, paper and other items. Increasingly, these become litter and find their way to the dumpsites. Because children are the decision-makers of tomorrow, making them aware of the need for change is necessary if Qatar is to achieve sustainability. [12] More effective and comprehensive measures are needed in order to gain an accurate understanding of economic sustainability. To this end, Qatar could adopt better economic measures such as Green Net National Product (green NNP), Genuine Savings, Safe Minimum Standards, and Natural Capital Stock. However, one measure alone will not suffice.

3.3.4 Environmental Indicators

It is clear that the environment is a critical issue in Qatar, Table 3.5, and the indicators suggest that much needs to be accomplished. Even so, the available indicators are insufficient as a basis for measuring performance in the efforts to move toward sustainable development. Qatar needs to actively pursue the effective measures discussed in chapter two, including ecological footprint, net primary production (NPP) and environmental space.

Table 3.5: Qatar Environmental Indicators

Measures	Planning Council	Expectation
Ozone depletion	16% reduction between 2000-2005	Decrease
Arable land	0.6% of Qatar	Increase
Use of fertilizers	5kg/hectar	Increase
Pesticides	3.5 kh/hectar	Increase
Fishing	14.9 kg / capita	Decrease
Withdrawal of underground water	218.32 mcm	Decrease
Protected area	11.2%	Increase to 20%

Source: Planning Council. Sustainable Development Indicators. [online]. [cited 2 March 2008]; Available at: http://www.planning.gov.qa/CDs/Performance_Evalluation_Dept/Sustainable_Develipmnt_Indicators/Intro.htm.

Qatar has a number of sustainable development initiatives underway or waiting to be implemented. Table 3.6 summarizes these initiatives.

Table 3.6: Schemes of Sustainable Development Initiatives in Qatar

No	Scheme of Sustainable Development Initiative	Status
1	General Framework of the National Sustainable Development Strategy	Underway
2	Preparation of the State of Qatar's Future Vision: Qatar 2025	Underway
3	Rehabilitation Bridge Program	2007
4	Small-scale Projects Scheme	Underway
5	Establishment of Fund in Support of NGOs Role in Development	Completed
6	Formulation of the State of Qatar's Population Policy	Underway
7	Preparation of the Labor Market Strategy Project	Completed
8	Education for a New Era Initiative	Completed
9	Qatar University Development Plan	Completed
10	Scientific Research and Technological Development Strategy Project	Completed
11	Science and Technology Oasis Project	Established
12	Electronic Government	Continuous
13	Information and Communications Technology Strategy	Established
14	Holding the World Conference on Communications Development	Completed
15	Assessment of the Environmental Impact of Developmental Projects Program	Continuous
16	Air Quality Monitoring Program	Completed
17	Creation of Chemicals Database	Continuous
18	Radioactive Materials Import and Handling Regulation	Continuous
19	Application of Modern Technology to the Discovery، Liquefaction and Exportation of Natural Gas	Continuous
20	Establishment of a Modern Industrial Zone in 2005	Continuous
21	Initiative Submitted to the WTO Trade and the Environment Committee in 2005 to Add Natural Gas and its Derivatives to the Environmental Goods List	Continuous
22	Participation with GCC General Secretariat in Negotiations to Conclude a Free Trade Zone with the European Union	Continuous
23	Signing the Framework Agreement on Free Trade with the USA in March 2004	Continuous
24	Conducting a Study to Liberalize the Services Sector within WTO Framework	Continuous
25	Creation of Free Trade Zones with Arab Countries	Continuous
26	Convening "Finance and Investment in Qatar" Conferences in Britain and the USA	Continuous
27	The State of Qatari's Accession to World Association of Investment Promotion Agencies, WAIPA	Continuous
28	Preparing New Laws on Anti-dumping, Fraud, Insurance and Trade Secrets	Continuous

Source: The Planning Council. Sustainable Development in the State of Qatar. PC; February 2006.

The table above explicitly illustrates genuine initiatives the state of Qatar is currently pursuing across the economic, social and environmental domains. However, the extent to which Qatar has effectively implemented these initiatives is a question that remains to be answered.

To sum up the above, sustainable development indicators are available, but Qatar needs to explore ways to create a truly strong set indicators. For social indicators, Qatar can measure rate of population growth, misery index, living index, human development index and Index of Sustainable Economic Welfare (ISEW); for its economic indicators, Green Net National Product (green NNP), Genuine Savings, Safe Minimum Standards, and Natural Capital Stock should be measured; and for environmental sustainability, indicators such as environmental space, ecological footprint, and net primary production need to be measured. In addition, there is an urgent need for a sustainable development strategy, particularly at this stage of the economic boom, in order to balance its requirements. Lastly, the question of whether or not Qatar is implementing its initiatives effectively and seriously has neither been discussed nor analyzed. The country's interests at this stage seem to be in a merely acceptable implementation level. This attitude is a result of international pressures. Effective government policies go beyond a self-fulfilling prophecy of mere acceptance. The next section explores policies that influence technology transfer in Qatar.

3.4 Government Policies

With regard to technology transfer, the role of government is to remove barriers to technology transfer, define an industry, define market development goals, provide links between public and private sectors to facilitate transfer of technology from public laboratories to commercial organizations, and stimulate certain research by participating in the commercialization of technology.[13] Government can also place restrictions on foreign economic activities,[14] or stimulate technology transfer through intellectual property rights protection.[15] In some respects, government policies that require public and private organizations to comply with health, safety and environmental regulations are effective methods to stimulate technology transfer.[16] Nevertheless, there is little evidence in the literature to adequately conclude that government policies actually drive technology transfer success.[17]

When the legal framework is not enforced with effective mechanisms, sustainable development is clearly hampered.[18] Besides the laws dedicated to the protection of the environment, Qatar has recently promulgated a number of laws and other legal instruments. Some of the most important laws that influence technology transfer are listed here:

1. Law No. (6) of 1987: Unified Regulations Granting Priority in Government Purchasing to National Products and Products of National Origin in the Arab States of the Gulf Cooperation Council
2. Law No. (6) of 1988: Restraints of the Exercise of Economic Activities in the State of Qatar by Citizens of the Arab States of the Gulf Cooperation Council
3. Law No. (7) of 1989: Unified System for the Protection of Industrial Products of National Origin in the Gulf Cooperation Council for Arab Gulf States (GCC)
4. Law No. (11) of 1993: Income Tax
5. Law No. (19) of 1995: Industrial Organization and its Executive Regulations
6. Law No. (13) of 2000: Organization of Foreign Capital Investment in the Economic Activity
7. Law No. (5) of 2002: Commercial Companies Law
8. Law No. (7) of 2002: The Protection of Copyright and Neighboring Rights
9. waL No (8) of 2002: Organization of Business of Commercial Agents
10. Law No. (9) of 2002: Trademarks, Commercial Indications, Trade Names, Geographical Indications and Industrial Designs
11. Law No. (40) of 2002: Stating Customs Law
12. Law No. (41) of 2002: Amending Customs Import Tariffs and Canceling Some Customs Import Duty Exemptions
13. Law No. (30) of 2004: Regulating Control of Accounts
14. Decree Law No.(31) of 2004: Amendment of some provisions of Law No.(13) of 2000: Organization of Foreign Capital Investment in Economic Activities
15. The Decree Law No. (36) of 2004: Establishment of the Supreme Council for Information and Communications
16. Law No (14) of 2004: Labour Law
17. Law No.(2) of 2005: Amendment of Some Provisions of Law No.13 of 2000: Organization of Foreign Capital Investment in the Economic Activities

18. Law No (5) of 2005: Protection of Secrets of Trade
19. Law No (25) of 2005: Combat of Covering up Illegal Practices Carried out by Non-Qataris

It can be inferred from the above that these laws are not directed towards effective technology transfer. Rather, these laws indirectly influence technology transfer by encouraging foreign investment, protecting intellectual property and copyrights, regulating the labour market, enhancing and regulating the use of information and communication technology, and controlling economic activity.

3.4.1 Industrial Policy

The industry in Qatar has witnesses four eras. The first was prior to 1949, when Qatar was scarcely inhabited. The population depended on fishery, basic equipment, and tent making. The second era took place between 1949 and 1973 and was characterized by oil production and refining industries. The third industrial age witnessed serious government initiatives to build medium and heavy industries. In this phase, from 1974 to 1990, Qatar established a steel industry (Qatar Steel Company), a petrochemical industry (Qatar Petrochemical Company), and gas to liquid manufacturing (Natural Gas Liquids). It also expanded existing industries such as fertilizer, cement, and refining. The present era began in 1990 and still continues; its focus is LNG & SMEs.

In 1998, Gulf leaders ratified the GCC Unified Industrial Development Strategy alongside objectives and goals specific to each member state. The Gulf Organization for Industrial Consulting (GOIC) issued a strategic document intended to be a hub of and catalyst for industrial investment, with the intention of diversifying industry and development within the Gulf Cooperation Council (GCC) countries.[19] These were among its objectives:

1. Increase the industrial growth rates in the GCC member states with the ultimate goal of a twofold increase in value addition every 10 years.
2. Endeavour to increase the national working force in the industrial sector to a minimum of 75% by 2020.

3. Increase the local component of national industrial products.
4. Build a genuine base for industrial research and development and applied sciences.
5. Consolidate integration between the oil and gas sectors and other industrial sectors.
6. Maximize the utilization of natural resources in the region.
7. Encourage localization of industries in underdeveloped areas.

Qatar's industrial objectives were derived from the GOIC strategic document’s focus on oil- and gas-related diversifications or development. Maximizing value addition from raw and intermediate materials, diversifying income sources, encouraging the local/foreign private sector contribution to industrial development, utilizing the advantages of the state to attract foreign investment, and generating profits from ethane and methane demand are all amongst its industrial objectives. Qatar succeeded in diversifying its income sources once LNG became a part of its economy. All the above are strong indicators that Qatar Petroleum is driven by an industrial strategy along with its subsidiaries. [20]

3.5 Qatar’s Internal Environment

In this section, the political, economic, social, technological and legal environments will be explored in relation to their influence over the effectiveness of technology transfer.

3.5.1 Political Environment: Peace and Security

Qatar strives to promote international peace and security through political cooperation with all countries worldwide. In accordance with its constitution, Qatar respects international pacts, honor pledges, and executes all international agreements. On the regional level, Qatar has been a member of the Gulf Cooperation Council for Arab States (GCC) since 1981. In 2004, Qatar settled its border disputes with Bahrain peacefully through the international community. Qatar is also acceded to the Treaty on the Non-Proliferation of Nuclear Weapons.

On the Arab level, Qatar has played a prominent role as an intermediary peace messenger between the foreign government and insurgent movements, and has also helped many Arab states to reconcile their differences. On the international level, Qatar was elected as a non-permanent member by the UN General Assembly to represent the Asian groups for 2006-2007. Generally, the political environment in Qatar can be characterized as a catalyst for technology transfer due to the country's support for international efforts, dialogue, development, poverty alleviation, and international stability.

3.5.2 Economic Environment

Globalization, trade, consumer protection, and investment highly impact the technology transfer process. Sustainability can be attained through consumer consumption patterns. Globalization enhances economic growth rates, increases job opportunities and promotes social welfare. Trade is vital to Qatar to acquire needed technologies, equipment and production capacity. In addition, foreign direct investment helps to boost wages, strengthen manufacturing, and allow the country to penetrate foreign markets.

Globalization

To Qatar, globalization means better economic growth rates, more job opportunities and improved social welfare. It also means fluctuation of the prices of goods, lack of stability of capital flows, inequality, poverty, and rising unemployment rates. Qatar has continued participation with the GCC Permanent Secretariat in negotiations with the European Union to conclude a free-trade zone and has contributed to the GCC free-trade zone. It also signed a memorandum of understanding with United Nations Conference on Trade and Development (UNCTAD) in 2005, with a view toward building Qatari capacities and providing technical support, research, technology transfer, investment and electronic trade.[21]

The State of Qatar has carried out numerous activities and measures to prepare a suitable climate to attract foreign direct investments. Such activities and measures have involved hosting awareness seminars; signing a free trade agreement with the United States (not yet in effect); joining the World Association of Investments Promotion Agreements

(WAIPA) in 2005; starting work in Qatar Financial Center, which will finance private projects in wealth, insurance and banking; and regulating trade and investment through a set of laws. Yet, it was not until 2005 that the Planning Council prepared a database on foreign direct investment flows in cooperation with the United Nation Economic Commission for Western Asia (ESCWA).

What is noted from study of the numerous meetings, gatherings, seminars, forums and even agreements in which Qatar has participated is that much effort is expended without a clear plan of action or proof of a substantial outcome. This study, then, needs to go beyond plans for basic technology transfer into an exploration of the complex cultural and political environment and an analysis of factors that lead to inefficiencies. In short, where is Qatar failing to obtain what is required or to effectively implement new technology? This is covered under the absorptive capacity section.

Trade and Freedom of Access to the Market

Qatar is a member of the GCC Economic Agreement, which was signed in 1983. This basic agreement has further developed in 2002 to regulate tariffs and trade. The true meaning of the GCC Economy came about in 2008 when the GCC Council announced the establishment of the Joint GCC Market. With this agreement, GCC citizens are equated with citizens in another member state and are free to participate in economic activities, such as transfer capitals, investment, employment, and to receive free education and medication in any member state. Qatar also became a member of the World Trade Organization (WTO) in 1995.Through the GCC, Qatar has been engaged in trade and investment negotiations with the United States, the Europe and Japan. Qatar joined the General Agreement on Tariffs and Trade (GATT) in 1996. Qatar has also signed economic and commercial agreements with Egypt and Tunisia in recent years.

Free trade zone does not exist yet but there are plans to allocate its site next to the new Doha International Airport, which will be operational by 2013. Qatar commercial law requires an import license; this is made available to non-Qataris who invest in education, health, tourism, or the energy sector. The local law concerning the regulation of local commercial agencies' activities and their foreign principal agents guides an agency agreement.

Qatar's exports totaled US$ 33.25 billion in 2006. The majority of Qatar's exports, about US$11 billion, went to Asian countries. Japan topped the list of Asian consumers (US$ 6 billion) followed by South Korea, Singapore, Thailand, China and India. European imports of Qatari commodities grew steadily, from US$ 82.4 million in 2001 to US$ 257 million in 2003 (Spain topped the list), while US imports of Qatari goods show a decline over the years (from US$ 383.6 million in 2001 to US$ 209.5 million in 2003). Qatar's imports totaled US$ 12.36 billion in 2006. Qatar imported mainly from Germany, the UK and Italy.[22]

The Commercial Companies Law regulates all private business activities in Qatar. It allows for mergers and acquisition, partnerships, and joint stock companies. Joint ventures with foreign companies are partnerships with limited liabilities and foreign investors may own up to 49% of partnership agreement. Foreigners are allowed to own residential property in select real estate development but are not allowed to invest in in privatized public services.

Trade contributes to increased productivity by providing needed technologies and production processes. Qatar has no antitrust laws but enacted laws on patents, copyrights and trademarks. Qatar's trade policy can be categorized as moderately protectionist. According to the Heritage Foundation, "some prohibitive tariffs, import restrictions and bans, services market access barriers, import licensing requirements, restrictive sanitary and phytosanitary regulations, and non-transparent government procurement add to the cost of trade." [23] Qatar's average tariff rate in 2006 is 4.2%. The rate was 5.2% in 2004, up from 4.2%, in 2002.[24] On trade barriers, Qatar hosted world's ministerial discussion in 2001 that opened the Doha Development Round of trade negotiations aimed to lower trade barriers worldwide.

Qatar Government Background Report No. 1 (2007) recommended strengthening the private sector by reducing the emphasis on public sector. Accordingly, Qatar has increased the private sector's role in the country through privatizing Qatar Telecommunication, the sea port services, a few municipality services, and water and gas utilities. Despite these initiatives, the private sector's contribution is still small, averaging around 30% over the span 1999-2003.[25] This is due in part to the fact that the service sector is still dominated by several Government companies, some of which are a monopoly or have exclusive rights, like the telecommunications, the postal services, and the air transport services.

In projecting an overall industrial contribution, the industrial sector, including oil and gas, accounts for 69.2% of Qatar's GDP. Oil and gas industry shares 61.86% while non-oil and gas sectors account for 7.35% of the GDP.[26] The government owns the majority share in manufacturing companies such as Qatar Petroleum, RasGas, cement, steel, and fertilizers, to name a few. Qatar promote industrial activities through investment incentives hoping to attract foreign investments. Available investment areas are in natural resources, industry, education, health, tourism and agriculture. However, foreign companies are still barred from investing in some key activities such as banking and insurance sectors.[27]

Consumer Protection

The State of Qatar has been exerting considerable efforts to protect consumers and enlighten them about their consumption patterns, with a view toward attaining sustainability through the following procedures:

1. The Consumer Protection Division at the Ministry of Economy and Trade imposes fines and other sanctions on companies and enterprises that produce/sell expired goods and combats fraud and counterfeiting of trademarks.
2. The Public Authority for Specifications and Standards has issued 291 local standard specifications and has adopted GCC specifications to protect consumers in the different economic sectors.

3. In 2004, the Planning Council conducted a comprehensive study on consumer protection in the State of Qatar. The study covered the status of consumption and consumer protection legislation. Ultimately, the Planning Council proposed the promulgation of a consumer protection law and the establishment of an association for consumer protection.
4. During the first quarter of 2006, the Planning Council carried out the fourth survey of family expenditures and income, which revealed Qatari and expatriate families' consumption and expenditure patterns for both goods and services.
5. Law No. 7 of 2003 was promulgated to award the Qatar Prize for Total Quality, hold annual quality conferences, and publish the Yearly Guide to GCC ISO-Winning Companies.

Qatar has also exerted efforts to bring about sustainable consumption in energy, transportation, industry and tourism. Qatar produces natural gas, a clean energy source, and has made progress in the application of modern technology in exploration and liquefaction. In the industry sector, there is a healthy trend to obtain the ISO 14000 certification, a marker of an environmentally clean and a quality firm. In the realm of transportation, Qatar issued firm regulations limiting vehicle pollution. On another initiative, it has modernized its public transportation to use cleaner, newer vehicles.

Investing in Qatar

Qatar Investment Promotion Department (IPD) is a government agency operating under the supervision of the Ministry of Economy and Commerce. Its role is to increase the country's economic development by attracting new foreign direct investment. It offers incentives and information related to the commercial environment in Qatar.[28] However, IPD stipulates that foreign investors must have one or more Qatari partners whose share is not less than 51% of the agreement. This law is not applicable for certain sectors like agriculture, industry, healthcare, education, tourism, where they can invest up to 100% of the capital. The investor is exempted from income tax for a period of ten years, can import needed machinery without customs, and is free to make all investment return transfers into and out of the country without delay.

There are a few investors who feel confident enough to invest their capital in spite of these regulations. However, many investors or businessmen fail to invest in Qatar for one or many of the following reasons: [29]

1. Inadequately educated workforce
2. Inefficient government bureaucracy
3. Restrictive labor regulations
4. Inadequate supply of infrastructure
5. Inadequate access to financing
6. Poor work ethic in national labor force

3.5.3 Social Environment

Two major fields are essential to the discussion of the social environment of Qatar as it relates to sustainable development: education and health services.

Education

Qatar has paid considerable attention to issues of education and scientific research, with an intense focus on building an information society. These priorities were reflected in the recent transformation of the Qatari education system, the development of educational institutions, and the creation of a science park. Qatar Foundation, under the leadership of the consort of the Emir, has worked hard to develop an educated community and today, its initiatives are reflected in the presence of many reputable research centers and universities in Qatar, including Carnegie Mellon, Weill Cornell University, Texas A&M, Georgetown University, the North Atlantic Community College and Virginia Commonwealth College of Design, and Rand-Qatar Policy Institute.

The education and scientific research sector is given great emphasis in the State of Qatar's Permanent Constitution. Article (24) stipulates that "the State shall promote science, arts, national cultural heritage and safeguard them and encourage scientific research." Article (25) stipulates that "education shall be a significant foundation for the progress of society sponsored and disseminated by the State." The State of Qatar has also implemented numerous programs that reflect its commitment to education, including:

- The conversion of public schools into independent schools (Education for a New Era initiative)
- The reformation of Qatar University
- The establishment of Qatar Foundation Education City, which houses reputable international universities
- The development of Science and Technology Park, which houses many multinational companies' research centers
- Implementation of community development programs

The Qatari government runs 195 K-12 schools, which have a total student enrollment of 67,967. [30] Of the 7,244 teachers working in the country, 5,069 are Qataris. Female teachers constitute 90% of the teaching force in government schools. Private schools enroll 62,507 students and employ 4,250 teachers. Looking at the ratio between private and government schools, it appears that the student-to-teacher ratio in government schools is 9:1, while in private schools the ratio is 15:1 indicating that there is either insufficient teacher capacity in government schools, a greater population of special needs students, or a higher commitment to low student-teacher ratio.

Qatar University enrolls 1253 Qatari students and 291 expatriates. Qatar University's teaching staff totals 387: 74 professors, 313 associate and assistant professors. Out of this total, 177 are Qatari. Foreign university student enrollment in Qatari higher education institutions reached 2018 students of both sexes. In the field of engineering, there are only 61 Qatari graduates that are focusing on broad subjects of mechanical, electrical, civil, chemical, and computer engineering. In the sciences, there are only 38 Qatari graduates focusing on general subjects of math, chemistry, physics, biology and biological science.[31] Some other essential facts include:

1. The education budget for 2008-2009 totaled QR 19.7 billion (21% of the budget outlay).
2. The annual number of graduates of the vocational training center in Qatar averages around 300.

The following section will present a case study of a representative government institution that reflects the other institution's cultures.

Education Reform Case[32]

The education reform "Education for a New Era" has witnessed three contradictory phases since its initiation in 2004. Initially, Rand-Qatar recommended three options: develop the existing Ministry of Education, establish independent schools that are managed by operators, or offer a paid voucher to every student. A decision was made in favor of creating independent schools that could also be profitable institutions. This phase lasted one year and was called cohort one. Due to social pressures, it was decreed that independent schools could no longer seek profitability, and must instead be non-profit institutions. In fact, no operator ever made a profit because all monetary surpluses were withdrawn to the Supreme Education Council (SEC) account that runs the initiative. The third change occurred after it became obvious that schools were facing many operational problems. In this phase, the SEC centralized authority for the operation of schools, effectively ending the “independent school” movement.

These contradictory, rapid and sweeping reforms had a dramatic effect on the nation’s educational system. Why did this happen? It may be because of the conflict between tradition and modernization. Desires for liberalization and the protection of culture have created a deep tension in Qatar’s government institutions.

It is well recognized that Qatar, like other societies, faces many challenges not only in education, but essentially within all its sectors. Though difficult to document in the literature, destructive attitudes contribute to Qatar’s problems. These attitudes are visible in newspaper cartoons, the grapevine, the impulsive reactions of senior managers defending their actions, and even risk management analysis in consultants' proposals. These attitudes have arisen from the tremendous changes that Qatar has experienced, including going from scarce to sudden abundant resources and from old traditions to sudden modernization. If these negative attitudes are addressed and corrected, local societies will be able to build competitive institutions.

The first of these destructive attitudes is impulsiveness. Too often, officials make decisions that affect a vast proportion of the society before adequately studying the possibilities. This comes about in part through competitiveness; decision makers feel supported by the highest leadership and have flexible financial resources. Out of a desire to impress the person who appointed him, a decision-maker will attempt to achieve results quickly, oftentimes sacrificing quality and service. In addition, these impulsive decisions stem from a perceived inability to refute what higher leaders wish to accomplish for fear of losing one's position.

The second destructive attitude is a lack of effort to communicate within and across government organizations. There is an existing believe that letting others participate in decision-making processes is a waste of time and effort.

The third destructive attitude is an inability or unwillingness to accept constructive criticism. Emotions succeed in influencing manners, discussions, answers and meetings. The solution to this is clear; the critic must differentiate between the person and the behavior and discuss each separately.

The fourth attitude is complacency. There is a clear dependency on others to do one's job, which indicates that, among other things, the performance review process is not effective.

The fifth negative attitude is the belief that employment, raises, accommodations, and privileges can and should be achieved through personal relationship and not necessarily performance. These cases are widespread and indicate major holes in legislation, complicated administrative procedures, or absence of accountability. What is needed to eliminate these harmful practices is leadership to command and direct the "Education for New Era" ship towards the right course.

Most of SEC leadership announcements in the media have not clearly shown a strategy with which to achieve their goals. On the contrary, the Evaluation Institute, a department under the SEC, sparked a heated, ongoing debate about the future of the initiative when it announced that independent schools still have not met national standards and that the initiative was doomed to fail. Watkins, head of the SEC Research Office, compared the introduction of independent schools into Qatar to the transplant of a foreign organ into the body. Continuing with the metaphor, he noted that in such cases, the patient is typically consulted and his opinion is taken into account. After the second cohort of schools was converted in the second year of the initiative, the SEC brought in outside consultants in an attempt to ensure that this new "organ" was not rejected.[33]

In spite of these efforts on the part of the SEC, the Education Institute's (EI) provocation has shaken the confidence of parents and local school societies. While the EI was not incorrect in its interpretations of the test results, the tests themselves should not have been implemented because they did not accurately measure student performance levels. When SEC sanctioned the K-12 National Standards, it implemented all the standards at the same time. The diagnostic reports showed that most students are two levels under national standards. Pedagogically, to develop these students, teachers should start at the students' levels and build up. Since there are independently operated primary, preparatory and secondary schools, teachers and school leaders face a dilemma of how to bridge the gaps at higher levels. For example, what should be done when students are weak in English but the requirement is to teach math and science in English rather than Arabic? Other questions have surfaced as well. What strategies must be used? How should teachers and administrators coordinate efforts between similar schools (e.g. primary with another primary), or complementary schools (e.g. primary with preparatory)? Will the student entering grade seven in a preparatory school graduate after ninth grade having adequately covered the set of national standards?

The answer to the final question will definitely be negative because current conditions contradict the steep learning curve concept.[34] In English language learning, for example, it is required that a student learn 1100 words in grade five, 1350 words in grade six, 1600 words in grade seven, 2100 words in grade eight, and 2600 words in grade nine. Memorization and usage is not a problem. However, a preparatory school (grades 7 to 9) must cover the requirements for grades 5-9 in three years time. This is too little time to ensure that such standards are met, especially taking into consideration the fact that other strands and subjects must be taught. This type of pressure will be subject to the forgetting curve concept that speaks to the extent to which students can retain information in memory.[35]

Instead of implementing all standards at once, the SEC should have implemented the level K standards in year 1, then K and Grade 1 in year 2 and so on. Reforming education takes a decade or more.

While this initiative has attempted to bring new concepts and methods to students, teachers and administrators, most of the teacher training at the Ministry of Education and Qatar University does not qualify teachers to implement this initiative. Realizing this fact, the SEC developed some professional development modules for teachers and administrators, but it could not sustain these and they stopped completely by the third year of the reform. Even after these courses, teachers did not implement in their lesson plans what they had learned in the professional development sessions.

Another problem is that while 45% of the curriculum in independent schools is in English, the percentage of teachers that speak English is 3%. Furthermore, the SEC's focus is on administrative issues and not on studying the extent to which national standards are being implemented and what can be done to further implementation. The SEC needs to enlist the assistance of an independent organization dedicated to measuring standards implementations and helping schools to do so.

The independent school concept is currently an empty one; the SEC controls most of operators' functions but also holds them accountable for underachieving. The curriculum is dictated to operators. Ninety percent of the school standards have been imposed externally. Thus, the operator is left with only 10% to achieve creativity and variety, an impossible task. This transition from independence (decentralization) in the first year to control (centralization) in the fourth year reflects a problem of trust. This lack of trust stems from the culture, habits, traditions, educational values, and social interactions surrounding schools. While lip service is paid to enabling compassionate, caring, responsible and civically-oriented leaders to innovate and do their jobs well, many leaders feel that they are quickly replaced when they fail to make changes quickly enough. The attrition rate is 39%, which is so high that an organization cannot build its capacity for innovation and absorption.

Another alarming factor affecting education in Qatar is the absence of transparency and of freedom of speech. It is interesting to note the mismatch between empirical data and reality. For example, 97% of school operators and managers said publically that they have the independence necessary to make changes in their schools. In actuality, there are regulations and policies that prevent them from doing so. This is an extreme contradiction of what "Education for a New Era" is advocating: transparency and freedom of speech.

The Labour Market Strategy developed by the Planning Council with the help of the World Bank offers a reflection on the strengths and weaknesses of Qatar's education system. The results are shown in Table 3.7. The results of this reflection support the above analysis and demonstrate that more initiatives and efforts are needed to develop the education and training of Qatar's labour force.

Initial financial support to independent schools was ranked as excellent in the first year. Schools were encouraged to employ 60-70 percent Qataris and native English speaking teachers. The salary budget was sealed at 76%, external auditors like KPMG and Ernst & Young were contracted to carry out quarterly and annual inspections, and grants were issued. In subsequent years, however, the SEC (the only source of funding to independent schools) did not increase their funding to independent schools in spite of high inflation, increased employee promotion, and the development of retention strategies. In order to remain competitive, schools needed funds to continue these initiatives.

Table 3.7: Strengths and Weaknesses of the Education System in Qatar

	Strengths	**Weaknesses**
Education	Major initiatives are underway to improve K-12 education (e.g. independent schools) The Academic Bridge program offers remedial education (if available to all those in need of remedial education –though it would be better to prevent than correct) Qatar has developed a systematic assessment of competence The Education City includes offerings from several foreign universities	New initiatives seem ad hoc and marginally coordinated with the Ministry of Education Quality and content of education at all levels can improve Implementation plans/guides are lacking Statistics show high dropout and low enrollment rates for Qatari males The future of public schools and the role of the Ministry of Education is unclear There are weak linkages to the labor market (e.g. curriculum and career guidance) There is no real support for the disadvantaged and those at risk There are few opportunities for lifelong learning
Training	Companies provide training (albeit limited)	Four different vocational credential systems are in operation The vocational system is dominated by weak and uncoordinated public sector training institutions There are no linkages between the education system and the labor market Systematic evaluation and research is lacking
Labour problems related to education	A new labor law has been implemented There are opportunities for qualified Qataris in the short run (internal margin) There is a relatively unlimited supply of expatiate labor to meet the demands of business and households	There is no workforce development vision There is a lack of administrative capacity and coordination to make proactive use of work permits Sponsorship rules discourage entrepreneurship among Qataris Qataris rely too heavily on public sector employment There are higher unemployment among the young and the less-educated Qatarization plan is vague and possibly unfeasible in its present form Quality statistics are lacking

Source: Government of Qatar, Planning Council. "*Labor Force Market Strategy for the State of Qatar: Main report*." Doha: Planning Council; 2005.

Employee attitudes changed with the surrounding environment. However, independent schools could not hire or terminate employees without the approval of the SEC. Although there are laws and regulations that allow the schools to expel teachers or students, the SEC interferes most of the time because parents complain publicly in the media. Also, if a teacher complains because of expulsion (he or she can complain in the media and spoil the image promoted by the reform), the SEC will negotiate or impose its decision on schools to keep the teacher employed. Negative consequences occur as a result of such actions, and these affect the learning process. Absenteeism is a commonplace in schools and is done legally on medical grounds using "common interest" doctors. Out of 180 school days, teachers can easily be absent 45 to 60 of those days and legally, the school cannot do anything. Everyone knows this is happening and no one is doing anything about it.

The educational case presented above represents similar cultures elsewhere in the public sector. Many recommendations can be presented to reduce the harmful effects of current policies and attitudes and to remove obstacles. These include:

1. Capacity building for leaders, administrators and teachers that concentrates on learning and instruction. Qatar University must design and implement a university degree for professional teachers.
2. The authorization of independent financial and administrative management and an accountability system.
3. The creation of an "Initiative Implementation Institute (III)" under the SEC and parallel to the existing three institutes (Education, Evaluation, and Higher Education Institutes) to supervise the implementation of national standards in independent schools and to provide the required support needed in unit and lesson plans.
4. Merger of education reforms with social reforms by allowing government institutions and ministries to participate in the initiative through an annual forum that consolidates the requirements of various stakeholders.

5. Development of the Qatar labour market to become competitive through implementation of the PC's Labor Market Strategy.

Health Care

In its constitution, Qatar has vowed to deliver full health care to its population. Even expatriates receive subsidized medical services. The budget allocation for health, 9% of 2008-2009 budget outlay or QR 9.2 billion,[36] promotes sustainable health services provision for its population.

In 1978, the Primary Health Care Services Department was established to manage 23 health centers across Qatar. These centers offer several programs related to health education, childhood and motherhood care, immunization against child diseases, diagnosis and treatment of common and chronic diseases, prescription of medicines, provision of healthy food and clean potable water, and ambulance and emergency services. Several hospitals have been founded in the State of Qatar, including one dedicated for cancer. Another opened in the north city of Al-Khor, Hamad Medical City (HMC). The HMC compound consists of 3 specialized hospitals - one for children, a trauma and orthopedic hospital, and a medical rehabilitation hospital - in addition to a kidney dialysis unit, a minor operations unit, and a 300-bed center for elderly people.
Today, Qatari patients select private healthcare centers based on word of mouth, advertising, and the aesthetics of the institution. Quality standards for health care providers are neither transparent nor understood by patients, thus these medical institutions always struggle to differentiate themselves in the market.

Various conferences were held recently in the State of Qatar concerning primary health care, pediatrics, and hepatitis. These eye-opening conferences have led to the planning of new initiatives. Some of the HMC's current projects focus on comprehensive development through increasing hospitals and care units, providing staff accommodation and entertainment, promoting human skill development, more effectively managing information technology, improving emergency response and interlinking with Weill Cornell Medical College and University of Clinics of Heidelberg. With the assistance of the Victorian Healthcare Association, HMC has also developed a health strategy plan. All of these projects and programmes will employ high-end technology.

3.5.4 Technological Environment

Qatar Science and Technology Park, ictQatar and Qatar telecommunication are three players in country who substantially impact technological environment. This study will look at the telecommunication regulation, e-government and research and technology to reflect the technological infrastructure available that impact technology transfer.

Telecommunications Regulation

The foreign capital investment regulations prevent FDIs in the telecommunication sectors but do not prohibit buying a limited share in the telecommunication stocks. Presently, the Government owns 55% of Qatar Telecommunication which has previously been permitted to monopolize the telecommunication sector. However, new regulations changed earlier commitments and opened the market for new comers in this sector. The sector includes internet services, mobile phone networks and cable television. The governance over telecommunication laws has been vested into the Supreme Council for Communications and Information Technology (or so called ictQatar). Besides, ictQatar, established in 2004, is responsible for implementing a vision, strategies and plans for this sector.

Current ictQatar initiatives include information security, which aims to manage information security risks and respond to security vulnerabilities in order to protect the information security of all users. To this end, ictQATAR has made partnerships with Carnegie Mellon University's CERT Coordination Center to mitigate risks. The role of Q-CERT is to collaborate with both government and industry to manage cyber security risks. The scope ictQatar’s other activities extend to e-government, e-finance, e-health and e-tourism services. In addition, Qatar hosted the World Telecommunication Development Conference, in 2006, attended by major stakeholders in the telecommunication sector. The objective of the conference was to agree on development priorities to bridge the gaps between developed and developing countries in the digital space.

e-Government

The Qatari government has made substantial investment in e-government and is making progress in offering citizens its services. Qatar has made significant investments to enhance its e-government capabilities, and these capabilities are likely to accelerate and expand, particularly in light of the government's recent entry into partnership with the Singapore InfoComm Development Authority. This partnership aims to improve ICT in both the public and private sectors.

At present, the main purpose of e-government is to receive payments and documents. The benefits of integration (effectiveness and transparency) and ease of access to information have yet to be implemented. E-government will not be a success before these are accomplished.

Scientific Research

In her closing address at the First Conference of Arab Expatriate Scientists (QFIRST 2007), Her Highness, the Consort of the Emir, emphasized the importance of research to Qatar's national development strategy:

> "From the start, we have always believed that promoting a scientific research system is a political commitment that comes within His Highness's vision to advance modern Qatar. Scientific research in this sense is an element with a mission closely related to educational and economic development."

Qatar Foundation was spearheaded to set up a number of research facilities in the country. Although both Qatar University and the GOIC have research facilities, these facilities lack a knowledge database and the network required to facilitate access to that knowledge. Even in the whole Gulf region, there has been little R&D and technological entrepreneurship. Only when Qatar Foundation set up Science and Technology Park in 2006 did the government begin to seriously investigate ways to diversify beyond oil, to invest heavily in education and science, and to encourage the private sector to play a bigger role in the economy. The Qatar Foundation's Research, Science and Technology Division aims to:

> "Pursuing cutting-edge research and development that helps build Qatar's innovation and technology capacity, supports the growth of Qatari society and uncovers solutions to national challenges in health, climate change, the environment, clean energy and other fields. QF's research strengths will be organized around core platforms of medicine, biotechnology, information and communication technologies, environmental sciences, molecular sciences and nanotechnology."[37]

Under Qatar Science and Technology Park (QSTP) supervision, many R&D and training centres including Cisco, ConocoPhillips, EADS, ExxonMobil, Gartner Lee, GE, iHorizons, Institut de Soudure, Microsoft, Rolls-Royce, Shell, SMARD, and Total have established bases in QSTP. In addition, Qatar Foundation links Education City's Universities, the R&D Department of Carnegie Mellon University, Virginia Commonwealth University, Weill Cornell Medical College, Texas A&M University, Georgetown University, and North Western with QSTP. The Park is still in its infancy and time is required before its performance and achievements can be adequately assessed. In 2003, RAND and Qatar Foundation partnered to establish the RAND-Qatar Policy Institute in Doha. The Institute seeks to improve all facets of the political, economic, social and environmental development. Rand-Qatar Institute will provide governments and non-profit organizations in the region with needed research data and analyses. However, so far these investments have been largely aimed at achieving economic gains and have not sought to build indigenous capabilities as a first priority. In fact, these initiatives are often seriously dependent on foreign skills. Consequently, Qatar urgently needs to establish a sustainable economy using diversification and becoming less reliant on importing expatriate expertise.

3.5.5 Legal Environment

Both Qatar's Ministry of Interior and the Department of Labor in the Ministry of Civil Service and Housing Affairs' regulate the recruitment of expatriate labor, and are presently focusing on reducing the demand on labour from South Asia by replacing it with workers from outside this region, and at the same time, developing local human capital. In May 2004, Qatari updated the labor law to give workers the right to strike and form committees, but prohibited strikes in vital industries of oil and gas, utility, transport, communications, and hospital care. Typically, expatriate workers in Qatar are provided accommodations, end of service benefits, and an allowance for travel to their home country in addition to their salaries. While there is no minimum wage regulation and all salaries and wages are negotiable, termination benefits are subject to three different laws.

In the face of international pressure to reform its labor regulations, Qatar has become increasingly active in the International Labour Organization (ILO) and is currently drafting a new labor law. Labor market reform has become an obstacle to the United States trade agreement with Qatar, and this might be the single biggest driver of change in the country. In addition, Qatari youth protest the fact that the salaries of private sector jobs do not meet local subsistence standards, even though most are performed by expatriate labor. This is another influence that will push Qatar to examine its population planning and labor market strategies and make vital changes. It will also motivate Qatar to integrate with its GCC members with respect to human resource availability and will foster integration into the global economy. India and the Philippines, which contribute the greatest number of expatriate laborers to Qatar, have already seen their external pressure transform working conditions for their citizens in Qatar. It is likely that other countries will follow suit unless Qatar begins to address the problem immediately. The course of change is clear, while the speed of reform is not.

Another barrier to technology transfer can be seen in the formulation of the IPR law. Qatar is not a member of the World Intellectual Property Organization (WIPO) , and also, does not belong to the Paris Convention for the Protection of Industrial Property. Thus, Qatar has created its own national laws and regulations for protecting property rights. In Qatar, copyrights protect literary and artistic work. The author or the owner of the copyright has the exclusive right to carry out or to authorize reproduction, translation or distribution of the work, and also has the power to transfer this right to other persons. This law does not clearly cover the protection of unpublished undertakings or criminate end-user piracy. So far, the Intellectual Property Rights Office has filed twenty cases of IPR violations.

When requirement arises, Qatar relies on the GCC patent law to satisfy the TRIPS Agreement. Also, provisional ministerial committees handle property rights issues in which the Ministry of Economy and Commerce is part of. A 2006 Emiri Decree on patents offered guidance on patent law, declaring that only industrial inventions can be patented. This means that the product or means of production must be innovative in order to be patented. The decree also states that inventions in health, agriculture, plants and software development are not eligible to be patented. Furthermore, only Qatari citizens or foreigners of WTO signatory countries are allowed to register a patent. It is the responsibility of the Ministry of Economy and Commerce to set up a patent registration office, creates regulations, and enforces the law.

The Patent Office of the GCC is a regional office which serves the States of United Arab Emirates, the State of Bahrain, the Kingdom of Saudi Arabia, the Sultanate of Oman, the State of Qatar, and the State of Kuwait. GCC Patent Office certificates of patents provide legal protection of the inventor's rights in all member states. The office operates under a collection of laws drawn from the World Intellectual Property Organization (WIPO). In late January of 2008, the Patent Office of the Cooperation Council for the Arab States of the Gulf (GCC) registered its 10,000th patent.

3.6 Absorptive Capacity, Value Chain, and Value Networks in Qatar

Absorptive capacity has not been measured in Qatar, and there has yet to be an explicit discussion of value chain and value networks in the context of Qatar. To overcome these obstacles, this methodology will concentrate on industry, universities and related government institutions to explore and, if possible, measure these values. Therefore, in this section, the following will be discussed:

1. Qatar innovation system
2. Industry and energy sector

As shown in chapter two, the literature discusses capacity building in terms of enhancing developing countries technical capabilities as a prerequisite to a successful technical transfer but capacity is needed in marketing, finance, service, information, policy development and other fields.

Measuring absorptive capacity requires gathering many indicators of marketing capabilities, breadth of knowledge, facility for learning by doing, and returns on investments. In another school of thought, absorptive capacity can be measured through assessments of scientific knowledge using bibliometrics and co-citations. Another method is measuring a firm's alliances and the degree of overlap in its collaborations. Other indicators include measures of in-house R&D capabilities, R&D intensities, shares of R&D personnel, the R&D budget, and the gap between available knowledge and skills for a firm to absorb and actual absorption. Most of the above measures do not exist in government publications and need to be gathered through surveys. However, it would be of great value to this study if the current practices of the industries, universities and a representative government agency or set of agencies were investigated with respect to absorptive capacity, value chain and value network.

In the realm of research, international companies participating with QSTP[38], mostly foreign companies, have dedicated more than a hundred million US dollars for researching commercial products and services so far. QSTP has recently introduced new enterprise funds (value of US$ 30 million) and technology venture funds (valued at US$ 100 million) available to support initial stages of technical initiatives or enterprise startups. Also, QSTP has introduced The Proof of Concept fund (valued at US$ 500,000) dedicated to help researchers commercialize their innovations. This fund is available for universities, SMEs, and government institutions.[39]

3.6.1 Qatar Innovation System

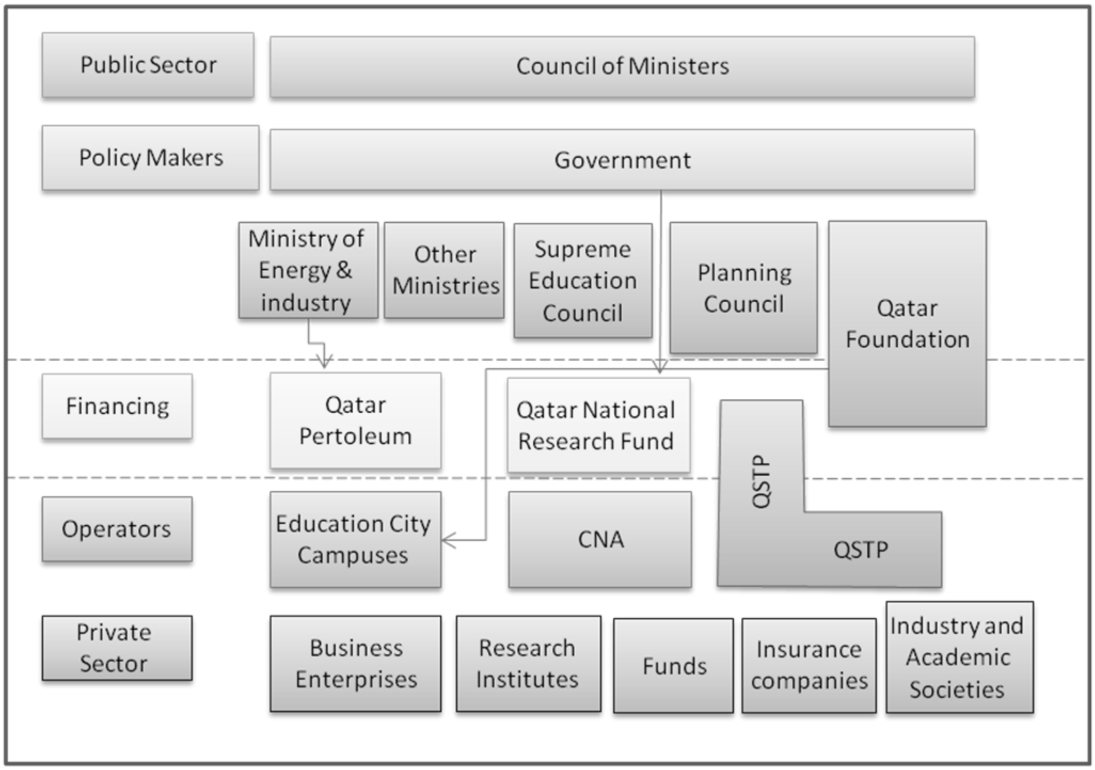
Innovation for economic development in Qatar is a recent theme. It has started after the Planning Council's "Knowledge Economy Project" that assessed knowledge economy in Qatar (May 2007). The project was transparent in projecting serious issues of low capacity for innovation in Qatar. It explained the lack of interactions and coordination amongst various stakeholders in the innovation network mainly universities, industry and government sectors.[40] The most privileged sector in Qatar economy to transfer technology and knowledge was and still the energy sector, and in particular Qatar Petroleum. Utilizing available joint venture setups, foreign technology and expatriate knowledge, QP has demonstrated some success. Other sectors are less fortunate.

According to Doloreaux & Parto, innovation systems are "a set of interacting private and public interests, formal institutions and other organisations, which function according to organizational and institutional arrangements, together with relationships conducive to the generation, use and dissemination of knowledge."[41] National innovation systems are built around history, culture, and language. Although the literature provides little on types of innovation and lack of agreements exists, some are radical but mostly incremental.[42] Qatar's "Knowledge Economy Project" identifies three innovation types; local improvements, modification to existing technology and design of new products. Qatar, according to the project report, uses the first two. The innovation in Qatar rests on importing human capital and recent QSTP investments.

Figure 3.2 shows Qatar's innovation system along with key players that influence technology development in the country. The lack of coordination and cooperation between them prevents the formulation of clear policy directions to promote the national innovation system. Visions and strategies must be mapped to establish a database of coordinated efforts that avoid duplication and specify the role of each entity in the input, process and output system.

There are areas that need to be addressed so that the economy can benefit from the spillover from R&D centres. The single most important challenge for successful innovation in Qatar is the accumulation of adequate qualified personnel. According to a study on the promotion of technology and innovation in Arab regions, other areas that need to be addressed include improvements in the availability of information about market practices and opportunities, reductions in the restrictiveness of regulatory policies, and a lower overall level of economic risk. The study found that the United Arab Emirates is currently the leading innovator in the region.[43] In terms of sectors, the ICT and the energy, and utilities sectors are ranked most innovative in the Arab world. Vast potential for innovation exists in other sectors, such as financial and health care, services. For Qatar, all of the above are true and relevant.

Figure 3.2: Qatar National Innovation System: Organizations and Coordination



Source: Government of Qatar. Qatar Foundation. Qatar Innovation System. Background Paper No 3. 2006

Dubai, one of the seven emirates in the United Arab Emirates, has moved away from its dependence on oil through the development of other innovative sectors. Dubai Media City, Dubai Internet City, Knowledge Village and Dubai Silicon Oasis are four initiatives that house international experts and innovators in one place. The success of these ventures in an environment similar to Qatar’s indicates that Qatar could do quite well using similar approaches to the development of its technology infrastructure.

First, however, this study will examine the various activities already taking place in industry, particularly in the energy sector. This will lead to the formulation of a profile of their efforts towards technology transfer.

3.6.2 Industry and Energy Sector

Although Qatar is a high achiever in terms of macroeconomic outcomes, improvements to infrastructure and business sophistication are needed. Qatar was assessed as the second-best developing country in the Arab world and scored 32nd (out of 40) within the group of advanced countries.[44] Given its economic boom and lucrative natural gas reserves, Qatar may soon have the highest per capita (GNI) in the world. Like other oil-producing countries in the region, Qatar's growth has benefited from the increased production and export price of oil and gas.

Although the country's monetary situation has improved noticeably, public debt remains high and the dollar's depreciation, combined with soaring housing costs, has created inflation. Also, despite intensive diversification efforts, the Qatari economy remains heavily dependent on natural resources, including rising gas exports.

Even with these worrying tendencies, Qatar ranks 4th in the entire sample on the macro-economy pillar of the Arab world.[45] Oil and LNG are pillars to Qatar's economy growth and accounts for more than 65% of government revenue, more than 60% of GDP, and roughly 82% of export earnings (47% for oil and 35% for liquefied gas).[46] In fact, the gas and oil sector's proportional importance to the GDP increased from 44.8% in 1999 to 61.9% in 2006. Rising oil revenues in the past few years have allowed Qatar to launch large-scale infrastructure projects, including highways and road networks as well as the newly built Doha International Airport and Doha Commercial Seaport.

The manufacturing industries sector (other than oil and gas) is considered the third largest contributor to Qatar's GDP. This sector lagged behind the government services sector, which scored second and took in US$ 3.86 billion in 2006, a relative share of 9.86% of the GDP. Interestingly, in 1999 this sector only took in US$ 0.94 billion.

There are many mechanisms that provide incentives to SMEs. Qatar encourages SMEs by incentives of land and technical and legal consultancy. Qatar Industrial Development Bank (later named Qatar Development Bank), established in 1997, provides support through financing small and medium industrial ventures. The Department of Industrial Development works with Qatar Development Bank and Qatar Manufacturing Industries Company to provide free consultation to investors in assessing their project feasibility.

Government and Quasi-Government Organizations Involved in Industry

In Qatar, there are two types of industries: major conglomerates and minor entities. The oil and gas industry is currently the country's most vital revenue resource, while other non oil and gas industries are considered an absolute minority. An overall assessment of Qatari industry reveals that the state-owned Qatar Petroleum is the single key player that has monopolized the majority of Qatar's industrial sector. Qatar Petroleum (QP), established in 1974 as a national corporation, works in joint venture organizational arrangements to explore, drill produce and sell crude oil and natural gas, petrochemicals and fertilizers. These joint ventures are listed in Table 3.9.

Qatar Industrial Manufacturing Company (QIMC) was established in 1989 through the participation of prominent Qatari businessmen and government officials. Its main objective is to develop the industrial sector using available natural resources and raw materials. The Qatari government owns 70% of its shares and the balance of 30% is publically owned by Qatari citizens. With a capital of US$ 55 million and direct support from the state, QIMC became, within a short period of time, one of the leading small to medium-sized industrial projects in the State of Qatar. Its business area is diversified into 13 industrial projects as clarified by Table 3.10.

Established by Emiri Decree in1997, Qatar Industrial Development Bank (QIDB) currently serves as a catalyst to industry development and diversification by financing, advising, and monitoring small and medium size industrial projects. The QIDB also conducts research and provides advisory services for the projects it funds. The authorized capital of the QIDB is US$55 million, paid in full by the State of Qatar.

Table 3.9: Qatar Petroleum Subsidiaries and Joint Ventures

No	Subsidiaries and Joint Ventures	QP's Share (%)
	A – Subsidiaries	
1	Gulf Helicopters Company (Gulf Helicopters)	100
2	QP Finance (Cayman) Limited	95
3	Industries Qatar Q.S.C (IQ)	70
4	Qatar Nitrogen Company (QAN)	50
	B - Joint Ventures	
1	Qatar Liquefied Natural Gas Company Ltd. - Downstream	65
2	Qatargas Joint Venture- Upstream	65
3	Ras Laffan Liquefied Natural Gas Company Ltd. (RL)	66.5
4	RasGas Company Ltd. (RasGas)	70
5	Ras Laffan Liquefied Natural Gas Company Ltd. II (RL II)	70
6	Qatar Chemical Company Ltd. Q.S.C (Q-Chem)	51
7	Qatar Vinyl Company Q.S.C (QVC)	43.4
8	Qatex Limited (QATEX)	51
9	Oryx GTL Ltd. (ORYX)	51
	C - Other Investments	
1	Qatar Fuel Company (WOQOD)	40
2	Qatar Shipping Company (Q-SHIP)	18.7
3	Qatar Metal Coating Company W.L.L	18.7
4	Qatar Real Estate Investment Company	0.7
5	Qatar Plastic Production Company (QPPC)	18.7
6	Qatar Electricity & Water Company (QEWC)	10.7
7	Ras Laffan Power Company Limited (RLPC)	10
8	Arab Shipbuilding & Repair Yard (ASRY-Bahrain)	18.8
9	Arab Maritime Petroleum Transport Company (AMPTC-Kuwait)	14.8
10	Arab Petroleum Investment Corporation (APICORP-Saudi-Arabia)	10
11	Arab Petroleum Services Company (APSC-Libya)	10
12	Arab Petroleum Pipelines Company (SUMED-Egypt)	5
	D - Joint Ventures and Subsidiaries of IQ	
1	Qatar Petrochemical Company Ltd. (QAPCO)	80
2	Qatar Fertilizers Company (QAFCO)	75
3	Qatar Fuel Additives Company Ltd. (QAFAC)	50
4	Qatar Steel Company Ltd. (SAQ)(QASCO)	100

Source: Ministry of Energy and Industry. Industrial Development in Qatar. [online]. [sited 5 April 2008]; Available at: http://www.mei.gov.qa/portal/page?_pageid=36,249751&_dad=portal&_schema=PORTAL

The government of Qatar does not publish detailed information on foreign direct investment (FDI). Table 3.11 was provided by the World Investment Report and provides some understanding of the overall picture of FDI in Qatar. However, because it is considered outdated, particularly given the fast pace of change in the current market, it does not offer a complete account of FDI. Information from the U. S. Department of State suggests that, from about 2002 to 2005, around 73 FDI projects were implemented totaling approximately US$ 34 billion.[47]

Table 3.10: Qatar Industrial Manufacturing Company Group Companies

No	Company	QIMC's %
1	Qatar Jet Fuel Company (QatJet)	40
2	National Paper Industries Company (NAPICO)	100
3	Qatar Metal Coating Company (QMCCO)	50
4	Qatar Sand Treatment Plant (QSTP)	100
5	Qatari-Saudi Gypsum Industries Company (QSG)	33
6	Gulf Ferro Alloys Company (SABAYEK)	10
7	Qatar Clay Bricks Company (QCBC)	39
8	Qatar Nitrogen Company (QAN)	50
9	National Food Company (NAFCO)	50
10	Qatar Plastic Products Company (QPPC)	33.3
11	Qatar Acids Company (Q-Acids)	100
12	Gulf Formaldehyde Company (GFC)	15
No	**Company**	**NAFCO's %**
13	Qatar Tunisian Food Company (Q-T Food)	51

Source: Ministry of Energy and Industry. Industrial Development in Qatar. [online]. [sited 5 April 2008]; Available at: http://www.mei.gov.qa/portal/page?_pageid=36,249751&_dad=portal&_schema=PORTAL

Table 3.11: Foreign Direct Investment in Qatar (1999-2003) in Million USD

	1999	**2000**	**2001**	**2002**	**2003**
FDI inflows	113	252	296	631	400
FDI inward stock	1668	1920	2216	2847	3247
FDI inward stock % of GDP	13.5	10.8	12.5	14.4	15.9
FDI outflows	30	41	112	61	71
FDI outward stock	104	181	293	353	424
FDI outward stock % of GDP	1.1	1	1.7	1.8	2.1

Source: UNCTAD. World Investment Report and WTO Secretariat Estimates. UNCTAD; 2004.

The Department also indicated that in 2006, around 36 FDI projects started, totaling US$ 282.5 million all together. According to the Department of State data, the United States is the main source of FDI in Qatar, followed by the United Kingdom, the United Arab Emirates, India and the Netherlands. Of 109 FDI projects, industry attracted only 25 projects. Nevertheless, QP and its foreign partners invested an estimated US$ 100 billion in upstream and downstream technologies. Also, the development of the North Gas Field will attract FDI and dominate all other sectors. ExxonMobil alone has invested about

US$ 10 billion in Qatargas Company (10%) and Ras Laffan Liquefied Natural Gas Co. (RasGas) (26.5%). U.S. investment in Qatar is estimated to be US$ 60-70 billion. Government officials expect an additional US$ 70 billion will be invested in Qatar's energy sector by 2010.[48] The following table depicts the norms of foreign investments participation in three major state-owned petroleum related industries.

Table 3.12: Typical Investment Shares in the Petrochemical Industry

Number	Company	Investors	Investment Share
1	Qatar Fertilizer Company Established : 1969 Equity Value: US$ 791.5 million	Industries Qatar	75 %
		Yara Nederland BV	15 %
		Fertilizer Holdings AS	10 %
2	Qatar Petrochemical Company Established: 1975 Equity Value: US$777.5 million	Industries Qatar	80 %
		Total Petrochemicals	20 %
3	Qatar Fuel Additives Company Ltd Established: 1992 Equity Value: Unknown	Industries Qatar	50 %
		Chinese Petroleum Corporation	20 %
		Lee Chang Yung Chemical Industry Corporation	15 %
		International Octane Limited	15 %

Source: U.S. Department of State. 2007 Investment Climate Statement –Qatar. [online]. [cited 6 April 2008]; Available at: http://www.state.gov/e/eeb/ifd/2007/80765.htm

Non oil and gas industries can be classified in accordance with the International Standard Industrial Classification by classifying the total number of registered and licensed industries as well as the total of all capital invested in those industries. See Table 3.13.

Industries are classified as small industries when the investment capital ranges between US$ 68,500 to US$ 1,370,000, and as medium industries when investment capital reaches between US$ 1.37 million to US$ 5.5 million.

Qatari industries are housed in four industrial estates: Mesaieed Industrial City (MIC), Ras Laffan Industrial City, Doha Industrial Area, and Umbab Industrial Area. MIC is a petrochemical and metallurgical plant with a full-service, 24-hour port handling exports and imports from all industrial sectors. Ras Laffan Industrial houses RasGas, Qatargas, and other major companies. It has a port that dispatches some of the largest LNG shipments in the world, and will soon add gas-to-liquid (GTL) projects to its list of supported endeavors. Doha Industrial Area is designated for SMEs, and Umbab Industrial Area is dedicated for minerals industries.

Table 3.13: Industrial Establishments by Size & Capital Investment up to 2003

ISIC Code	Industrial Activity	Total Nos.	Investment in QR (000)	Small		Medium		Large	
				Investments	Nos.	Investments	Nos.	Investments	Nos.
31	Manufacture of Food, Beverages & Tobacco	48	987,065	46,014	28	92,228	10	848,823	10
32	Textiles, Wearing Apparel & Leather Industries	33	136,665	57,176	5	56,749	5	22,740	1
33	Manufacture of Wood, Wood Products including Furniture	38	65,659	40,038	34	25,621	4 0	0	0
34	Manufacture of Paper, Paper Products, Printing & publishing	29	174,883	34,730	20	69,688	8	70,465	1
35	Manufacture of Chemicals, Petroleum, Coal, Rubber and Plastic Products	77	31,550,275	77,387	47	139,240	16	31,333,64	14
36	Manufacture of Nonmetallic Metal Products except Products of Petroleum and Coal	95	1,532,437	124,234	63	184,209	21	1,223,99	11
37	Basic Metal Industries	4	1,554,081	1,800	1	5,950	1	1,546,331	2
38	Manufacture of Fabricated Metal Products, Machinery and Equipment	83	817,707	108,848	74	60,866	7	647,993	2
39	Other Manufacturing Industries	4	7,646	7,646	4	0	0	0	0
TOTAL		**411**	**36,826,418**	**497,873**	**298**	**634,551**	**72**	**35,693,994**	**41**
Ratio %		**100**	**100**	**1.3**	**72.5**	**1.7**	**17.5**	**97.0**	**10**

Source: Ministry of Energy and Industry. Industrial Development in Qatar. [online]. [sited 5 April 2008]; Available at: http://www.mei.gov.qa/portal/page?_pageid=36,249751&_dad=portal&_schema=PORTAL

3.7 University-Level Research and Development

In this section, the performance of R&D, particularly in universities, will be investigated. Apart from universities, the other major source of R&D in Qatar is Science and Technology Park. The role of the park in R&D may expand greatly, because in April 2008, Qatar Petroleum signed a US$ 75 million five-year agreement with the park to establish a research center that will develop cutting-edge oil and gas technologies. There, QP will carry out R&D projects to find innovative solutions to operational problems.

Another source of R&D is the RAND-Qatar Policy Institute, involved in the analysis of policy problems and implementation of initiatives in MENA countries and South Asia. RAND-Qatar has already completed several projects in the region. With the help of this institute, Qatar is implementing a comprehensive program of education reform, "Education for a New Era." It has also designed a national funding organization, called the Qatar National Research Fund (QNRF), to support research in the sciences, engineering, humanities, and the arts. It has also helped to reform Qatar University. RAND-Qatar asserts that, by focusing on a few select fields, its initiatives are more successful. Though the results of many of its initiatives have yet to be measured, it is possible to see evidence of the positive effects of the institute's reforms.

The QNRF, established in 2006, grant funds to competitive research in science and technology, engineering, and social science. The fund amounts to 2.8% GDP, which, when compared internationally, is very competitive (see Table 3.14 below). A total of US$ 25million was awarded to 10 institutions to fund 47 projects over three years period, mostly at the American universities in Qatar.

Table 3.14: Comparing R&D in Selected Countries

High Human Development	R&D % GDP
Sweden	3.7
Qatar	2.8
United States	2.7
United Kingdom	1.9
Kuwait	0.2

Source: The UNDP Human Development Report 2007-2008. Apart from Qatar's figure that has been published recently at Qatar Foundation. Qatar Foundation announce Qatar's first international research awards. [online]. [12 May 2007]. [cited 7 April 2008]; Available at: http://www.qnrf.info/s2/news/ann_detail.php?ID=1211

QNRF has the potential to make great contributions to the development of Qatar's knowledge-based economy. The QNRF's vision is ambitious. It seeks nothing less than advancement in knowledge on the national, regional and international scale through collaboration with academia, public entities, and private partners. Furthermore, the Foundation sees itself as a mechanism through which to diversify Qatar's economy and develop human capital. Through its research, QNRF hopes to improve the health, environment, and security of Qatari citizens. It intends to accomplish this through the provision of financial support both publicly and privately to researchers both novice and advanced.

Carnegie Mellon also has a substantial presence in the knowledge economy of Qatar; it is home to more than 90 centers and institutes dedicated to undergraduate and graduate students. [49]

Sidra Medical and Research Center, which was initiated by Her Highness Sheikha Mozah and is scheduled to open in 2011, describes itself as a high-tech academic medical center. It intends to offer "world-class clinical care, medical training and biomedical research in Qatar."[50] Hamad Medical Corporation, the major public healthcare provider in Doha, will be working with Sidra and Weill Cornell, As partners, Sidra, Weill Cornell, and Hamad Medical Corporation will cooperate on both research projects and skill development in order to maximize the benefits to patients and staff in Qatar's public health system.

Qatar University Research Center is another research facility that aims at fostering and improving the national research environment. To do so, the Center hopes not only to direct policies governing the allocation of fund for research, but also to conduct applied research in order to inform curriculum, meet local and regional needs, and develop a well-respected academic faculty. Currently, the focus of the university is on academic research, the environment, gas processes, and materials.

Cornell's total research expenditures were US$ 605,341 in FY 2006. These funds supported the university's research priorities, including the new life sciences, cross-college collaborations, computing and information sciences, genomics, advanced materials, and nanoscience.[51]

Texas A&M University at Qatar (TAMUQ) opened in 2003. It has brought outstanding engineering programs to the country and the region, offering undergraduate degrees in chemical, electrical, mechanical and petroleum engineering. Texas A&M University Qatar is now the cornerstone for engineering research in the region, particularly for oil and gas. Since it has opened, the University has conducted professional engineering training, but has not documented any actual research. This can be attributed to the fact the university is still in the nascent stage and is likely still surveying local energy and environment problems.

In summary, R&D performance cannot be accurately assessed for one reason: absence of information. By looking at the above, R&D assessment is hindered by:

1. Scarcity of R&D centers
2. Scarcity of researchers
3. No research and development programmes in Qatar industry
4. Absence of statistics on research activities or lack of current information
5. No statistics on patents

3.8 Qatar's Competitiveness

Qatar is one of the most competitive economies within the GCC and the Arab World, mainly because of its institutions and labour markets. To maintain this advantage and improve further, Qatar needs to build its infrastructure, improve its education system, and promote market efficiency. The Global Competitiveness Index (GCI) ranks Qatar 31st on its performance. [52] According to the GCI report, Qatar's four pillars are ranked in accordance to their highest scores sequentially; these are its institutions, infrastructure, macroeconomic stability and health and primary education. On the negative side, the report found seven major pitfalls that need to be addressed:

1. Inflation
2. Restrictive labour regulations

3. Inadequate supply of infrastructure
4. Inadequately educated workforce
5. Inefficient government bureaucracy
6. Lack of access to financing
7. Poor work ethic in the national labour force

Selecting other indicators from the GCI report that have a bearing on technology transfer, Table 3.15 list additional strengths and weaknesses.

Table 3.15: Qatar Technology Transfer Competitiveness Balance Sheet

Advantages	Rank/131	Disadvantages	Rank/131
Wastefulness of government spending	4	Tertiary enrollment	79
Public trust of politicians	10	Local availability of specialized research and training services	55
Judicial independence	22	Company spending on R&D	41
Ethical behavior of firms	26	Business impact of rules on FDI	58
Intellectual property protection	27	University-industry research collaboration	42
Quality of math and science education	25	Female participation in labor force	120
Prevalence of trade barriers	9	Availability of scientists and engineers	67
FDI and technology transfer	6	Broadband Internet subscribers	42
Availability of latest technologies	28	Firm-level technology absorption	33
Production process sophistication	25	Capacity for innovation	89
Government procurement of advanced technology products	18	Value chain breadth	55
		Quality of scientific research institutions	46

Source: Geiger T. Qatar: Successful Policies Bode Well for the Future. Detail Country Profile. Global Competitiveness Index Report 2007-2008. [online]. [sited 9 April 2008]; Available at: http://www.gcr.weforum.org/

The information in the above table illustrates strengths and weaknesses that will affect Qatar's ability to implement sound technology transfer policies and initiatives. One of the primary downfalls is the inadequate supply of infrastructure. Interestingly, the Qatari government is aware of this fact and has started a massive infrastructure development initiative, particularly for a new airport and a national airways carrier to link other regions and contribute to regional economic integration and mobility. Although the literacy rate in K-12 education is high, attention needs to be turned to higher education. Again, the government, in collaboration with Western universities, has launched the project "Education City," which aims at creating a state-of-the-art education facility for grades K-graduate level. It is hoped that this project will reduce the shortages of scientists and engineers in Qatar.

The International Monetary Fund (IMF) report on Qatar praised the country's impressive GDP growth, substantial current account surpluses, and vigorous financial sector. The report advised Qatari authorities that they must focus on "sustaining growth while maintaining financial stability, creating appropriate policies for managing hydrocarbon revenues, and developing a competitive private sector." [53]

On the HDR, Qatar scored 35 out of 177 countries with an index of 0.875. On indicators related to technology diffusion issues, such as patents granted, receipts of royalties and license fees, research and development expenditures, numbers of researchers in R&D, and tertiary education, there is no data available. [54]

3.8 Overall Assessment

During the secondary search for information for this chapter, it was difficult to locate the right information to build an accurate picture of technology transfer. Most government publications, annual reports, and statistics have been found to be biased toward the oil and gas sector and toward profitable commercial activities. The independent international information sources on Qatar, such as the publications of the World Bank, the United Nations, the Economist Intelligence Unit and the International Monetary Fund (IMF), have been found to serve their individual objectives. Special surveys related to the objectives of this study must be conducted in a consistent manner. This lack of information shows that government officials are uncertain about the environment in which they are managing technology transfer issues.

Qatar is in an advantageous position compared to other countries. It is endowed with abundant wealth that can easily be utilized to develop the sophistication of its technology through development of its education systems, including universities and training in the tertiary system. It also can direct its funds towards SMEs instead of primarily targeting large government projects. There, the funds can be used to build innovation and real expertise. To build value in its economy, Qatar needs to reform its labour market to be more competitive, reform its education system, and develop its financial markets.

Qatar's immigration policy is flexible, whereas its labour market is inflexible. This is contrary to other developed countries where immigration is difficult, but once an expatriate is accepted as an immigrant, he or she can switch easily between jobs. The private sector employs cheaper labour. This results in rock-bottom quality products and services. In turn, the skill of local labour is influenced and declines. This goes against sustainability principles because nationals are deprived of access to experience and quality training.

In order to bridge the gap in the scholar literature to appropriately measure technology transfer in Qatar, the author conducted a field survey encompassing industry, universities and government bodies. Chapter four will build on the research methodology in chapter one and use the thematic model in the same chapter to measure technology transfer effectiveness.

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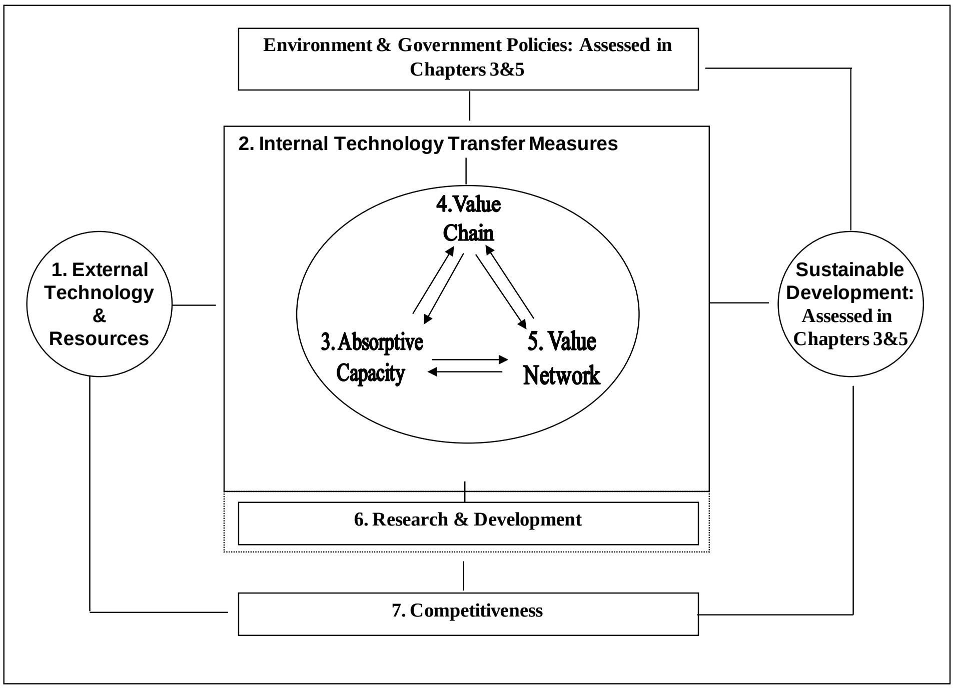
CHAPTER FOUR

Measuring Technology Transfer in Qatar: Fieldwork and Findings

4.1 Introduction

This chapter will discuss research methodology and empirical findings from the investigation of industrial enterprises, universities, and government bodies involved in the process of technology transfer. It builds on the research methodology discussed in chapter one and focuses on the application of this methodology during the field survey. It will measure technology transfer effectiveness among industrial enterprises, research and development (R&D) establishments, and government organizations. Through field survey and empirical findings, this chapter will complement the findings at the macro-level in chapter three that used secondary sources to present past and current sustainable development and technology transfer initiatives in Qatar. It will provide a satisfactory explanation of the reasons why some local enterprises benefit from sustainable development initiatives and others do not, and will offer and sometimes lead to suggestions that improve sustainable development and technology transfer. Thus, this chapter heeds Fransman's (1986) advice: if the goal is to yield more precise information about the process of technology transfer, it is necessary to investigate the firm's level. [1]

Figure 4.1: Fieldwork Structure Themes; Assessing Technology Transfer Effectiveness in Qatar



Source: Chapter One, Figure 1.1.

Following a description and discussion of the data collection and analysis, this chapter will present the findings in accordance with the same study methodology structure found in chapter one (Figure 1.1 page 1-17). Chapter four will start by presenting fieldwork methodology, and then ensue with measuring and evaluating external technology and resources, enterprise internal technology transfer measures, absorptive capacity, value chain, value network, research and development and competitiveness, and end with a summary. Figure 4.1 clarifies that the field work is structured around seven themes. Note that only seven themes will be discussed in chapter four as numbered in the figure.

4.2 Data Collection

To achieve the aims of the study, the researcher chose both a structured questionnaire and semi-structured interviews as methods of data collection. While the questionnaire investigated and assessed the general practice of technology transfer, including competitiveness, absorptive capacity, value chain, value networks, cultures, and research and development, the interviews served to validate the questionnaire answers and elicit information that strengthened the questionnaire in the categories of absorptive capacity, value chain, and value network.

To select participants for the study, the researcher deliberately chose 23 entities, covering all major industries, government bodies and R&D centers involved in technology transfer. The industries chosen were selected based on the high value they added to the GDP. According to the General Secretary for Development Planning, the oil and gas sectors accounted for 90% of the net industry revenue in Qatar (around US$ 13 billion) in 2005.[2] Also, the contribution to Qatar's GDP from these energy industries was 60%, while the rest of the small non-oil-and-gas manufacturing enterprises contributed only 7%.[3] According to Emerging Qatar, a report by the Oxford Business Group, this trend will not change in the short term. Since this dissertation is involved in the study of other enterprises as well, such as the R&D establishments that contribute commercially to the industries and the government ministries that influence technology transfer effectiveness, it can be assumed that the entities investigated herein represent over 90% of the value added to Qatar's industries. Because all of these enterprises were surveyed, the complete enumeration of the population is considered a census rather than a sample and thus there is no requirement for sample theory. As a result, the data is more likely to be accurate. Table 4.1 shows the number of participants chosen in each sector. Initially there were around 31 participants that were reduced to 23 as will be clarified later.

Table 4.1: Number of Participants Selected for Field Survey

Participants	**Number**
Gov. & Semi-Gov.	8
Industries	18
R&D	5
TOTAL	31

Source: Qatar Fieldwork, 2008

To achieve the goals of this study, it was important to account adequately for all of the technology transfer practices in Qatar. If only a sample were surveyed, then the information gained might not allow generalization or analysis of the most productive industrial enterprises. Moreover, the population of 23 enterprises and organizations surveyed is small when considering that only a single person from each enterprise needed to be given an opportunity to respond to the questionnaire. In most cases, the selected respondents were specialists who represented their organizations on technological matters. According to Yin, replication logic dictates that this kind of purposive sampling should be used because of the nature and specificity of the questions.[4] McMillan defines purposive sampling as "a method in which the researcher chooses participants because of their specific knowledge of the research topic."[5] To further ensure the quality of the questionnaire, it was decided that each industrial enterprise would be studied so that subsequent sites could be used to either confirm or extend previous findings.

At the time the questionnaire was administered, there were only 23 participants because many of the enterprises originally selected for investigation had merged or been acquired by other enterprises (which were also surveyed). This has not changed the fact that the study covers the entire population, but it did reduce the number of institutions involved with the study.
Initially, the researcher sought assistance from the Planning Council and the Emiri Diwan (the Ruler's Office) to legitimize the study and to encourage respondents to release important information. Specifically, the researcher requested that the Emiri Diwan issue a letter to the industrial enterprises selected for the study in order to facilitate the researcher's work. While this did not occur, the Planning Council (now named the General Secretary for Development Planning or GSDP) did contribute data from many earlier studies, and this data was used to verify the research results.

Table 4.2: Participants Surveyed by Sector

Sector	Number	Participants
Gov. & Semi-Gov	8	ictQatar Qatar Armed Forces Ministry of Interior General Secretariat for Development Planning Ministry of Energy Supreme Education Council Ministry of Economy and Commerce Ministry of Municipality and Urban Planning
Industries	11	Qatar Petroleum (QP) Qatar Fertilizers Company Limited (QAFCO) Qatar Petrochemical Company Limited (QAPCO) Industries Qatar (IQ) RasGas Company Limited Qatar Gas Company Limited Qatar Steel Company Limited(QSC) Qatar Chemical Company Limited (QChem) Qatar Vinyl Company Ltd Qatar Fuel Additive Company (QAFAC) Qatar Electricity & Water Co
R&D	4	Texas A&M University Carnegie Mellon University Qatar University Qatar Science and Technology Park
TOTAL	**23**	

Source: Qatar Fieldwork, 2008

The researcher spent eleven months (from March 2008 to January 2009) collecting data. First, the researcher selected and called five respondents for a pilot study to test the questionnaire. He explained the purpose of the survey and sought the respondents' approval to participate in the survey. The survey was loaded online through QuestionPro,[6] an online survey tool that is user friendly and capable of generating research statistics.

After testing 64 questions on the five respondents in the pilot study, 42 questions were selected for use in the questionnaire. The main issues leading to the removal of 22 questions were unavailability of particular types of financial information, confidentiality of information, and/or the participants' lack of understanding of the technology transfer process. Almost all industries investigated were unwilling to respond to questions that pertained to their internal financial, logistical, and human capital performance. Appendices A & B show the original and revised questionnaires, respectively.

After the pilot testing phase, the researcher emailed all of the remaining selected participants. Some respondents required an in-person follow-up meeting to further explain the research study or to provide assistance with the survey.

Data collection was difficult. There were many bureaucratic procedures to work through in order to receive approval for the study. In addition, the researcher struggled to combat the prevailing cultural belief regarding the unimportance of research studies, statistics, and data collection. Locating appropriate participants, for example, often involved many explanations, meetings, referrals, calls and approval processes. Because the study involved a census rather than a sample, obtaining participants from each institution was important; therefore, the researcher had to either negotiate with and persuade unwilling participants or compromise on the number of questions posed to them.

Ultimately, because of participants' hesitation, it was agreed that enterprises would not be evaluated individually and that neither the respondents' names nor the names of the enterprises they represented would be published if doing so could expose them to criticism. In short, the researcher agreed to only critique technology transfer effectiveness from a general standpoint. In accordance with this agreement, no respondent names have been reported in the results of this study and each enterprise name was replaced with an encoded number wherever negative performance is discussed.

Heidegger[7] once stated that the researcher is "part of the social world of his participants and as such, he must necessarily use his own experiences in order to interpret those of the research participants." In addition, Kellett,[8] Van der Zalm, and Bergum[9] agreed that the role of the researcher was to work with the participants in order to shape a meaningful phenomenon mutually. Technology transfer, acquisition, training, consultancy, research and development, and sustainability were the phenomena of interest in this study. For this study, the researcher's role was to capture the respondents' accounts of these processes without influencing the findings. To prevent any bias, the researcher tested the questionnaire with five respondents and made sure they understood each set of instructions and every question. Furthermore, a semi-structured interview enabled the construction of a shared researcher-participant understanding of technology transfer and related processes and augmented the questionnaire by reflecting the phenomenological part of the research.

4.2.1 Assessment of Appropriate Indicators

In chapter two, the researcher constructed a set of indicators that measures technology transfer effectiveness and sustainable development. Using government publications, published articles, statistical abstracts, studies, and annual reports, chapter three reflected on many useful measures related to the economy, the environment, government policies, foreign direct investment, the legal arena, and the field of education. Many measures did not need any triangulation as they were available and evident. For example, one need not confirm the availability of intellectual property rights regulation through a different source; the rights exist or they do not. However, measures of absorptive capacity, value chain, value networks and R&D needed further research. While some data relevant to the assessment of these areas is in the public domain, all of the available literature did not answer the question of whether or not there is an effective system for technology transfer within Qatari enterprises and whether or not they are sustainable.

Therefore, the questionnaire initially sought to gather information on the sources of technology transfer, the value added by particular technology projects, research and development activities, and common barriers to technology transfer. It also sought to differentiate various organizations' competitiveness, marketing strategies, absorptive capacity, and organizational cultures and attitudes. Finally, it was intended to address concepts like value chain and value networks. See Appendix B for further information on the levels and types of questions.

The pilot test on five respondents revealed that many changes needed to be made to the questionnaire. The bases for these changes were a lack of understanding of many technology transfer concepts. Other organizational/cultural issues also influenced participants' willingness to respond to certain questions related to performance evaluation (Questions 10 to 14, 50-53 and 55 in Appendix A). Specifically, surveying the effectiveness of methods for learning about competitors' innovations, asking about financial ratios, and requesting that participants rate products and services on Ansoff's market growth mix proved to be very difficult for several reasons. First, as mentioned earlier, respondents lacked awareness of technology transfer terms or did not implement certain practices and marketing strategies concepts. Second, financial ratios were either considered confidential or were not present in financial statements. After discussing these issues with respondents, the researcher removed some of the questions that might influence the reliability of the survey.

To meet participants' expectations, and, at the same time, to compensate for the loss of information, the researcher deleted particular questions or parts of questions and simultaneously looked for alternative sources to collect the same information due to their significance in evaluating the dissertation's indicators. The performance evaluation questions were omitted and the original questionnaire adjusted into its final form as shown in Appendix B. The researcher decided to fill in the gaps left by the deleted technology transfer and financial ratio questions through publications released by the organizations or from credible international sources.

The questionnaire was designed to collect a wide array of technology transfer indicators. It was also designed in such a way to accommodate enterprises with and without research and development centers. Given the accommodations made after the pilot test, the duration of the questionnaire was reduced from 45 minutes to 30 minutes.

4.2.2 Research Reliability and Validity

In this study, triangulation was achieved through the collection of different types of data from various data sources and the use of different methods of data analysis. Questionnaire data was evaluated against interview data and other questionnaire data. Also, diverse sources provided data, including many industrial enterprises and government offices. Finally, the analysis included comparisons of findings from the various primary sources as well as an interrogation of the research process itself.

For data, the researcher focused on questionnaire results, interviews and credible government statistics and studies. Using multiple data collection methods enabled the researcher to test the reliability and validity of the research results. The mix of methods was also intended to build a more in-depth understanding of the circumstances surrounding technology transfer in Qatar; qualitative research methods traditionally favor multiple means of data collection, such as augmenting survey data with interviews, particularly when the main research objective is to build an understanding of a particular phenomenon. More precisely, because technology transfer effectiveness has not been systematically studied, this approach met the researcher's specific need to validate the respondents' answers to certain questions in the questionnaire and to develop an in-depth understanding of technology transfer management practices.

Criticism may be lodged against the definition of effectiveness because of the lack of agreement in the field about what makes technology transfer effective. This subject has already been treated in chapter one (pages 1-31&32) where reliable and consistent indicators of technology transfer effectiveness were presented and discussed. In addition, the extent to which the results of this study will present an accurate portrait of technology transfer over time is an issue because unprecedented change is currently taking place in Qatar. Qatar's investments in the development of its gas reserves and its focus on increasing its revenues mandate continuous production growth in the oil and gas industries. Looking at the planned long-term production capacity development projects, agreements with other countries, and joint ventures with multinational oil and gas companies, it appears that this trend is going to continue into the next decade. Also, it is likely that the results accurately predict the trends in technology transfer because the country’s vision, mission and policies are likely to remain stable; they are even outlined in Qatar’s National Vision 2030 statement. This researcher suggests that the stability of the results is likely to hold for approximately 18 months, as this is the time required for new programmes and projects to be implemented. The inaccuracy of long-term predictions is not a new problem in the field; most previous economic, demographic and industrial predictions – even those made by many international and world class institutions, such as the UN Human Development Index, Standards & Poor's, Moody's, the World Bank, Qatar Planning Council and others – have been sometimes inaccurate by more than 50%, even on the best attempts. In 2004, for example, the Planning Council predicted that the population (it was then 744,000)[10] would reach 1.3 million by 2010. The population reached 1.5 million in 2008.[11] However, reliability can be assured within a shorter time period, particularly when measurements are taken repeatedly through empirical research or objective questionnaires.

Validity, on the other hand, can be checked through triangulation within the research project itself or through cross-checking with other research data. The main categories requiring verification were the challenges to technology transfer, dependency on foreign technology, competitiveness of the environment, significant accomplishments, impact of agreements, supply chain effectiveness and legislative barriers to technology transfer. Several features within the design of the questionnaire and the interview process made verification possible. These were multiple sources of data collection (questionnaire and interview), the use of many respondents within a similar sector, and the selection of the right officials to respond to the questions in both data collection methods.

During the analysis, some questions were used to provide data for multiple categories. For example, questions related to intellectual property protection could be used to assess government policies, competitiveness, and research and development. In addition, some indicators could be augmented with other data or blended together.

Table 4.3: Operationalizing and Addressing Research Questions

RESEARCH QUESTIONS (ENTERPRISE LEVEL)			Questionnaire	Interview	Other Research*
Principal Research Question	**First Level Operationalization**	**Second Level Operationalization**			
How effective is technology transfer in Qatar's search for sustainable development?	**Assessing the External Technology and Resources**	Sources of technology transfer	√	√	
		Current number of technology transfer projects	√	√	√
		Number of licenses for external technology	√		√
		Rating of new technology success	√	√	
		Rating of organization’s information scanning systems	√	√	
		Percentage of new products using foreign technology	√	√	
		Sales due to products using foreign technology	√	√	
		Profitability of products using foreign technology	√	√	
		Degree of understanding of technology transfer	√	√	
		Barriers to technology transfer	√	√	
	Assessing Environment and Government Policies	Environment: laws and regulations		√	√
		Environment: international conventions			√
		Government policies related to industry and technology		√	√
	Assessing Sustainable Development	Social indicators			√
		Economic indicators			√
		Environmental indicators			√
	Assessing Competitiveness	Marketing strategies	√	√	
		Effectiveness of methods for learning about competitors	√	√	
		Major activity fields under focus	√	√	
		Organization's type of management	√	√	
	Assessing Research and Development	Allocation of resources to research and development	√	√	
		Percentage of research that is commercially viable	√	√	
		Investments in manufacturing and national priorities	√		√
		Government grants as a percentage of total R&D expenditure	√		
		Ratio of global gross expenditure on R&D to total	√		
		Proximity to other universities or R&D centers	√		
		Science parks’ R&D indicators	√		√
	Assessing Value Chain	Success of the organization at producing successful projects	√	√	
		Efficiency of tendering systems	√	√	
	Assessing Value Networks	Level of R&D institution agreements	√		√
		Number of cooperative agreements related to technology	√	√	√
		Variables, properties, or constraints affecting value	√	√	
		Organizational culture	√	√	√
		Technology diffusion channels	√	√	√
		Technology absorptive capacity adopted	√	√	
		Training programme evaluation by trainees	√		
		Rating of organizational attitude			√
	Assessing Absorptive Capacity	Percentage of ICT budget in annual budget	√		√
		Sales by product	√		√
		Plotting of products on Ansoff's product market growth mix			√
		Recommendations to drive market plans to success	√	√	
		Rate and return on investment and liquidity ratio			√
		Number of employees, categorized by their qualifications	√		√
		Average of training expenditures per employee	√		
		Return on human investment ratio		√	
		International quality standards			√
		Access to the internet	√		
		Organization’s internet presence	√		√
		Maximum capacity compared to actual output			√
		Surveys conducted to elicit customer satisfactions	√		
		Rating of successful teamwork		√	
		Rating of internal communication		√	
		Rating of staff morale		√	
		Training relevance to employee job and level of expertise	√		

* Other research is drawn from secondary research, official publications and government statistics .

Source: Author

Questions within the questionnaire were structured in a manner befitting descriptive and explanatory research. In fact, many questions were adapted or adopted from other questionnaires, enhancing reliability. A few brief questions were developed originally in order to fully address the research question. See Table 4.3.

The researcher carefully designed each form with attention to both content and layout, pilot tested the forms, and then carefully planned and executed the questionnaire. The pilot test involved a group of five diverse respondents; each was asked to give feedback about the content and format of the questionnaire. The survey was put online along with an opening cover letter that explained its purpose. At the end of the survey, a note from the researcher thanked the respondent and presented an email address for further communication if necessary. See sample screen shots, Appendix C.

Using an online questionnaire provided many advantages. To fill out the questionnaire, the respondent had only to click on a link in the email request and begin selecting from the choices in front of him; therefore, it negated the need for overly computer literate individuals.

Furthermore, since the survey was emailed directly to the selected respondent, the researcher had confidence that the appropriate person was filling out the survey. In addition, the probability that the answers were contaminated was low. The response rate was high, most likely because the questionnaire design – including forced choice or short open-ended questions - made answering easy and quick. Also, respondents who did not respond to the email invitation were sent reminder emails every three weeks. Using QuestionPro, an online survey creator, was advantageous in that it eliminated reproduction costs and the need for clerical support. In addition, the program automatically provided data entry and enabled fast and easy analysis of the close-ended questions.

The survey was online for ten months and cost a total of US$ 1490 to create and maintain.

4.2.3 Interviews

The interviews' phenomenological approach enabled it to build on the questionnaire. It facilitated greater understanding of concepts and of the relationships between variables. It also allowed the researcher to probe areas that could not be fully accounted for in the questionnaire, such as absorptive capacity. Finally, it was also an opportunity for the interviewees to ponder questions they may not have thought about thoroughly during the questionnaire. Because the interviews required the researcher to meet face-to-face with the interviewees, they elicited more honest, in-depth responses than the questionnaire, where participants felt it was not appropriate to provide confidential information to someone they had not met. Respondents were generous with their time and the response rate was high. The interview data provided multiple perspectives on the issues of concern.

In total, the researcher conducted eleven interviews. Interviews were conducted face-to-face at the interviewees' workplaces. However, in one case, the interview was conducted by telephone due to the interviewee's time limitations. At the end of each interview, interviewees were asked whether or not they wanted a transcript of the interview, and transcripts were emailed to a few participants. Only one interviewee sent revisions to the transcript; the remaining participants did not comment.

The aim of the interviews was to explore participants' experiences with and expectations regarding the subjects under scrutiny. The interview protocol was semi-structured to guide discussion without limiting participants' responses. Key questions had been delivered to participants in advance through fax or email in order to allow them to prepare. This proved helpful in that some interviewees provided documentation to support their answers; this documentation was used to triangulate the data.

Three issues impacted the quality of the interview data: confidentiality, generalizability and bias. First, some respondents were not empowered to reveal information that was perceived to be confidential (the definition of what is confidential information was not defined by the participant or his employer). It is likely that, at least in part, interviewees' refusal to respond to certain questions stemmed from fear of reprimand or even of prosecution; local newspapers have carried stories of court cases involving the leaking of secure information related to civil aviation and the energy sector. Because confidentiality was such a prominent concern for many interviewees, the researcher had to redesign the survey invitation letter, reword certain questions, and take other measures to ensure his respondents' privacy. While the invitation and questions stressed that the information requested was in the public domain and the words "confidential" and "secret" were removed from the questionnaire, it was not until the researcher verbally convinced respondents that neither their organization's nor their own names would be used in the dissertation that they consented to be interviewed.

The interview data alone does not allow generalizations about the entire population. However, because every question in the interview explored the subject of technology transfer effectiveness and expanded on survey questions, it is more likely to offer significant insights of interest to the entire population.

Finally, the researcher took several measures to reduce bias. The researcher always prepared for the interview by reading company reports and other publications related to the organization. This enhanced the researcher's credibility perceived by the interviewee and encouraged the interviewee to give more input. It also helped to ensure the accuracy of some of the information offered in the interview.[12] Also, the interview questions themselves were designed to reduce bias. The interview contained seven thematic questions, each designed and phrased clearly so that the interviewee would understand it. These open-ended questions helped to avoid bias. During the interview, the researcher followed every thematic question with probing questions in order to produce a fuller account, as illustrated in Appendix D.

During the interview, the researcher controlled his posture, tone and gestures and offered neutral responses to reduce bias. He summarized the interviewees' explanations to avoid incomplete interpretations. The researcher opened each interview by thanking the interviewee for agreeing to the meeting and stating the purpose of the research and its progress to date. The researcher then informed the respondent that he had the right to decline to answer, let him know what would happen to the data collected, and reassured him that the researcher was not after confidential information.

The researcher allowed a full day for each interview. After each interview, which normally took between one to two hours, the researcher transcribed the interview on the same day so as not to mix up the data with other interviews or forget what was said. To increase reliability, the interview was not tape recorded as advised by Easterby-Smith et al[13] and Ghauri and Gronhang[14]. By not taping, respondents feel freer to express their ideas without fear that the tape will later be used as evidence against them.

There were no cultural differences between the researcher and most of the interviewees since most interviewees were Qataris who had achieved similar educational levels from Western universities, and who had similar backgrounds in technology. The mutual understanding enhanced reliability and offered a rich exchange of information.

4.3 Data Analysis

QuestionPro's statistical tools provided a thorough summary of the close-ended questionnaire data. The summary consisted of frequency analysis charts, mean values, confidence intervals at 95%, standard deviations and standard errors. The QuestionPro statistical tools also provided key facts, including the highest and lowest values of some questions. Although this significantly reduced the amount of analysis required, it was not sufficient to comprehensively analyze some of the close-ended questions. This statistical tool was also unable to integrate the open-ended answers. For example, questions that provided an option to "list other variables" had to be analyzed separately, even though some parts of the question could be analyzed using the statistical tools provided. Hence, the researcher had to analyze these close-ended questions and/or compare them with other open-ended answers in order to fully account for the data given. Also, the researcher analyzed individual open-ended answers and attempted to integrate questions in order to create a more holistic set of findings. To analyze the qualitative data gathered in the interviews, it was crucial to identify the unit of analysis in each question, generalize, and make inferences.

Themes and patterns were compared or matched between the questionnaire data and the interview data in order to confirm or disconfirm hypotheses, cross-validate themes, and gain a more in-depth understanding. The findings were then compared with other studies.

4.4 General Survey Results

The questionnaire was viewed by 27 participants and completed by 23, a completion rate of 88.89%. Most of the commercial enterprises surveyed were limited liability companies (LLC), an ownership type typically suitable for smaller companies with a single owner. Out of the twelve industrial enterprises surveyed, seven were LLCs, two were partnerships, one was a limited partnership, one a cooperative, one a corporation, and one a sole proprietorship.

4.4.1 Organizations Surveyed

A total of 23 organizations were surveyed. Table 4.2 shows that this number is less than the original planned population of 31 organizations. Once the survey started in March 2008, it was found that the industry population decreased due to mergers, but the scope of the study did not change; it simply analyzed the merged companies under their parent organizations. Finally, the survey encompassed eleven major industries, nine energy and petrochemical industries, one steel industry and one power industry.

Within the government sector, eight organizations were selected. Four of the eight organizations regulate technology; they include the Ministry of Economy and Commerce, the General Secretariat for Development Planning (GSDP), the Ministry of Energy and the Supreme Council of Information and Communication Technology (ictQatar). These were analyzed with respect to their contribution to, support of, and regulation of technology transfer. The remaining four organizations are public non-profit organizations and users of technology. They were assessed with respect to technology transfer effectiveness, along with another organization, ictQatar, which not only regulates information and communication technology, but also manages a commercial enterprise that delivers ICT solutions.

Research and development organizations surveyed included two local establishments (QSTP and Qatar University) and two foreign universities with branches in Qatar (Carnegie Mellon and Texas A&M Universities).

4.4.2 General Survey Results

The survey showed that technology regulation bodies did not exist before the year 2000. In fact, technology regulation was acknowledged only recently, in 2005, when ictQatar was established and started regulating the information and telecommunication technologies. Prior to this, in 2003, Industries Qatar was established, a company whose sole purpose is to develop certain industries commercially. In 2006, the GSDP in Qatar initiated a focus on sustainable development and planning. Lastly, in the year 2009, the Qatari government established the Ministry of the Environment to achieve a balance between the protection of the environment and its natural resources, and the requirements of development for a better life for present and future generations.

Parallel to the development of technology regulations, industry became focused on gas development beginning in 2001. The focus was and still is on gas-to-liquids (GTL) advanced technologies. When QSTP was established, research and development became a strong initiative in Qatar as QSTP encouraged research in areas that would serve local economic priorities.

4.5 Focused Results Aligned with Technology Transfer Effectiveness Model

The following sections will now highlight the survey findings in accordance with the Technology Transfer Effectiveness Study Model, Figure 1.1, p. 1-17. It is important to mention here that assessment of the "Qatari Environment and Government," which is part of the model, along with analysis of sustainable development, are not part of this micro-level assessment since chapter three has analyzed them at the macro-level. In fact, the indicators used to analyze these can only be measured at the national level. Therefore, the scope of the enterprise survey will focus on external technology and resources, internal technology transfer measures, R&D, and competition.

To date, there are very few measures available that would enable an analysis of policies to promote technology transfer – either for commercial gains or for social benefits. It would be particularly difficult to analyze short and medium term gains. The reason for this is the difficulty in finding a relevant denominator to normalize various outputs. Thus, this dissertation fills a gap in the literature through its attempt to design a framework and a set of indicators that would allow for the assessment of the overall technology transfer within a developing country such as Qatar.

4.5.1 External Technology and Resources

This section will present the findings on current practices related to external resources and how these practices have influenced the effectiveness of the technology sought.

Around (40.26%) respondents indicated that their organizations chose to employ experts and technical consultants as their main means of transferring technology. Table 4.4 ranks the sources of technology transfer sought by local enterprises. As shown, foreign direct investment was the least popular; only 2.6% of organizations selected it as a means for technology transfer. However, purchasing machinery and supplies, forming joint ventures, and initiating total process contracting were also popular sources of technology transfer. In addition, procurement of hardware and services accounted for 35% of the preferred practices for acquiring technology. This indicates that Qatari enterprises rely on various channels for technology transfer.

Four respondents added other sources of technology transfer; these included turnkey projects (one case), collaboration with QSTP (one case), and internal capability (two cases selected by the two foreign universities surveyed).

Table 4.4: External Sources of Technology Transfer

No	Source of Technology Transfer	Rank	Number	%
1	Employment of experts	1	**16**	**20.78%**
2	Technical consultancy contracts	2	15	19.48%
3	Purchase of machinery supplies	3	14	18.18%
4	Joint venture	4	13	16.88%
5	Total process contracting	4	13	16.88%
6	Others	5	4	5.19%
7	Foreign direct investment	6	2	2.60%

N=77, mean= 4.026, confidence interval= 95%, standard deviation= 1.821, standard error= 0.207

Source: Results of questionnaires calculated using QuestionPro Software

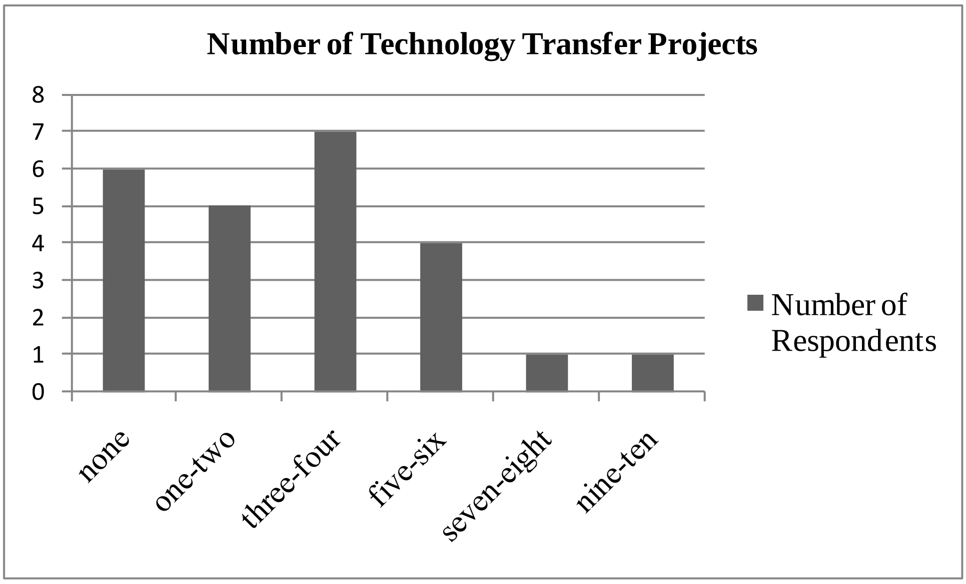
4.5.2 Enterprise Internal Technology Transfer Measures

At the heart of the technology transfer effectiveness model (Figure 1.1) are the internal technology transfer measures. In general, this study will evaluate broad measures of technology transfer within enterprises, such as technology diffusion, licenses, and factors that hinder technology transfer. Following this, the study will present the assessment of findings related to absorptive capacity, value chain and value network. To simplify the internal technology transfer measures of an enterprise, the study will determine the extent to which the enterprise’s initiatives have been successful in transferring technology domestically. For this, the current number of projects, products and licenses is determined, then assessed. Finally, factors that hinder technology transfer are evaluated.

This study surveyed three types of organizations: 45% public, 45% private, and 10% national. The study did not define technology transfer so that managers and staff were free to use their own interpretation. Based on the data, it was clear that the participants’ interpretations of the concept could be categorized into equipment transfer, knowledge transfer, or both. Along with this general finding, the researcher noted that enterprises found the transfer of equipment and knowledge to be very important because of their unavailability in the domestic market.

Economy and efficiency in the use of limited skills and material resources is essential to continued growth and productivity. Developing modern technology will yield efficiencies and socioeconomic benefits to host regions. Thus, embarking upon projects that build skills and assist in the acquisition of modern resources is essential to Qatar, which has limited human resources and skills.

Figure 4.2: Number of Technology Transfer Projects that Should Diffuse Unavailable Technology



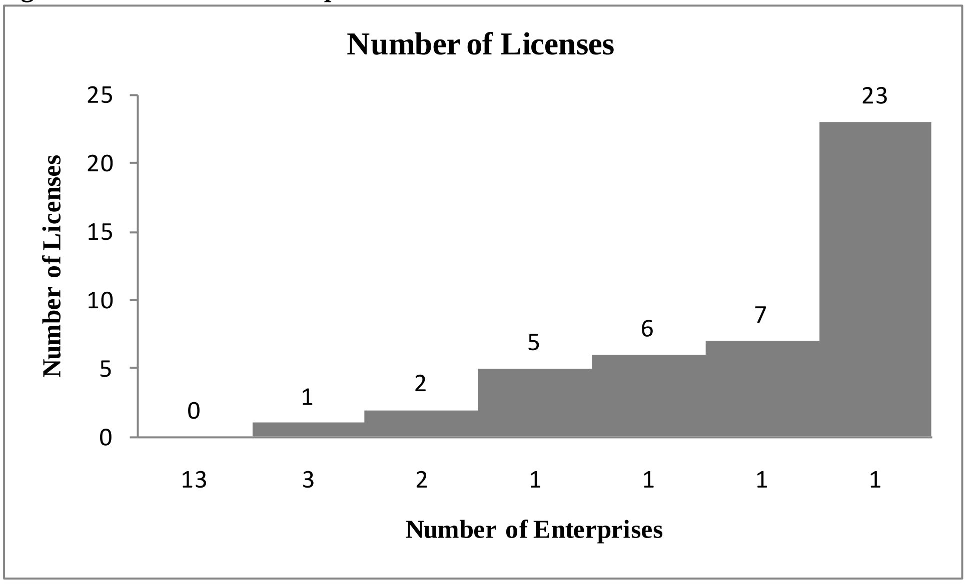
Source: Using Questionnaires results in QuestionPro

When asked about technology projects already underway, almost 75% of all respondents revealed that their organizations had at least one ongoing project that would diffuse technology within the enterprise. About 29% respondents replied that they currently have three to four projects underway. Six respondents had no projects at the time of the survey. IctQatar had the greatest number of projects to develop the ICT infrastructure, applications and skills (a stake of 13% of all projects surveyed). Carnegie Mellon University followed immediately behind it with seven projects (10%). Taken all together, is this a sufficient number of projects to promote technology growth in Qatar? This question will be evaluated in the next chapter.

To maintain a competitive edge in today’s international markets, commercial enterprises often collaborate with the public research sector to innovate, acquire technology licensing agreements, and promote further technology development. The strength and management of these technology licenses is important to the enterprises' interests and their workforce growth.

Through licenses, the government can easily transfer national laboratory technologies to the private sector. This study has shown that the only substantial activity in this regard was conducted through Carnegie Mellon University, a branch of an American university located in Qatar, with 23 licenses signed in the last year. See Figure 4.3.

Figure 4.3: Number of Enterprise Licenses



Average = one license

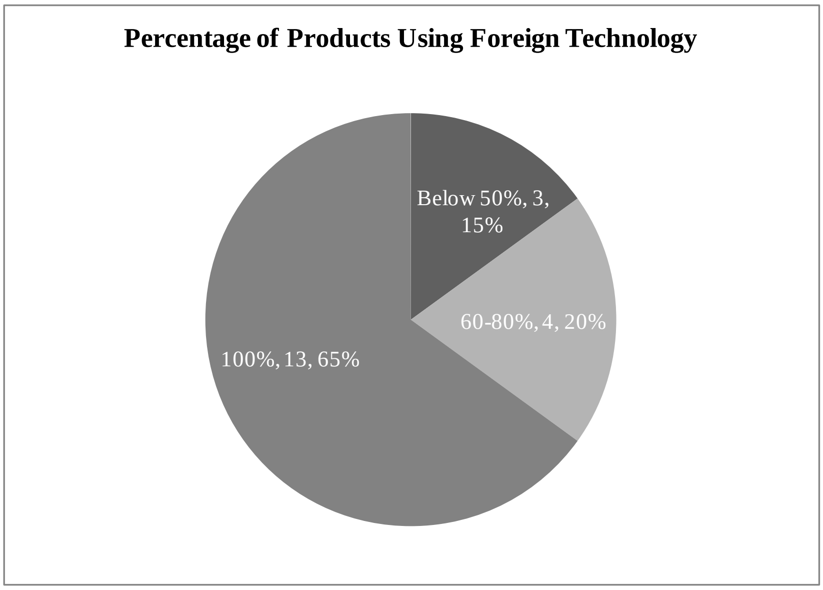
Source: Using Questionnaires results in QuestionPro

The remaining enterprises' initiatives were lower than the researcher's expectations. Figure 4.3 shows that one institute, the Ministry of Economy, listed 7 licenses. This number only accounts for licenses that the Ministry kept track of in its statistics. These seven licenses included two industrial and five software licenses. The Ministry of Economy did not provide data on the licenses of some independent organizations such as the Armed Forces, the Ministry of Interior, and ictQatar, all of which have software licenses as well (a total of nine licenses). Cross-checking this data with the interview results, it was revealed that these software licenses are mandated by companies like Oracle, Microsoft or IBM to operate and use their developed software, but do not enable the enterprise to transfer source codes.

The questionnaire also asked whether or not new technologies met the needs of the organizations. Around 52% of respondents declared that they had partial success in using the new technology to meet their needs. Additionally, 48% of the respondents thought the new technology was a success. No respondent believed the new technology was a total failure. This was reinforced with another survey question intended to evaluate organizations' scanning systems. Around 95% of the respondents thought that the information scanning system used by their organization was either useful or advantageous.

The survey sought to ascertain whether or not the enterprises' products were developed using local technology. Thirteen out of 20 respondents reported developing 100% of their products using external technology. Four respondents answered that they developed 20 to 40% of their products using local technologies. These four respondents were ictQatar, MOI, and Qatar University. IctQatar develops customized software for the education, health and service sectors. This is done through external companies involved in the design, implementation and management of imported technology. IctQatar has signed contracts with consultants and agglomerate IT companies and annually spends a great deal to support its initiatives. MOI sells its services online. These online services, such as driving license renewal, traffic violation settlement, visa application, and so on, have been programmed internally by MOI staff. Qatar University, on the other hand, does manufacture certain products (it claims 20%) using its research center.

Figure 4.4: Percentage of Products Created Utilising Foreign Technology



***Note*:** 100%, 13, 65% reads: 13 respondents said they use 100% foreign technologies. This is 65% of all respondents to this question.

Source: Using Questionnaires results in QuestionPro

The only interesting case was the Armed Forces, which claimed to have 50% of its services and maintenance done locally without external help. Although 100% of its weapon systems is manufactured abroad, its support is not. The remaining 50% of its services and maintenance are comprised of third and fourth line maintenance sought from manufacturers. Finally, the American Universities in Qatar claimed that they generate about 25% to 50% of their products from external resources.

In light of the above, the percentage of sales and profits due to products using technology developed outside the organization followed a similar trend. The only difference that should be highlighted is that the respondents who indicated that they used locally made technology used only old technologies, like agricultural tools and equipment.

Barriers to Technology Transfer

There are several factors that hinder the process of technology transfer or cause projects to fail. The survey produced the following results, found in Table 4.5.

Table 4.5: Barriers to Technology Transfer in Qatar

No	Reasons	Rank
1	Lack of knowledge: If an organization is short of skills and knowledge, it may be unable to use the technology offered.	First
2	R&D effectiveness	Second
3	Lack of awareness: Many organizations are not aware of available technology.	Third
4	Management attitudes	Fourth
5	Lack of funds: Organizations may be unable to purchase or develop technology.	Fifth
6	Lack of common interest: Organizations may exhibit a lack of motivation to reach agreement or settle differences of opinions about available options.	
7	Poor coordination: Individuals within an organization or within collaborating organizations fail to effectively coordinate and find common ground on the activities, processes, goals and directions of the venture.	
8	Lack of resources: Organizations may require more physical resources or may lose a key member.	
9	Organizational problems	
10	Conflict of interest: Competing organizations may be unwilling to collaborate.	Sixth
11	Lack of time	Seventh
12	Technical problems	
13	Administrative burdens	
14	Legal constraints	Eighth
15	Weak links between customers and suppliers	
16	Poor information flow	
17	Changes in the project structure	
18	Lack of trust	
19	Resistance to change	Ninth
20	Cultural differences	
21	Geographic differences	Tenth
22	Dependency on public R&D institutions	
23	Short-term pressure	Eleventh

Source: Using Questionnaires results in QuestionPro

It is worth restating that 24.11% of respondents chose the following two options:

- Lack of knowledge: If an organization is short of skills and knowledge, it may be unable to use the technology offered .
- R&D effectiveness

The top inhibiting factors also included management attitudes and lack of funds. It is noteworthy that attitudes could have a strong impact on research and technology transfer; if management believes the project to be of little consequence, moving projects from research to development becomes more complex. The least chosen option was short-term pressure (1.42%).

4.5.3 Absorptive Capacity

Chapter two identified four types of indicators to measure absorptive capacity; these included marketing capabilities, breadth of knowledge, learning by doing, and return on investment. In this chapter, marketing capabilities are assessed at the firm level through three joined indicators: marketing growth strategies (Ansoff's Matrix), the firm's future marketing plans, and its sales by product. Breadth of knowledge is measured through past patents and assessments of the ICT budget, employees' qualifications, and training expenditures. To evaluate learning by doing, the study will look at five indicators: access to the internet, firm sites, teamwork, internal communication, staff morale, and the relevance of training to employees' jobs.

For an overall assessment of absorptive capacity, a unified index could have been calculated. However, such an index would not serve the objectives of the study because of the many paradoxes inherent in the local environment. For example, while the rate of investment may be high, the ability of indigenous workers to absorb technology may be low. In an overall measure, these would counterbalance each other, revealing little. Also, there may be no patents or productive training investment, yet the marketing and sales rates are growing substantially. Therefore, each factor is examined independently and the study then offers an overall assessment of absorptive capacity in Qatar.

Marketing Capabilities and Absorptive Capacity

Based on the literature review in chapter two, this dissertation was set to calculate marketing capability as one element out of four to measure and evaluate absorptive capacity. This capability depends on an understanding of the marketplace and is an important source of competitive advantage for firms that can enhance financial and market performance.[15] Overall, the Global Competitive Index ranks Qatar 67 out of 117 countries on the production index, which measures its production of new and different products. Qatar's score on efficiency of production practices is also low (45). Ansoff's Matrix supports this assessment; the local industry is focusing on existing products in existing markets only, which is a market penetration strategy. The absence of products in the product development area indicates that there is little initiative to undertake new ventures (lack of innovation). This trend can be seen across the energy industry and reflects the effects of conservative government policy in the area of innovation.

Figure 4.5: Ansoff's Matrix of Qatar's Industry

	Existing Products	New Products
Existing Market	**Market Penetration** Oil, LNG, Urea, LDPE, Ethylene, Sulphur, Water, Electricity, Vinyl Chloride Monomer, Ethylene Dichloride, Caustic Soda, 1-Hexene	**Product Development** Nil
New Market	**Market Development** Urea (direct to farmers), LNG Offshore Terminals	**Diversification** Nil

Source: Using Questionnaires results in QuestionPro

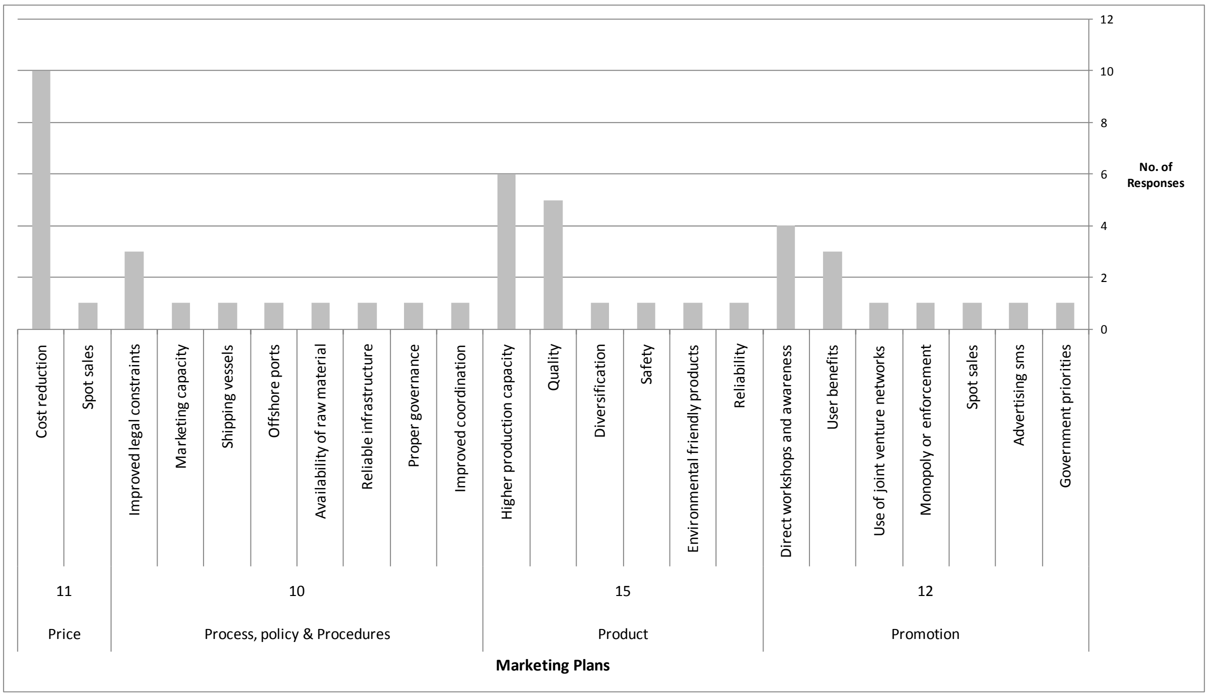
Marketing Plans and Absorptive Capacity

Marketing strategy can be defined as a firm's efforts to gain a competitive advantage in the marketplace.[16] A marketing strategy allows enterprises to position a product accurately in the right market and to develop its competitive advantage. When respondents were asked for three recommendations to increase their marketing success, they came up with a variety of answers. The researcher categorized these responses and displayed the results in Figure 4.6.

Respondents felt that the most important marketing plan is to decrease the cost of the product or service. This was followed by higher production capacity. Higher production capacity aims at reducing cost through volume of scale. Clearly, then, the single most important marketing strategy is cost reduction and increased sales. The relationship of this strategy to sustainability will be addressed in chapter five.

The second recommendation type focused on quality. The interviews revealed that many organizations are seeking to implement ISO 9001-based quality management systems (QMS). One interviewee stated, “Quality improves economics by making it more efficient and competitive.” Another interviewee said that the local industry could benefit from international industry experiences, new technology, and better managerial and organizational practices. This indicates an awareness of the benefits of increased quality.

Figure 4.6: Recommendations to Drive Market Plans to Success



Source: Using Questionnaires results in QuestionPro

The third marketing plan included workshops, seminars, conferences and forums. These strategies aimed at promoting industrial products to international clients.

It is worth mentioning that enterprises also saw the legal environment as an important aspect of product promotion. This means that government legislation is important to organizations' abilities to promote their products.

Sales by Product

Technology transfer has the potential to lead to new products, creating a positive economic impact. When the number of products a country develops increases, sales revenues, spinoffs, jobs, government gains and spin-backs increase. Table 4.8 projects annual growth of Industries Qatar as an example to be used in a perception assessment to the spinoffs created. Earlier studies focused on input-output approaches, where output was the immediate or intermediate product of technology transfer. Later on, the focus shifted to final impact. The major focus of Qatar's industry is to leverage its comparative advantage in terms of availability of petrochemical resources. By chemical conversion, primary petrochemical are transformed into more complex intermediate products.

Table 4.8: Annual Sale Growth of IQ Products 2007-2008 (in 1000 tons)

Industry	Product	2007	2008	%Growth
QAPCO	Ethylene	207	296	43
	Sulphur	55	53	-4
	LDPE	308	410	33
QAFCO	Ammonia	402	434	8
	Urea	2939	2923	-1
QAFAC	Methanol	650	807	24
	MTBE	608	673	11
Qatar Steel	Steel Bars	1376	1440	5
			Average	15

Note : Due to unavailability of data, the author used quantity sale in tones. The best projection is to use sales revenue by product. **Source**: Using Questionnaires results in QuestionPro

Table 4.9: Percentage of Sales by Product 2008

INDUSTRY	PRODUCT 1	PRODUCT 2	PRODUCT 3	PRODUCT 4
Qatar Petroleum	Oil	Gas	-	-
	57%	43%	-	-
QAFCO	Ammonia	Urea	-	-
	13%	87%	-	-
QAPCO	Ethylene	Sulphur	LDPE	-
	58%	3%	38%	-
Ministry of Energy	Water	Electricity		-
	25%	75%	-	-
Industries Qatar	QAFCO	QAPCO	Qatar Steel	QAFAC
Sales by companies	38%	28%	27%	7%
RasGas Company Limited	Ras Laffan I	Ras Laffan II	Ras Laffan III	
	19%	39%	43%	-
QChem	Sulphur,	Ethylene,	(HDPE)	1-Hexene
	3%	48%	44%	5%
Qatar Vinyl Company Ltd	Vinyl Chloride Monomer	Ethylene Dichloride	Caustic Soda	
	24%	17%	59%	

Source: Using Questionnaires results in QuestionPro

Table 4.9 clearly demonstrates that Qatari industries focus on producing intermediary raw materials or products that are later used to develop other final products. These intermediary materials include ethylene dichloride, ethylene, high-density polyethylene and vinyl chloride monomer. However, it is also worth noting that some final products are being developed, such as lubricants and other oil refined products like steel and fertilizers. Thus, diversification is focused only on a small segment of energy and related petrochemical products.

Globally, petrochemical sales have fallen in the past years by 10% and are characterized with overcapacity. Many petrochemical companies are affected. With the present overproduction by Iranian and Gulf State countries and the planned production expansion by these countries, Qatar will be less fortunate to enjoy a lower feedstock cost and must focus on other plans to offset this situation. Why Qatar does not change its focus to final products is a question to be discussed in the next chapter.

Breadth of Knowledge

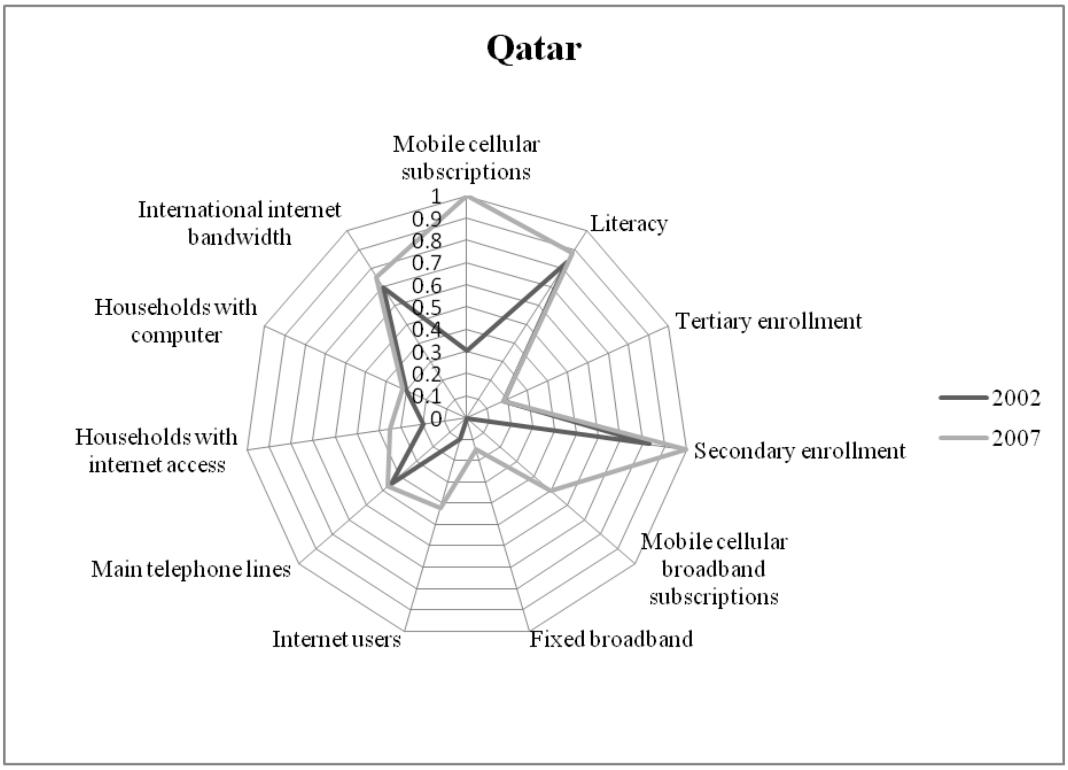
One element of measuring breadth of knowledge is calculating the number of patents held by a particular entity. According to a recent study by the General Secretariat of Qatar's Ministerial Council, the number of patents filed in the fields of engineering, science or technology during the years 2005 and 2007 did not exceed one. Therefore, the rate of patents per million in populations is very low when compared to advanced countries.[17]

Another measure of the breadth of knowledge within an entity is information and communication investment. The information and communication technologies have contributed considerably to the social and economic development of nations attempting to bridge the digital divide in the current global, knowledge-based economy. Integrating globally presents profound socio-economic and cultural challenges and opportunities. Unfortunately, Qatar's annual ICT budget is not accessible as an isolated data point. However, this study is able to shed some light on this through its survey of many major enterprises.

ICT access, use and skills can indicate the level of absorption of technologies within an entity. These indicators are being calculated regularly by the International Telecommunication Union (ITU). Access indicators include infrastructure, affordability, knowledge, quality and actual usage. The ITU has developed a unified development index

(ICT Development Index) that integrates three indicators: access, use, and skills. In 2009, Qatar ranked 44th in the world on the ICT Development Index.[18] Looking further at the three sub-indicators reveals that Qatar ranked highest in access (39), followed by use (44) and skills (79).[19]

Figure 4.7: Qatar Information Development Index Web Chart

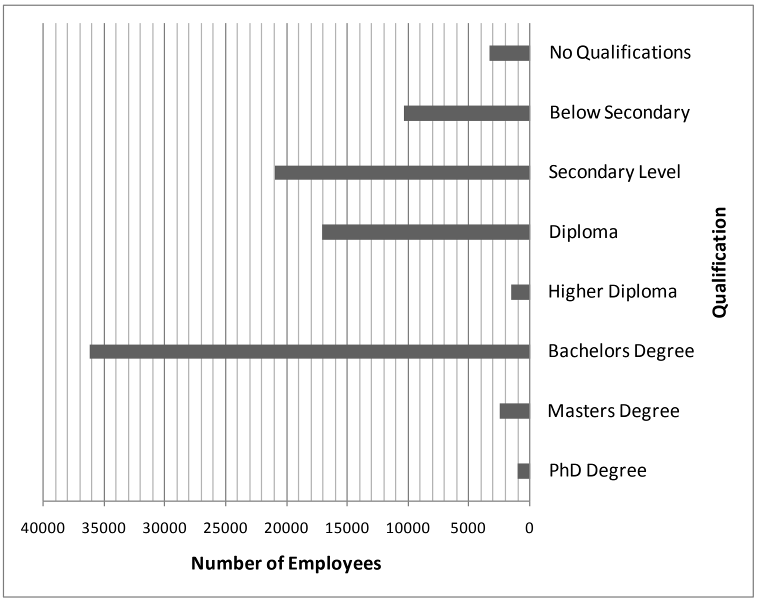


Source: International Telecommunication Union. Measuring the Information Society: The ICT Development Index. ITU, Geneva Switzerland. 2009. p. 25.

IctQatar has the biggest ICT budget, with spending reaching around QR 200 million (US$ 55 million) in 2007. Following ictQatar is the Ministry of Interior, which spent a substantial (8%) share of its annual budget. The American universities - Texas A&M and Carnegie Mellon - scored third and fourth respectively. The Supreme Education Council allocated 2.5% of its annual budget to ICT in 2007. The remaining enterprises varied in their expenditures, but all came in below 1%. QSTP did not answer this question, although it is believed that they rely on ICT to a great extent.

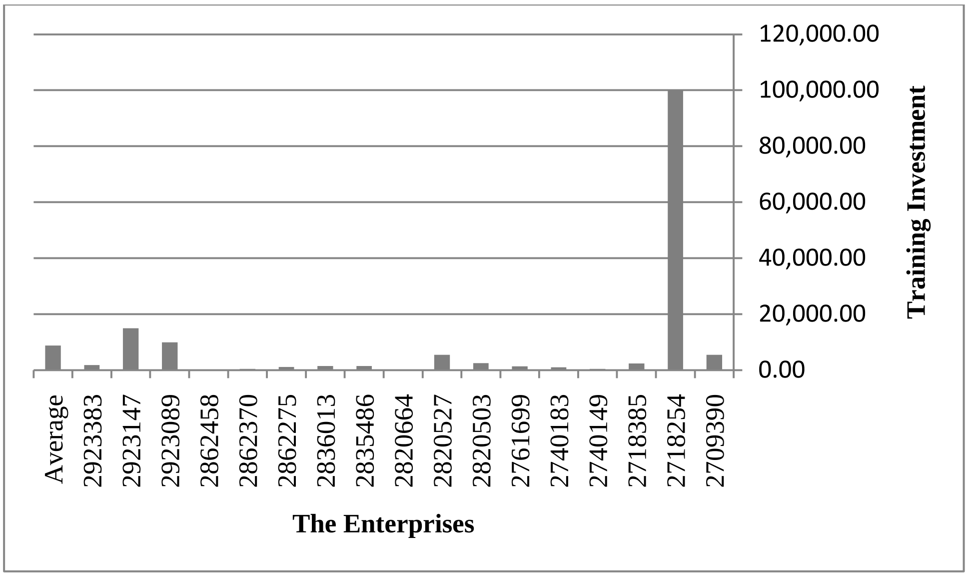
The third measure of breadth of knowledge is qualifications. Through the qualifications portion of the survey, this study found that the majority of staff at Qatari enterprises and institutions has a diploma, a higher diploma or a Bachelor of Science degree. It was surprising to discover that QP recruits candidates with bachelor's degrees more often than candidates with diplomas. Employers do not prefer higher diploma levels. The industrial enterprises and agencies involved in managing their technologies are staffed appropriately with qualified personnel.

Figure 4.8: Number of Employees and their Qualifications



Source: Results of Questionnaires calculated using QuestionPro Software

Figure 4.9: Training Expenditure



Note: The enterprises have been coded automatically using the statistical tool "QuestionPro." IctQatar spends the most on training. **Source**: Results of Questionnaires calculated using QuestionPro Software

A fourth measure of breadth of knowledge is amount of training expenditures. In response to survey questions regarding training, seventeen entities provided data on their training expenditures. On average, organizations allocate around QR 8,800 (US$ 2,400) per employee annually on training. The minimum expenditure was QR 150 (US$ 40) per trainee annually, and the maximum was QR 100,000 (US$ 27,400) per trainee annually. See the distribution of training expenditures in Figure 4.9.

Learning by Doing

As indicated earlier, the percentage of employees that have access to the internet from their desks is part of the assessment of learning by doing. Twenty-one respondents replied to this question. More than 50% of the respondents indicated that fewer than 50% of their employees had access to the internet. The least chosen option was “100%” access (9.5%). Figure 4.10 illustrates a frequency analysis of employee access to the internet from their desk.

Figure 4.10: Internet Access Frequency Analysis

Do you access the internet from your desk?	Count	Percent	20% 40% 60% 80% 100%
100%	2	9.52%	
75%- 99%	2	9.52%	
50%-74%	3	14.29%	
25%-49%	4	19.05%	
10%-24%	**7**	**33.33%**	
Less than 10%	3	14.29%	
Total	**21**	**100%**	

Source: Results of Questionnaires calculated using QuestionPro Software

In response to the survey question regarding the purpose of internet access, 64% said they use it mainly for emailing, 18% for email and research and 18% for email, research and sales. All who were surveyed indicated that their organization has a homepage on the internet.

Teamwork, staff morale, and internal communication ratings formed a third element of this assessment. These were evaluated during the interview in Question (2) (see Appendix D) and answers to these questions were also used to assess dependency on foreign technology. All respondents answered favorably, rating the teamwork, staff morale and internal communications within their enterprise as good, very good, or excellent.

The final element used to assess learning by doing was the rating of training relevance to employees’ jobs. When asked whether an employee’s performance review is the basis for selecting a training program for the employee, 67% said “yes.” It is therefore inferred that 67% of training programmes are relevant to employee’s jobs.

Figure 4.11: Training Relevance to Job

Is your training relevant to your job?	Count	Percent	20% 40% 60% 80% 100%
Yes	**14**	**66.67%**	
No	7	33.33%	
Total	**21**	**100%**	

Source: Results of Questionnaires calculated using QuestionPro Software

Return on Investment

Return on investment (ROI) assesses the company's ability to earn an adequate rate of return and provides information about the effectiveness of its management. To calculate ROI, this study divided net profit by total assets. The simplicity of this formula facilitated comparison, particularly as some enterprises had little financial data available. In combination with other measures, it reflects the enterprise's success in building capacity and transferring technology. During this survey, it was noted that a few enterprises - particularly those registered with the stock market - publish annual reports and have external financial auditors like Ernst & Young or KPMG to audit their performance. However, the auditors do not present financial analysis. Also, many other enterprises, including those that are state-owned, do not publish their financial data online. Table 4.10 provides a comparison between a few industries in Qatar and also compares these figures with multinational companies in the same industrial sector.

It is noted that almost all the energy sector enterprises have very high returns on their investments. QP posts the highest ROI (61%), particularly when compared with Exxon Mobil (17%) or Shell (9%). On the other hand, a company like Electricity and Water Co. has only a 6% return on investment.

Table 4.10: Return on Investment

No	Industry	Net Income USDx1000,000	Equity Capital USDx1000,000	ROI	Year
1	QAFCO *(Fertilizer)*	698	2,181	32%	2007
2	QP *(Qatar Petroleum)*	5,992	9,858	61%	2005
3	QAPCO *(Petrochemical)*	386	1,795	22%	2007
4	Industries Qatar	1,993	7,520	27%	2008
5	Electricity and Water	207	3,723	6%	2008
6	Shell	26,277	282,401	9%	2008
7	Exxon Mobil	40,610	242,082	17%	2007

Sources: Extracted from enterprises' Annual Reports. ROI is calculated using net profit over net assets.

4.5.4 Value Chain

The firm's value chain accepted primary activities include inbound logistics, production, outbound logistics, marketing, and sales and services. The accepted support activities include administrative infrastructure management, human resource management, research and development, and procurement. The literature review and the discussion in chapter two revealed that certain key performance indicators must be evaluated to analyze the value chain. Thus, to assess the value chain, environmental analysis, contribution analysis, product/service analysis, competitive analysis, an evaluation of market assumptions, financial management, customer satisfaction, marketing management, sales revenue, performance management, production, IT management, new product development management, and contingency planning must be conducted. Though many of the above appeared individually in analyses of other areas, they will now be extracted or brought together in one place to evaluate the effectiveness of the value chain.

Environment Analysis

In an effort to analyze the environment surrounding technology transfer, this section focuses on tendering, regulations, and economic changes that affect operations. Perhaps the greatest influences on Qatar's economy are the prices of oil and gas. These prices affect the energy industries that sell petrochemical products and change both their final profit and their return on investment. In July of 2008, oil prices went down and continued to drop in subsequent months until the prices of some products returned to the same level they were at in 2006.

Another environmental factor that influences value chain is the tendering regulations. Well written and managed tendering could involve finding long-term partners or commitments. Alternatively, if not regulated and managed appropriately, tendering can involve long waiting times and unmet deadlines. The question, "Do the tendering regulations enhance the internal business operations of our organization?" was posed in the questionnaire to evaluate each enterprise's tendering regulations. More than 90% said "yes" in response to the question. This indicates that the industries in Qatar enjoy a competitive tendering policy.

Product and Contribution Analysis

Contribution analysis focuses on understanding which key products and customer groups are generating profitable revenue for the business. In 2004, slightly over 97% of Qatar's export value was from oil, gas and related products. The main consumers were Japan (42%), South

Korea (15.9%), Singapore (9.2%), African countries (8.5%), India (5.4) and the United States (1.3%). Recent statistics have yet to be published and are expected to reflect substantial changes as many customers have been enlisted to receive LNG exports.

With respect to products, this study gathered data from various sources - mainly official annual reports - and assembled in Table 4.10. This table projects the most valuable products in terms of generation of revenue. The annual revenue for each product had to be calculated individually since there was no data available publicly, nor was data provided through the surveys. Often, the exported volume was available, but the price was not. Thus, available international prices were used where there was no available price. Also, buyers' publications published some prices, such as Qatar Steel's. It is worth mentioning that the international prices were slightly higher than those proposed by Qatari companies. This is likely due to the fact that QP pursued new clients for long-term contracts with lower costs. As Table 4.11 indicates, the most valuable products are oil and liquefied natural gas. Recent 2008 figures show that LNG revenues amounted to US$ 120 billion and oil to US$ 100 billion.[20]

Table 4.11: Most Valuable Products *(in US$)*

Rank	Company	Product	Annual Revenue (2007)
1	QP	Oil	80,374,000,000
2	QG	LNG	61,936,000,000
3	QASCO	Bars	1,350,000,000
4	QAFCO	Urea	692,984,000
5	QAFAC	MTBE	628,300,000
6	QAPCO	LDPE	397,000,000
7	QASCO	DRI	264,500,000
8	QAFAC	Methanol	235,000,000
9	QASCO	Wire & Coil	216,000,000
10	QAPCO	Ethylene	210,000,000
11	QASCO	Coil	204,300,000
12	QASCO	Billets	184,000,000
13	QAFCO	Ammonia	143,520,000
14	QAPCO	Sulphur	3,225,000

Source: Calculated using market prices and product sales in enterprise annual reports

Following oil and LNG, steel bars came in as the third highest income producer. However, this should not be confused with the return on investment generated from the product, because steel raw material is imported from other countries; therefore, its production cost is substantially higher than that of petrochemical products.

Market Assumptions

Market assumptions make businesses monitor changes in key areas so that plans can be adjusted. The global oil, gas and consumable fuels industry has a market share of 97.6% of the energy industry and reached a value of US$ 10,026 billion in 2008, a compound annual growth rate of 25.5% for the period spanning 2004-2008.[21] Qatar energy shared 0.61% of the $10,026 billion, or US$ 62 billion, a growth of 88% from the previous year. Despite concerns about overdependence on the hydrocarbon sector, Qatar’s nominal GDP growth remains strong. The growth in the hydrocarbon sector is attributed to higher energy prices and a continued increase in output volumes. Because many large products got off the ground, gas production increased by 40% in 2008. This demonstrates that Qatar’s market assumption that the LNG sector would grow at a rapid pace is fairly accurate; it also explains Qatar’s strong focus on this area.

However, interviews revealed that the quality of Qatar’s business environment is significantly ahead of its companies’ sophistication. With respect to innovation, which is fundamental to competitiveness in high-income economies, Qatari businesses will undoubtedly fall behind; they lack the trained staff necessary for research activities and they do not utilize opportunities to build skills and knowledge through collaboration. Furthermore, when combined, the previous section’s findings and the findings in this section indicate that while marketing capabilities and effectiveness are achieving a high return on investment, there is a lack of focus on innovation and business sophistication.

Financial Management

Financial management analysis could not be conducted because many enterprises do not publish or disclose their financial performance.

Customer Satisfaction Surveys

Table 4.12 reflects all responses to the survey question eliciting information about the types of customer satisfaction surveys the organizations conduct and the frequency with which they distribute such surveys. The table is further analyzed to find the percentage of organizations that conduct each particular type of survey and, among those organizations, the average number of surveys conducted. It is clear from the table that product and service quality surveys are distributed most frequently (48% of organizations) and organizations who seek such information do so an average of four times per year. Staff service surveys came in second (33% of organizations) with an average of three surveys per year among organizations that conduct them. Following this, reputation surveys were distributed by 26% of the organizations, with conducting organizations delivering an average of two surveys per year. The least covered survey areas were delivery and value for the money (22%).

Table 4.12: Type and Number of Surveys the Organization Conducts Each Year

	Product / Service Quality	Delivery	Staff Service	Organization's Reputation	Value for the Money
Total Surveys	52	20	29	15	11
No Response	14	21	18	20	21
Response	13	6	9	7	6
Total Surveyed	27	27	27	27	27
Percent Conducting Survey Type	48%	22%	33%	26%	22%
Surveys / Yr	4	3	3	2	2

Source: Results of Questionnaires calculated using QuestionPro Software

Sales Performance

This topic has been covered earlier in this chapter within the absorptive capacity section, but here the analysis will be broadened. Qatar's industries focus on selling products with high market values and low production costs, such as gasoline-blending stock and chemical plant raw feedstock. To further illustrate, methane (natural gas) can be a very important source of petrochemical feedstock for the production of intermediate and finished goods. It can also be used as a source of hydrocarbons (e.g. ethane and propane) that are higher in molecular weight than methane and are also important chemical intermediates. Qatar needs to develop its downstream industries by setting up more diverse industries that could utilize a portion of the abundant gas resources, such as petrochemical and fertilizer plants, instead of only exporting the gas as LNG to developed countries. In the long run, this would create job opportunities for local citizens. In sum, the government and private sector should invest in gas–based industries. The sale of LNG to other countries is good, but the money earned from it should be invested in gas–based industries to create job opportunities for Qataris.

Performance Management

Performance management is also interrelated with absorptive capacity and marketing capability. With respect to value chain, individual enterprises must develop their key performance indicators (KPI) through an action plan in order to benefit from their productivity and supply chain management. The study did not find a roadmap plan to evaluate the logistics KPIs. However, based on the previous analysis, it is clear that skill gaps need to be addressed. In particular, it is important to solve the problem of importing skills rather than generating them within Qatari institutions. Also, although the ICT infrastructure is promising, there is a need to build an integrated network that connects businesses with government and education. The interview findings also highlighted the need for vocational training in order to respond to businesses' growing demands for a skilled labour force.

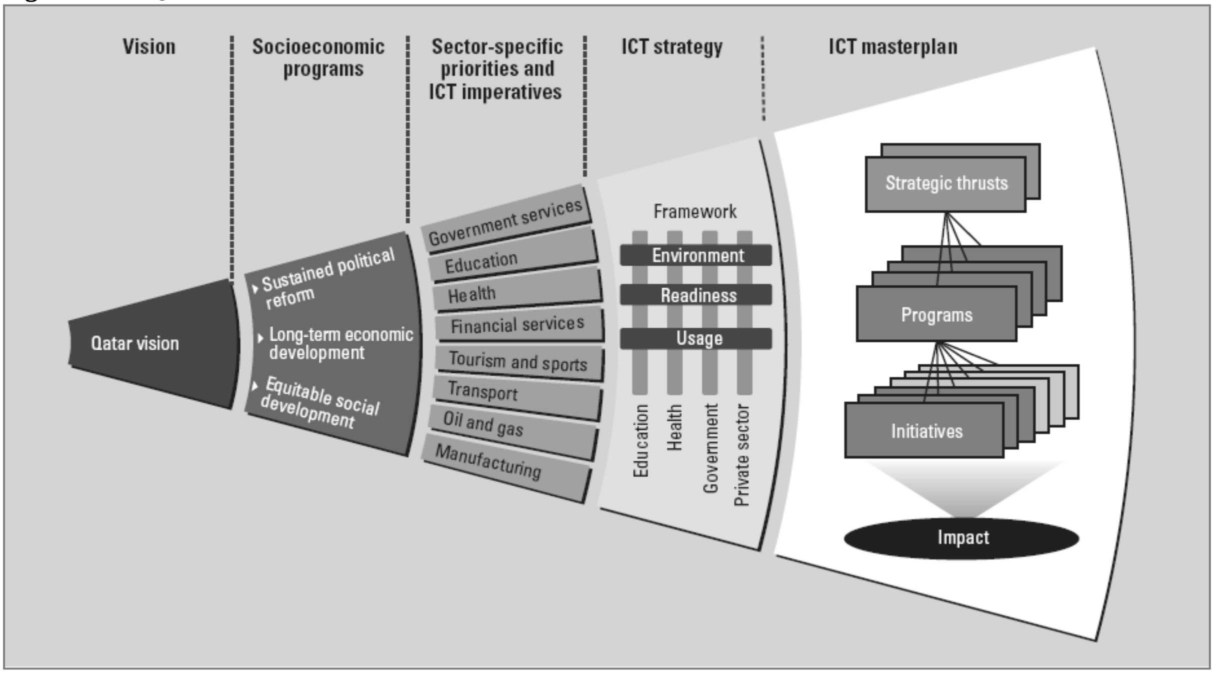
Cost of Production

While surveying production costs, the researcher found that most of the energy industries depend on natural gas as a raw material and that they contract with QP for the natural gas at competitive rates. This enables the local industries to produce goods at a low cost. QAFCO, a fertilizer company, relies on natural gas as a raw material and this material comprises 80% of the cost of production. Compared with other producers, QAFCO is considered to be a low cost producer of ammonia and urea. In addition to natural gas, the petrochemical company QAPCO requires utilities and production chemicals to produce its goods. QAPCO signed a long-term agreement with QP to deliver feedstock with a yearly set price to reduce the price fluctuation. QAPCO is self-sufficient in producing needed electricity, water, steam and air. The primary raw materials for QAFAC, a fuel additive producer, are methane and butane. Methane is contracted from QP on a fixed price, while butane is acquired from QP at open market prices and therefore is sensitive to price fluctuations. Unlike these producers of petrochemicals, QASCO, a steel company, has higher costs of production. It buys raw materials from international markets through suppliers. It also consumes electricity, water and natural gas, which are supplied by Qatar Electricity and Water and QP respectively. In short, the production costs within Qatar's energy industry are much cheaper than in other countries due to the government support in reducing the intermediary feedstock.

IT Management

Qatar made its first serious foray into the information technology domain in 2005. IctQatar established a master plan, as shown in Figure 4.12, for an integrated approach to achieve Qatar's long-term vision. Each of the components plays a complementary and indispensable role. This vision integrates all substantial contributors to the development of the information technology in Qatar and extends to eight national programmes. IctQatar has also deregulated the communication sector, as mandated by the World Trade Organization. These initiatives allowed Qatar to rank 32nd in the 2008 Networked Readiness Index (NRI). This rapid success has been attributed to singular government leadership. However, this initiative is still in its infancy. The real success will be the effective utilization of ICT to produce value in terms of both social growth and prosperity, which has yet to be seen.

Figure 4.12: Qatar's ICT Master Plan



Source: Qatar ICT Master Plan 2005, ictQatar.

The above summarization is in agreement with earlier findings; technology has been imported, but use of this technology in business and daily life is still lagging behind. It has been four years since ictQatar implemented its vision but to date, the initiatives designed to build human skills are deficient and need immediate attention. At the same time, this study found that most enterprises lack an ICT strategic plan to synchronize with ictQatar's master plan.

New Product Management Development

New product management was covered within the section on marketing capabilities and absorptive capacity. However, this section will analyze the effect of new product management on the value chain.

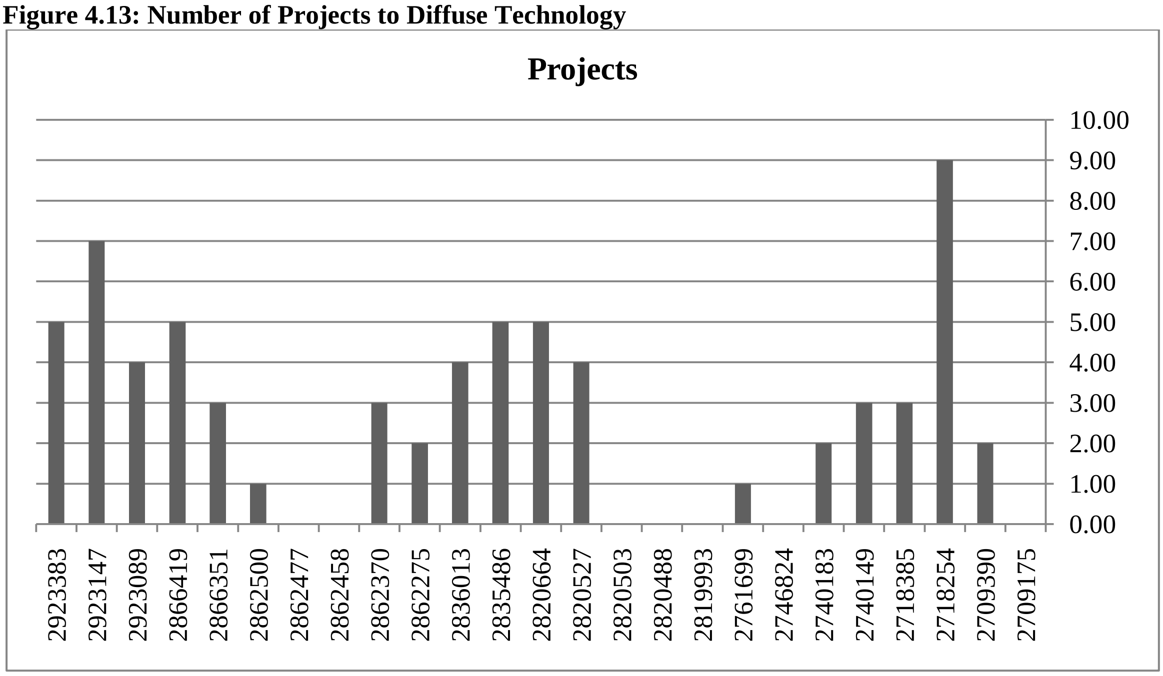
Organizational innovation is the basis for the management of complex processes. It is also the base for new product development. A well established, innovative infrastructure will add value along the value chain and create a competitive advantage. Although Qatar's innovation system has shown progress in international reports, this study did not confirm this finding.

This is because the international bodies base their calculations on the way the measure is defined for the innovation pillar and not on the real progress. Demonstrating real progress requires one to measure the output, whereas some international reports are satisfied with measuring only symbolic gestures, such as the presence of policies and not their implementation.

In this researcher's view, Qatar's innovation system started when QSTP, QNRF and the Supreme Education Council were established in 2004. At the same time, the government, through the Ministry of Finance and Commerce, issued a policy encouraging FDI and permitted 100% foreign ownership in ventures in the health, education and tourism sectors. Through Qatar Development Bank, the Ministry of Finance encouraged small to medium businesses by providing financial support and technical assistance. This has spurred a few projects.

The study surveyed the technology transfer projects that are currently underway to diffuse unavailable technology within a particular organization. The first finding was that such projects are limited in number; they average 2.72 per organization. See Figure 4.13.

Figure 4.13: Number of Projects to Diffuse Technology

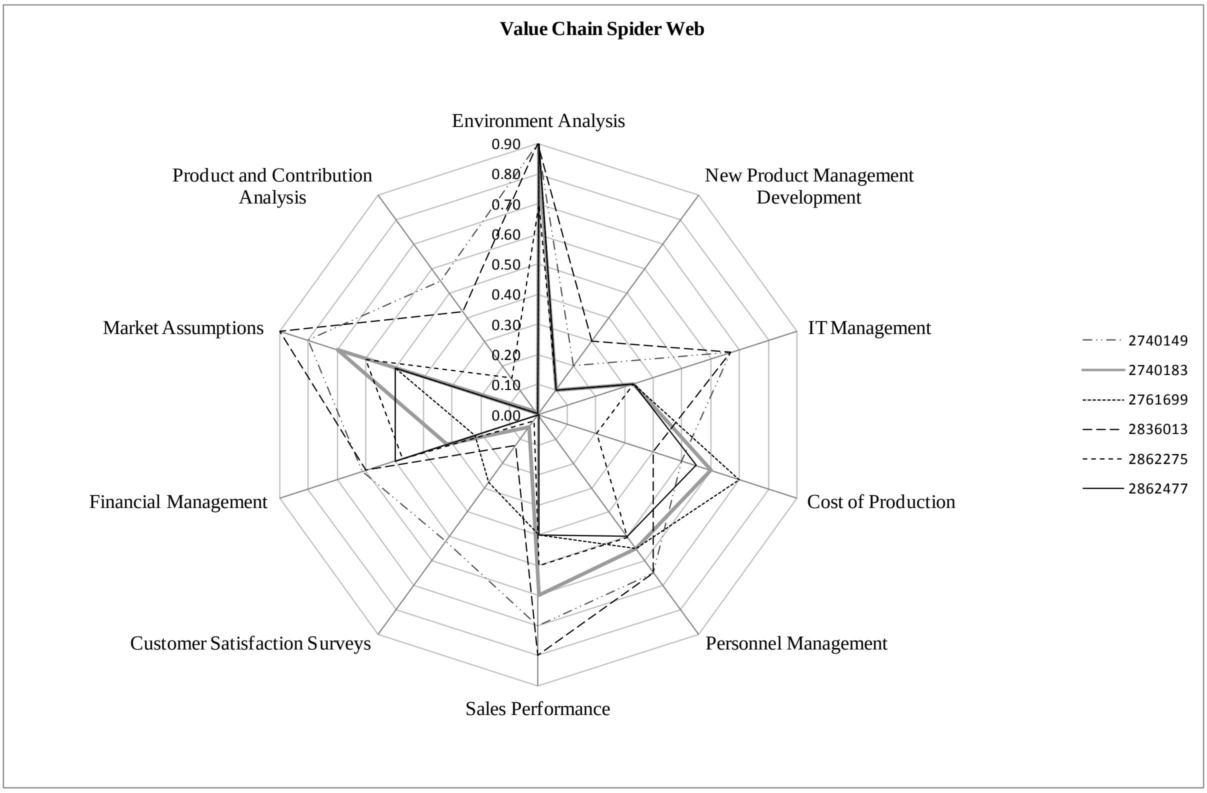


Source: Results of Questionnaires calculated using QuestionPro Software

In the interviews, respondents spoke gravely about Qatar's shortage of skilled human resources in the field of science and technology, which puts more limitations on absorptive capacity. The main reason for this shortage is the limited amount of available tertiary education in science and technology. To illustrate, only 22% of the 2007 graduates from Qatar University earned degrees in science and technology.

To summarize, the absence of a few important KPIs makes it difficult to assess the value chain. The study found some KPIs for a few industries and managed to measure almost all of the value chain indicators, including environmental analysis (through tendering regulations), contribution analysis (through contribution towards GDP), market assumptions (through competitiveness and marketing capabilities), financial management (through profit calculations), customers satisfaction surveys (through benchmark comparison of variety of customer surveys), sales performance (through the number of contracts signed), peformance management (through KPI in-place), cost of production (through a scale of 0-1, with 0 as high cost), IT management (through IT policies and infrastructure), and finally, new product management (through innovation measured on a scale of 0-1, with 1 as innovative). Figure 4.14 illustrates a web chart that assigns an overall value to the chain.

Figure 4.14: Qatar Industrial Enterprises Value Chain Web

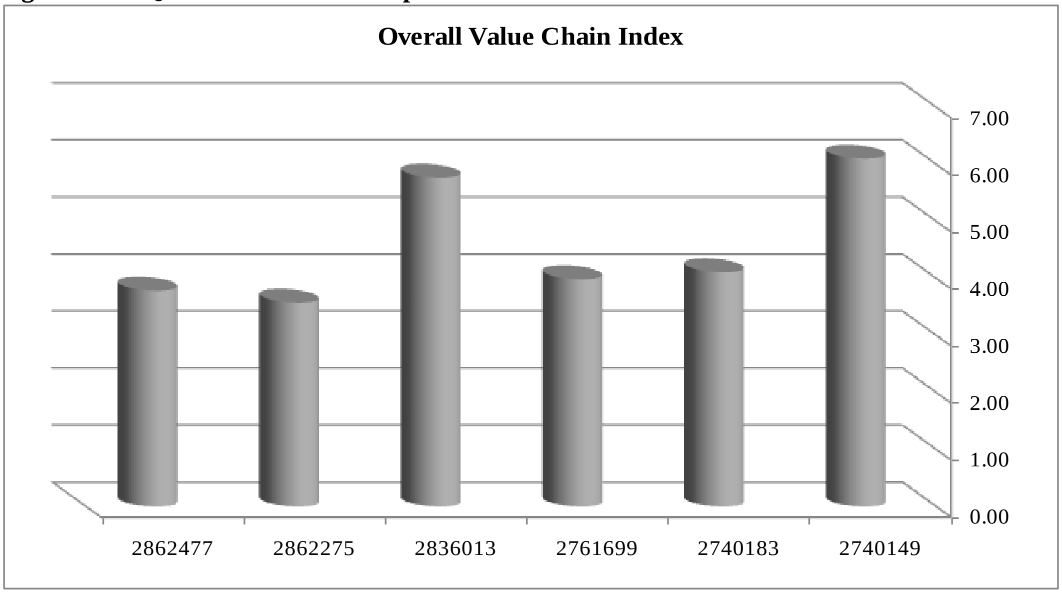


Source: Appendix E

Also, Figure 4.15 compares the overall value chain assessment.

This study found that the comparative advantage for Qatar industries is marketing LNG products. The supply chain is characterized by excellent procurement processes, competitive product prices, high quality, and fast delivery times. Adequate management systems are in place to plan, organize, monitor and control the supply chain cycle. The sales performance is excellent due to the utilization of available natural resources. The infrastructure is excellent because of state-of-the-art technologies. However, with volatile products, there is risk of underperforming and there is a need to diversify beyond related energy products. Of the major concern, then, are the inadequate skills of the workforce, which have slowed the success rates of many projects and have decreased the innovation index.

Figure 4.15: Qatar Industrial Enterprises Overall Value Chain Index



Maximum Index Value = 10.

Source: Appendix E

4.5.5 Value Networks

Value networks address both financial and non-financial values. Financial value addresses financial investments, operating capital, time, materials, facilities, and equipment. Non-financial value deals with human skills and competence, internal structures and systems, and business relationships and agreements. These intangibles also cover value conversion processes, value enhancements, perceived value and social value. It is difficult to measure these values because of insufficient metrics.

To assess financial value, the study will measure asset utilization. For non-financial value, the study will not attempt a value network analysis but will measure network value through number of agreements, human skills, intermediary products (value conversion), customer satisfaction (perceived value), and social capital.

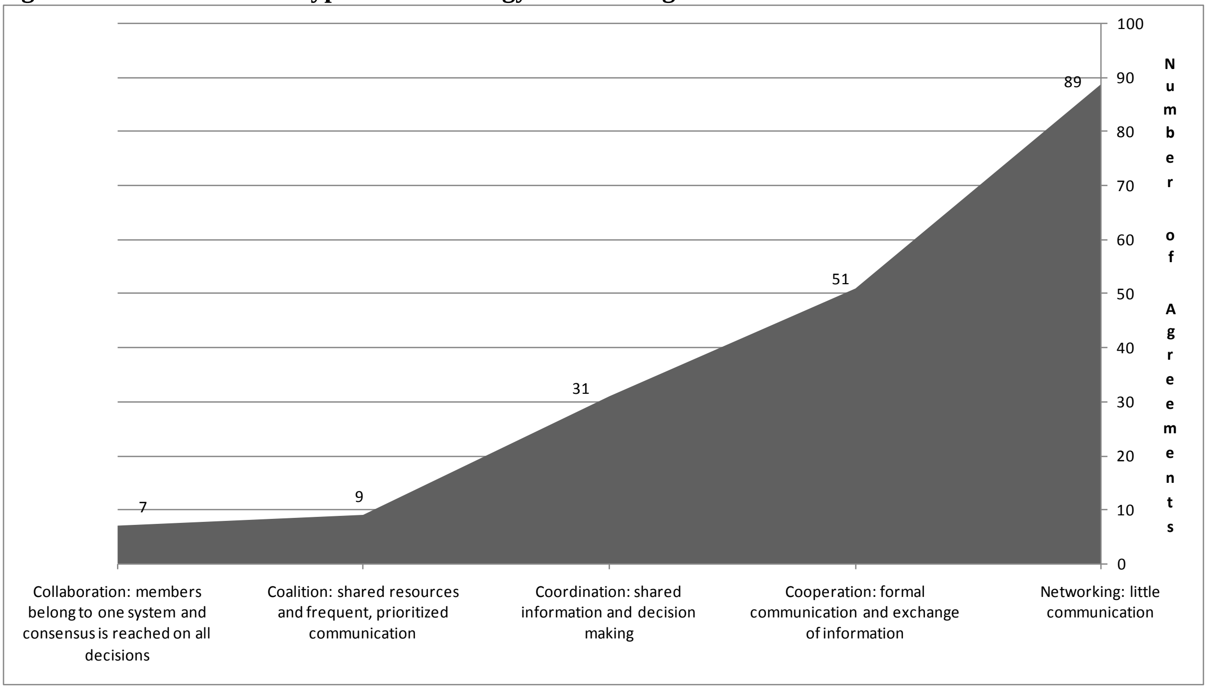
Financial Values

The financial value has been shown in Tables 4.8 & 4.9 by calculating growths and investment. This analysis showed that all the energy sector enterprises had very high returns on investment, but non-energy sector businesses recorded much lower ROIs. It is important to note that this figure does not necessarily indicate the energy sector's enterprise effectiveness, but may simply reflect the gains from the supply of abundant cheap feedstock.

Non-Financial Values

The number of active technology transfer or science and technology agreements between enterprises and R&D centers can be used as a simple measure of value networks. However, comparable data are not widely available at this time for such an indicator. For an alternative assessment of the performance of and value gained from such agreements, the study ranked the types of agreements from least to most effective in the areas of networking, cooperation, coordination, coalition and collaboration.

Figure 4.16: Number and Types of Technology Transfer Agreements



Source: Results of Questionnaires calculated using QuestionPro Software

Value networks involve a larger number of firms with a more complex set of relationships between them than do value chains. This is expected to be reflected in the number of agreements between corporations. By looking at Figure 4.16, it is noted that ten entities responded that they had some sort of agreement (42% of the population surveyed). When it came to types of agreements, networking agreements topped the list (89 agreements in total), followed by cooperation (51 agreements), coordination (31 agreements), coalitions (9) and collaboration (7). It is logical that the more complex the type of agreement, the lower the number of agreements made. It is important to note that the number of agreements is not a good indication of the value of the type of network established. However, it can be concluded that networking agreements are a simple but powerful means for developing team and community collaboration.

The extent of human skills is another indicator that contributes to the assessment of value networks and has already been analyzed earlier in this chapter. The findings indicated that the industrial enterprises are staffed appropriately with qualified personnel, though these are mostly expatriates.

With respect to intermediary products, a third measure of value networks, it was shown earlier in this chapter that Qatari industries focus on high market value products, such as gasoline-blending stock and chemical plant raw feedstock, because such products have lower production costs. However, it would be beneficial to develop the downstream industries by setting up more industrial enterprises that could utilize some part of the abundant gas resources.

A fourth measure of value networks used in this study is use of customer satisfaction surveys. Customer satisfaction surveys are regularly conducted and mostly focus on the quality of products and services. Recent studies have shown that customers generally place a great deal of trust in Qatar's local products. However, this study did not establish the mechanisms to follow up on these surveys.

Social Capital

Within an organization, the study of social capital is not necessarily vital to organizational success, but it does offer many benefits. High social capital within an organization can lead to lower transaction costs due to a high level of trust. It can also lower turnover rates, thereby maintaining valuable organizational knowledge and creating greater organizational bonding and stability.[22] Across organizations, social capital is important to the establishment of strong networks and communication, which facilitates the transfer of knowledge. Quantitative measures of social capital have proved to be complex and problematic. Therefore, this study measured social capital through qualitative data that was then distilled into a measure of the level of relationships. This will shape the perceptions of the value network between enterprises.

“Institutions are composed of cultural-cognitive, normative and regulative elements that, together with associated activities and resources, provide meaning to social life.”[23] Thus, understanding the social life of the organization entails understanding its cultural-cognitive, normative, and regulative elements. Understanding norms and the cultural-cognitive structures would facilitate an assessment of successful interactions between universities and practitioners, as well as suggest how to increase networking between collaborative bodies.[24] The regulative element consists of rules and sanctions that are embedded in any institutional system. The regulative element emphasizes regulative changes to improve collaborations between universities and business.[25]

The social relationship between the government of Qatar and its people has evolved to emulate that of care-giver to needy children. The care-giver strives to freely educate, socially care for and regulate its citizens. The impact of this relationship or "social contract" has led to a trust issue. Interviews indicated that organizations have difficulty trusting a “cared-for” citizen to lead or be part of the elite working force in a complex venture, such as an energy complex. At the same time, the government perception is that citizens are “not helping themselves.” However, the citizens' perceptions are that there should be a mutual responsibility between the government and its people; this can be maintained through competitive institutions and the promotion of trust and accountability. Although there is a trend toward creating competitive and learning organizations, the perception of government as “care-giver,” as one interviewee said, "lingers in the media." Interviews supported the finding that the focus in Qatar is to quickly increase the country’s wealth at the expense of technology transfer and sustainable development.

In chapter three, Figure 3.2 focuses on the stakeholders in the national innovation system. The main players in the system are the public sector (the Council of Ministers), the policy makers (Ministry of Energy and Industry, Supreme Education Council, Planning Council, and Qatar Foundation), the financers (Qatar Petroleum, Qatar National Research Fund, and Qatar

Science and Technology Park), the operators (Education City campuses, College of North Atlantic, and QSTP), and the private sector (business enterprises, research institutes, insurance companies and industry and academic societies). According to this study, the collaboration and coordination between universities, private companies, research centers, and government agencies on science and technology issues is either non-existent or existent only at the networking level (weak communication). Also, human capital and the skills to innovate do not exist in the private sector for incentives reasons. Businessmen in Qatar claim that the private sector cannot compete with the public sector in funding R&D initiatives. However, in Qatar University and the public sectors, improvements meant to limit dependence on imported technologies have been noted.

Overall, there is still much to be done to build social capital through improved relationships. This is achieved through improved communication channels that employ knowledge in order to improve products and services. It is also necessary to create shared goals that build trust in relationships and provide better knowledge-sharing for decision makers.

4.5.6 Research and Development

In chapter three, secondary research indicated that there is a scarcity of R&D centers in Qatar and that researchers and related development programmes do not exist in Qatari industry. Furthermore, there is no statistical data on R&D in Qatar. To contribute to this field, then, the researcher conducted a field survey using a questionnaire and interviews to gather information on essential R&D indicators that will enable a comparison with international benchmarks.

The R&D indicators selected earlier included the number of government grants, the ratio of global gross expenditure on R&D to total expenditures, measures of the intensity of R&D, the proximity of universities to industry and to each other, the number of patents granted by the country, and the expenditures on human development in R&D. However, the availability of information made it necessary to be selective in choosing indicators. The study will start with government grants.

Expenditures on research and development (R&D) are a key indicator of government and private sector efforts to obtain a competitive advantage in science and technology.[26] Table 4.13 shows government grants as a percentage of total R&D expenditure. QSTP and Qatar

University are the two entities that receive 100% of their research grants from the government. The foreign universities, Texas A&M University and Carnegie Mellon University, each receive a substantial grant from Qatar Foundation (Qatar National Research Fund) and these make up exactly 90% and 85% of their R&D budgets respectively. Surprisingly ictQatar, which is charged with the task of influencing ICT legislation and of testing and recommending IT solutions, receives the fewest government grant dollars (30% of its budget) in comparison to its other funding sources.

Table 4.13: Government Grants as Percentage of Total R&D Expenditure

Entity	% Grants
ictQATAR	30%
Qatar Science and Technology Park	100%
Texas A&M University	90%
Carnegie Mellon University	85%
Qatar University	100%

Source: Qatar Fieldwork, 2008. **Note**: the above are all the independent sources of R&D centers surveyed

Another indicator measured was the ratio of global gross expenditure on R&D to total expenditures. This is an important indicator of nations' performance in the high-tech race.[27] Only six respondents answered this question.

QSTP came in with the highest level of expenditure as it considers 100% of its expenditures to be contributing to R&D in Qatar. Qatar University spends 2.8% on R&D, which is considered competitive according to international standards, while Texas A&M University and Carnegie Mellon University spend a slightly lower percentage of their total expenditures (2.5% each). Looking at industrial R&D, the study found that energy enterprises, the most financially able and independent, registered very low ratios (less than 0.5%).

Table 4.14: Ratios of Global Gross Expenditure on R&D to Total Expenditures

Entity	Ratio of R&D Expenditure
Energy Enterprise Number 2740149	0.03%
Qatar Science and Technology Park	100%
Energy Enterprise Number 2835486	0.30%
Texas A&M University	2.50%
Carnegie Mellon University	2.50%
Qatar University	2.80%

Source: Results of Questionnaires calculated using QuestionPro Software

R&D intensity is often defined as the ratio of a firm's expenditures on research and development to its sales. This indicator is a means to measure competitive advantage and future market returns. Since many industrial enterprises do not spend on R&D, it can be concluded that the R&D intensity within Qatari industries is very low.

Most industrial respondents did not respond to the question soliciting information about their relationships with universities or R&D centers. Through interviews, the study found that there is no real cooperation between the industries and R&D centers. When asked, only a couple of interviewees answered that R&D centers were located more than 10 kilometers away. However, Qatar Science and Technology Park regulates six universities' R&D centers along with other original equipment manufacturers who conduct research, and all are located next door to each other except one which is within ten kilometers. In other words, QSTP is considered the heart of Qatar's R&D. Three foreign universities' R&D centers in Qatar are located next to each other, creating an environment of collaboration among them. Qatar University, the only national university in Qatar, is located within ten kilometers of QSTP.

Calculating the number of patents a country produces can be used to measure a country's progress in or developments in R&D, though it does have its limitations. The study found that no patents were registered in science and technology. Therefore, the number of patents generated in science parks as compared to the total number of patents is almost nonexistent. The American university, Carnegie Mellon, registered 33 patents; however, these were not registered locally and they were mostly in the field of robotics. In addition, Carnegie Mellon has already started up 18 ventures and has seven products in development. Again, though, this is likely due to the experience of personnel brought in by the university and to the fact that much of this work is an extension of activities done on its main campuses in America, therefore these patents are not counted in this study. The study did count two startups from QSTP.

To reach a better understanding of the depth of R&D conducted by local and offshore centers, the study asked respondents to identify the percentage of research that is classified as having some degree of commercial viability. Qatar Petroleum responded that its research is 100% commercially viable research. QSTP, RasGas, Texas A&M, and Carnegie Mellon estimated that 75% of their research is commercially viable. IctQatar (30%) and Qatar University (20%) are involved in developing commercially viable research to a lesser degree.

Other R&D Indicators

The questionnaire attempted to gather data on some additional R&D indicators, but only three entities responded: ictQatar, QSTP and Carnegie Mellon University. Table 4.15 shows the results.

Even those who responded to the R&D indicators question did not complete the table. Only Carnegie Mellon University mentioned how much of its budget is allocated to R&D. No respondent recorded the average faculty salary or the royalties paid to R&D staff. The return on R&D investment was also left blank. Offering minimal input indicates that QSTP needs to design and update its R&D information database. QSTP only responded to two indicators: the number of start-ups and the land grant from the government. IctQatar, a telecommunication legislator in the country, mentioned that it has 5 staff assigned to R&D, made two invention disclosures, and supports fifty jobs through technology transfer from academic institutions. Carnegie Mellon mentioned that it has started 18 companies as a result of its R&D.

Table 4.15: R&D Technology Transfer Indicators

R&D Indicator	ictQATAR	QSTP	Carnegie Mellon University
R&D Expenditures	-	-	US$ 4.18m
Number of R&D Staff	5	-	13
Number of Invention Disclosures	2	-	132
Number of New Patent Applications	-	-	75
Number of Licenses	-	-	23
Ratio of Public to Private Universities	-	-	-
Return on R&D Investment	-	-	-
Number of Start-up Companies	-	2	18
Land Grants	-	100	-
Royalties Paid to R&D Staff	-	-	-
Average Faculty Salary	-	-	-
Number of Jobs Supported by Technology Transfer from Academic Institutions	50	-	-

Source: Results of Questionnaires calculated using QuestionPro Software

Interviews revealed that the government recently started to allocate around 2.8% of its revenues to research and development. This has taken place following the establishment of Qatar foundation, QSTP, and the QNRF. In addition, two awards have been established to encourage researchers in the fields of Islamic studies, humanities, economics, science, applied science, and art and literature. In 2007, the expenditure on research and development was US$ 213 million (0.33% of GDP versus 2.4% average worldwide).

The survey on human development in R&D shows that there are 953 researchers (431 Qatari, or 45%) or 500 for every million citizens (a mere one tenth of the world's benchmark). The public sector allocates 96.5% of research funds, while the private sector contributes 3.5%. This ratio is in contrast to international benchmarks, where the opposite is true. The ratio of research assistants to researchers is one to one, whereas internationally it is three to one. On an average, every researcher is allocated US$ 223,000, which is considered a reasonable amount by international standards. Although the task of developing sustainable scientific and technological advancements lies with researchers, only 16% of the research conducted in Qatar is carried out in the field of science and technology with only 11.5% of the researchers involved. Most researchers are in universities and the public sector. Researchers' qualifications are distributed as follows: PhDs: 541 (38.3% are Qataris); Masters: 116 (29.3% Qatari); Bachelors: 296 (64.2% Qatari). This is in contrast to other countries where most researchers hold PhDs or masters degrees. [28]

Table 4.16: Qualifications of Researchers

Qualification	Qatari	Non-Qatari	Total
PhDs	190	106	296
Masters	34	82	116
Bachelors	207	334	541
Total	431	522	953
	953		

Source: Results of Questionnaires calculated using QuestionPro Software

Research is absent in the fields of environment engineering, medical engineering, industrial biotechnology, nanotechnology, and animal science. Most research is focused on administration, economy, geography, social sciences and the humanities, including languages, art, literature, history, philosophy and Islamic studies. Comparing this to the private sectors in Japan and Korea, where 70% of research is in the field of science and technology, Qatar's figures pale in comparison.

The general findings on R&D are in line with the secondary research conducted in chapter three and reveal the fact that Qatar still has a shortage of skilled workers in the R&D field, which puts limitations on developing the country's R&D capabilities. These findings also conform to the data provided by the GCI in Table 4.17, discussed in the next section.

4.5.7 Competitiveness

A country's competitiveness rests on its ability to prosper and provide social benefits to its citizens. Competitiveness is defined as "the set of institutions, policies, and factors that determine the level of productivity of a country."[29] Competitive economies produce higher incomes and determine the rates of investment returns. A more competitive country will grow faster in the medium and long terms. Economists from the Adam Smith era to today have tried to determine what makes a country competitive and they have all found that it is a complex issue; there are multiple measurements of competitiveness that must be taken into account. The World Economic Forum (WEF) bases its competitiveness analysis on the Global Competitiveness Index (GCI), an index that measures national competitiveness at the national and institutional levels.

Since the WEF measures are at the national level and compared globally, this chapter will make use of available data from the WEF report as benchmarks to assist in the analysis of the results presented here, which are at the level of individual enterprises. Therefore, some WEF measures related to competitiveness will be used for comparison in this section, and other WEF benchmarks will be used for the findings related to absorptive capacity, R&D, value chain and value networks.

According to the GCI, Qatar's competitiveness has been showing a robust upward trend. It ranked 26th overall in 2008-09 (a rank of 1 means the best country), which represented a move upward of 5 places compared to the previous year's ranking. This gain is most likely due to the development of the financial markets and the educational system. However, the 2008-09 report also criticized the low tertiary enrollment and the low rate of female participation in the labour market. It also warned against the rising inflation: the inflation rate in Qatar reached 14% in 2007, causing Qatar to rank 129th out of 134 countries on this indicator.

This study drew a selection of measures related to technology transfer from the WEF report and tabulated them in Table 4.17. In short, the data in the table suggests that technology has been imported but not absorbed. In fact, these measures reveal many positive signs of importation, such as the procurement of advanced technology products, FDI and technology transfer, and the quality of the education system, particularly in math and science. The data also suggest that there are quality R&D institutions and university-industry research connections in Qatar, but on the other side, there is an inadequate number of scientists and engineers and the capacity for innovation is lagging. The government laws and regulations encourage science and technology transfer, but the business rules inhibit FDI and thus, foreign footprints in this field are scarce.

Table 4.17: Measures Related to Technology Transfer in Qatar

No.	Measure	Rank out of 134
1	Property rights	31
2	Intellectual property protection	35
3	Quality of overall infrastructure	40
4	Quality of the educational system	16
5	Quality of math and science education	12
6	Local availability of research and training services	45
7	Intensity of local competition	53
8	Effectiveness of anti-monopoly policy	47
9	Prevalence of foreign ownership	97
10	Impact of business rules on FDI	71
11	Female participation in labour force	125
12	Availability of latest technologies	32
13	Firm-level technology absorption	40
14	Laws relating to ICT	33
15	FDI and technology transfer	11
16	Local supplier quality	72
17	State of cluster development	33
18	Nature of competitive advantage	36
19	Value chain breadth	43
20	Production process sophistication	29
21	Capacity for innovation	60
22	Quality of scientific research institutions	30
23	Company spending on R&D	35
24	University-industry research collaboration	25
25	Gov’t procurement of advanced tech products	9
26	Availability of scientists and engineers	53

Source: World Economic Forum. *Global Competitiveness Index*. 2008-2009. Edited by Porter M., Schwab K. Geneva, Switzerland, 2008. p 285

Rather than rely solely on the GCI index, it makes more sense to assign two indexes to measure competitiveness here: one that accounts for technology supply and another that measures technology absorption. According to the above, technology supply ranks with the developed countries and technology absorption ranks with the countries under development.

Next, the study will assess the findings related to marketing competitiveness and major firm activities in an attempt to add more elements to the measures within the GCI index and then will compare these with related measures.

Marketing Strategy

The marketing strategy portion of the survey revealed some interesting practices. The most frequently used strategy among commercial enterprises surveyed - particularly those in the energy sector and those offering oil and gas related products - focuses on increasing capacity to reduce costs and compete globally (24%), see Table 4.18. Around 12% of the companies selected “supply chain management” and “agreements and joint ventures” as strategies employed. Supply chain management involves enhancing logistics efficiency and effectiveness through improving warehousing, building offshore terminals for degasification, or improving shipping methods for LNG transportation. The “agreements and joint ventures” category covers practices like establishing networks and encouraging FDI, development, sharing, and shipping agreements. “Quality” and “building human capacity” both ranked third, each with a 9% rating.

Table 4.18: Marketing Strategies of Qatar's Major Industries

Marketing Strategy	**percentage**
Economy of Scale	24%
Supply Chain Management	12%
Agreements and Joint Ventures	12%
Quality	9%
Human Capacity	9%
Improved Regulation	5.5%
Ads	5.5%
Monopoly	5.5%
Nationalism	5.5%
Diversification	5.5%
Spot Markets	5.5%

Source: Calculated using results in Questionnaires

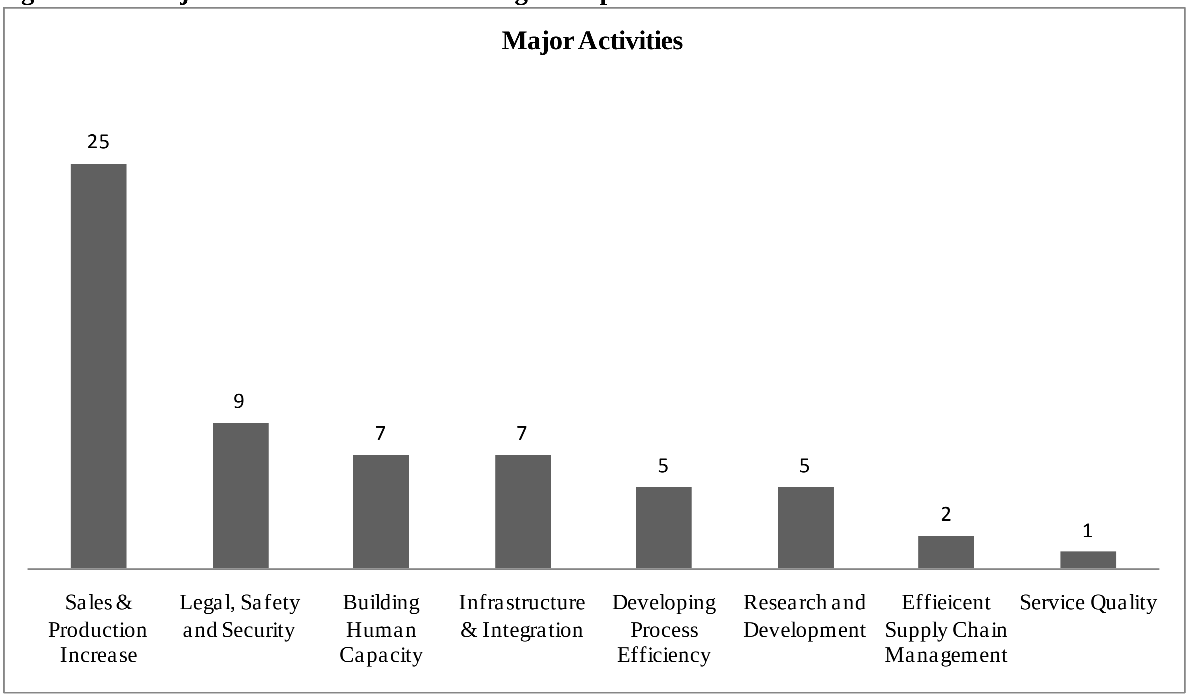
Participants were offered the opportunity to write in strategies that were not represented on the survey, and these write-in answers proved interesting. The most interesting marketing strategies listed were “focus on nationalism,” “spot markets” and “monopoly.” Nationalism was reflected in reforms like "Education for a New Era," "the Promise of e" of ictQatar, and also in “satisfying citizens’ needs.” “Spot market” refers to a place where goods are sold for cash and delivered immediately. Some enterprises, such as the communication service sector and parts of the industry sector were sole players in the local market and therefore, have no competitors. Thus, maintaining their monopoly bolstered their sales.

Responses to the question regarding major marketing focus are displayed in Figure 4.17. It is evident that the majority of enterprises focus on increasing sales by increasing production or using other means (41%). The respondents in this category indicated that their industries focus on increasing production capacity, reducing production costs, expanding the market or using long-term marketing efforts in order to maximize their returns.

The second most important focus was on legal issues, safety and security. Some respondents stressed attention to the regulation of their industries, while others discussed the need for security, and still others focused on the economic environment and sustainability.

The third most important area of focus, at 11%, was building human capacity. Businesses indicated that they targeted enhancing local skills, increasing competency, promoting Qatarization, and building leadership capacity.

Figure 4.17: Major Three Activities Attracting Enterprise Focus



Source: Qatar Fieldwork, 2008

The fourth most important domain was building infrastructure and networking. Respondents focused on network-centric operations, IT infrastructure projects, cooperation with other local enterprises, FDI, SMEs, and global market integration. A few respondents focused on developing process efficiency (8.2%) and R&D (8.2%). Supply chain management and service quality scored the least, at 3.3% and 1.6% respectively.

From the above, it is apparent that the energy market in Qatar is very competitive and uses economy of scale strategies to reduce cost and increase sales. This strategy is supported by government regulations that protect industrial products. Other strategies are used far less frequently, such as building human capacity and R&D.

4.6 Chapter Four Summary

The gathering and analysis of data in this chapter is more accurate than that done by international bodies tasked with similar assignments, such as the WEF's Global Competitiveness Index, ITU's Information Development Index or the UN's Human Development Index, for two reasons. First, when analyzing the workforce, these international organizations do not differentiate between permanent citizens and temporary immigrants. Second, international reports treat the subject technology transfer abstractly, without the depth presented in this chapter.

With regard to the first point, the Qatari population is much smaller than the current population; in fact, it is as low as 15% of the total population. This difference is readily apparent in Qatar's labour market, where foreign workers dominate every sector. One can imagine that when the aggregate population is surveyed, the results will be skewed. Moreover, international reports do not assess whether or not development plans will improve the local human capital.

With regard to the depth of analysis, international organizations do analyze the environment, innovation, technology, and human development, but the indicators used do not cover absorptive capacity indicators, value chain, and value networks, which are important because they allow an overall visualization of the current situation and present enough information for the decision maker to plan a sound development strategy.

The findings in this dissertation have been in harmony with all of the findings in international reports and have added much more depth to them using simpler methods. To some extent, this has increased the researcher's confidence in the methods used and has allowed for generalization of the findings. Chapter five will conduct an in-depth analysis in order to establish a framework for technology transfer effectiveness indicators.

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CHAPTER FIVE

Challenges to Securing an Effective Technology Transfer System

5.1 Introduction

The purpose of chapter five is to analyze Qatar's progress toward sustainable development and its technology transfer effectiveness. The chapter will present an overall framework for measuring the effectiveness of technology transfer as it pertains to sustainable development in Qatar. Chapter five will augment the primary and secondary research in chapters four and three respectively, and will fill important gaps that were either beyond the scope of those chapters or left unaddressed due to the limitations in the literature and in the primary research. The secondary research in chapter three fell short on some social information and could not answer why some initiatives in Qatar have not been successfully implemented. Furthermore, the primary research in chapter four could not measure sustainable development and was marred by the unavailability of certain data. This chapter will address these issues.

Structurally, chapter five will mirror the thematic modules in Figure 1.1; it will begin with a discussion of sustainable development in Qatar and assess Qatar's effectiveness in promoting such development. Then, it will assess governance effectiveness at both state and corporate levels. This will give insights into the influence of the internal environment and government policies on sustainable development and technology transfer initiatives. Following this, the chapter will present an assessment of external technology and resources and internal technology transfer measures. Subsequently, chapter five will assess absorptive capacity, value chain, and value networks in Qatar. Finally, it will present competitiveness and research and development indicators to assess innovation sustainability. At the end of above assessments, chapter five will pull all thematic indicators into one holistic framework and assess the risks and challenges that confront technology transfer and sustainable development.

5.2 The Challenges to Sustainable Development in Qatar

"Anyone who believes exponential growth can go on forever in a finite world is either a mad man or an economist."

Kenneth Boulding, Economist

Academic discussion of sustainable development tends to remain fixated on either the national or enterprise level. This dissertation discusses sustainable development both at a particular country's level and at the firm level. Both analyses are important if one is to develop an adequate understanding of the sustainability of technology transfer initiatives and of the challenges and opportunities in the realm of sustainable development.

Different countries have different priorities inherent in their development policies. Qatar's Vision 2030 rests on four priorities: first human development, then social, economic and finally environmental development.[1] The Vision responds to pressing challenges, including balancing modernization and the preservation of traditions, providing for the needs of this generation and of future generations, managing growth and uncontrolled expansion, determining the size and the quality of the expatriate labor force and the selected path of development, and achieving economic growth, social development and environmental management.[2] From a sustainable development perspective, Qatar has employed the basic tenets of the concept, which require an entity to respond to the needs of both this generation and future generations, and to develop the social, economic and environmental arenas. However, some present practices undermine this Vision at the enterprise level and even at the national level.

Mainly, the conflict resides in the country's push for unlimited economical growth and its need to preserve the environment and safeguard future assets. While Qatar's unprecedented growth (discussed in chapter three) gives the illusion of limitlessness, it must have a limit somewhere. Hasn't the national wealth grown enough to improve the well-being of the population? Natural resources, particularly gas and oil, are produced at a cost to the environment; digging, crushing, chemical treatment and pollution cannot be undone, but could be offset.

Logically, apart from scholarly debate about whether there is a limit to growth, the consequence of acting as though natural resources are unlimited is bound to be a collapse of our limited systems. Therefore, Qatar needs to implement effective sustainable development policies that are paced realistically and continue to grow the economy in accordance with its naturally evolving "available" or "induced selective" capacity. To determine whether or not Qatar is doing so, the country's sustainable development initiatives will be analyzed for effectiveness.

Although Qatar has signed international environmental treaties that focus on safeguarding the environment, implementation of these treaties has been slow. This may be partially attributed to human and institutional capacity constraints, but part of the blame also falls on the initial absence of adequate sustainability indicators to highlight immediate needs and priorities. In an effort to move environmental protection forward, Qatar adopted the Johannesburg Plan of Action in 2006, then progressed to establish a set of sustainability indicators modified to suit the country in 2007, and finally began focusing on particular environmental problems that need immediate attention.[3] This is a prime example of the natural evolution of sustainable development initiatives. While it is difficult to establish sustainability indicators that can be universally agreed upon, a set must be established regardless; it is necessary to illustrate whether the environment is improving or deteriorating.

Raising citizen awareness and developing an overall appreciation of the concept of sustainable development is another limiting factor to the implementation of sustainable development plans. While the General Secretariat for Development Planning did well in the initiation and coordination of Qatar's sustainability development plans with the United Nations Development Programme, it did not promote an adequate awareness about sustainability locally (see Johannesburg World Summit 2002 section 2.2 page 2-1). This has affected the timely production of statistical measures of sustainability and has created data gaps.

The third limiting factor to implementing sustainable development plans is institutional. Some institutions view sustainable development as a political project. As Gamsci suggested, sustainable development is a site of political ‘wars of positions’ with the potential for bringing about political and structural change.[4] Other for-profit institutions and market liberals ignore the social consequences of environmental justice issues. Still other institutions adopt the term “sustainable” as label for initiatives that are neither sustainable nor development, or as Tim Luke puts it, sustainable development has become an “ideological construct in contemporary global society,” meaning that it can be defined in a variety of ways.[5] Still other institutions view sustainable development as simply reducing pollution and waste.

Redcliff explains that there is an ongoing tension between control of meaning and discursive processes.[6] Therefore, what is required for these institutions is an overarching body that can use a dialectical, relational approach to integrate the various meanings of sustainable development in a manner that will serve Qatar’s Vision 2030. Although the Ministry of Environment was established in 2008, the country needs more than a mere focus on the environment; it needs to align various institutions’ missions to the Vision 2030. Furthermore, even with environmental governance, other dimensions of sustainability need to be considered, such as the social, economic, moral, legal, and political dimensions.

5.3 In Search of Sustainable Development Indicators

Chapter two provided recommendations for the assessment of sustainable development at the national level. These included indicators such as Green Net National Product (NNP), Genuine Savings, Safe Minimum Standards, and Natural Capital Stock. These sets of measures are more integrated and realistic than the set of measures currently available through the Qatar Secretariat for Development Planning, which has been extracted from the United Nation’s Development Programme’s environmental indicators. However, even with the use of field surveys, this dissertation did not gather sufficient information to measure sustainable development using the suggested indicators because some of the necessary data is unavailable or restricted. Because of this, the dissertation presents available data and an analysis of some of the recommended indicators to begin assessing whether or not Qatar is on a path to sustainable development.

Table 5.1: Qatar's Sustainable Development in Perspective

Overall Peace Index[7]						
	New Zealand	Iraq	Qatar	UAE	Singapore	High
Rank	1	144	16	40	23	
Score	3.341	1.202	1.392	1.667	1.533	
Human Development Index[8]						
	Iceland	Sierra Leone	Qatar	UAE	Singapore	High
Rank	1	177	35	39	25	
Score	0.968	0.336	0.875	0.868	0.922	
Gender Gap Index[9]						
	Norway	Yemen	Qatar	UAE	Singapore	Low
Rank	1	130	119	105	84	
Score	0.8239	0.4664	0.5948	0.622	0.6625	
Life Expectancy[10]						
	Macau	Swaziland	Qatar	UAE	Singapore	Middle
Rank	1	224	80	70	4	
Score	84.36	31.88	75.35	76.11	81.98	
Most Competitive Economy[11]						
	USA	Chad	Qatar	UAE	Singapore	High
Rank	1	134	26	31	5	
Score	5.74	2.85	4.83	4.68	5.53	
Economic Freedom[12]						
	Hong Kong	North Korea	Qatar	UAE	Singapore	High
Rank	1	179	48	54	2	
Score	90	2	65.8	64.7	87.1	
Misery Index[13]						
	Vanuatu[14]	Zimbabwe	Qatar	UAE	Singapore	Middle
Rank	1	195	100	102	32	
Score	0.1	550	14.4	14.4	0.061	
Renewable Energy[15]						
	Iceland	NA	Qatar	UAE	Singapore	Low
Rank	1	NA	NA	NA	NA	
Score	72.60%	NA	0	0	0	
Emission Of Carbon Dioxide Per Capita (tCO_2)[16]						
	Chad	Qatar	Qatar	UAE	Singapore	Low
Rank	1	177	177	2	23	
Score	0	79.3	79.3	34.1	12.3	

Source: Information collected from various sources. See sources' endnote on every index.

Before discussing this analysis and assessment, it is likely to be helpful to offer data on available sustainable development indicators from a few other countries for the purposes of comparison. This data is available in Table 5.1. The table reveals Qatar's rank on a variety of indicators, as well as the highest ranking country, the lowest ranking country, a rival country (the United Arab Emirates), and a country with similar geo-political standing (Singapore).

Table 5.1 clearly illustrates that Qatar ranks high on economic indicators, but not on social and environmental ones. Its comparatively low scores in these areas should be seen as a challenge; Qatar needs to encourage high institutional commitment to sustainable development in the public and private sectors and to establish monitoring agencies to ensure proper participation. Given the relative infancy of the sustainable development movement in Qatar, it may be inevitable that the country's environmental policies will be implemented slowly. However, should sustainability be accepted as a core imperative in policy and governance, one could expect, based on Qatar's history of good economic governance, rapid implementation of environmental, social and economic sustainable development. Monitoring development will be an important part of any movement toward sustainability.

This dissertation has demonstrated that there is no clear and simple framework for presenting sustainable development indicators (see section 4.6 page 4-51). Furthermore, the General Secretariat for Development Planning's selection of sustainable development indicators for Qatar either failed to engage and motivate stakeholders and policy makers to track them or the indicators were unavailable or unknown to potential users. The complexity of choosing sustainability indicators stems from the fact that there are many forms and sets of indicators available to compare countries (composite indicators) or to assess the national or the local levels. The relationships between indicators and objectives are also complicated; should a set of objectives be developed first, with indicators to match, or should a selected indicator or index dictate the objectives? Finally, it is also important to consider whether or not a given indicator can be used at the level of a particular private or public enterprise as well as within the country as a whole. The conclusion to this debate has been presented by Weiss (1983)[17], Shulha and Cousins (1997)[18], Johnson (1998)[19], and Weiss et al. (2005).[20] They assert that the development of indicators should remain intimately connected to the uses one envisions for them; in this way, indicators of sustainable development remain valid and reliable.

Because of the problems discussed above, the GSDP developed the Second Human Development Report for Qatar.[21] In this report, the GSDP displayed data from select years during the past twenty years (including 1990, 2000, 2005, 2006, and 2007) and reflected on trends related to a variety of human development indicators. It adopted the UN Human Development Index, but focused on Qatar's immediate concerns: water scarcity, climate change, and the marine environment. Unfortunately, the GSDP did not include a long term sustainable development vision. It is even possible to question the appropriateness of the GSDP as the governing body for sustainable development. Should the Ministry of Environment head development efforts?

Sustainable development requires collective action. Although hierarchical governance is suitable for ecological sustainable development,[22] sustainable development in other domains must rely on the deliberative processes of businesses and civil organizations, and even social consensus. Therefore, it seems reasonable to conclude that there is no organizational body shaping and governing sustainability efforts in Qatar. Since this study focused on social, environmental and economic sustainability only, these will be discussed in turn starting with social sustainability.

5.3.1 Effectiveness of Qatar's Social Sustainability Initiatives

The preceding chapters recommended that the following social sustainability indicators be used in this study:

1. Rate of population growth
2. Misery Index
3. Living Index
4. Human Development Index (HDI)
5. Index of Sustainable Economic Welfare (ISEW)

Chapter three discussed the major problem that is population explosion in Qatar. Rapid population growth has interfered with almost every aspect of life in the country and is detrimental to sustainable development. The population has tripled in 18 years (Table 5.2). This unprecedented increase in population is the result of a huge influx of expatriate workers - mostly males - to participate in the country's oil, gas and infrastructure development. This is causing increasing demands for housing, energy, water, waste disposal, sewage treatment and many other services. The exceptionally high population growth must be balanced so that quality of life is not sacrificed for future generations. This uncontrolled development mandates a comprehensive urban development plan that adopts a sustainability policy with regard to urban expansion and population distribution.

Table 5.2: Qatar's Demographic Trends

Demographic Trends					
	1990	2000	2005	2006	2007
Total population (millions)	0.4	0.6	0.9	1.0	1.2
Annual population growth rate (%)	3.2	5.1	15.5	15.9	16.3
Total fertility rate (births per woman), Qatari	5.7	4.2	4.2	4.2	4.4

Source: General Secretariat for Development Planning. Advancing Sustainable Development: Second National Human Development Report. GSDP, 2009.

In addition to the rate of population growth, the misery index can also give insights into the economic and social well-being of a country. It is calculated by adding the unemployment rate to the inflation rate. A decreasing index means that the economy in question is improving, and vice versa. In 2008, Qatar's Misery Index was 14.4%, placing Qatar at a rank of 100 out of 192 countries. It is surprising that Qatar performs so poorly on this index given its high GDP per capita and strong economic indicators.

Because data is not available to calculate the Living Index for Qatar, the consumer price index (CPI) will replace it for the purposes of this study (Table 5.3). Increases in the CPI mean that the consumer inflation rate is rising. In 2005, Qatar ranked 92nd out of 172 countries with a CPI of 120.84%. This figure is high and must decrease to reduce the social and economic costs associated with inflation. Unfortunately, the trend in Table 5.4 shows that the CPI is increasing exponentially; in fact, it is rising to percentages that are likely to create economic and social turbulence and could hinder development. The reason, again, is the increase in population and the subsequent increases in demands for limited services and resources.

Table 5.3: Qatar Benchmark in Consumer Price Index

Consumer Price Index						
	Libya	Angola	Qatar	UAE	Singapore	Medium
Rank	1	172	92	95	11	
Score	78.68 %	1,845.91 %	120.84 %	121.7%	103.27 %	

Source: NationMaster, 2005. [online]. [cited 29 August 2009] ;Available At: http://www.nationmaster.com/graph/eco_con_pri_ind-economy-consumer-price-index

Can this be controlled? Looking at Qatar's unique population issues, it can be assumed that CPI will remain high for a long time to come, at least until enough infrastructure is built to accommodate the huge influx of people that rely on the existing infrastructure and services. One possible solution is to dedicate significant portions of Qatar's annual budget to increasing the production of water, electricity, and other infrastructure and utilities. The private sector will spontaneously adjust the supply of housing, food and other services.

Table 5.4: Qatar's CPI Trend

Years	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
CPI	101.4	101.6	104	111.1	120.8	135.1	153.7

Source: The Cooperation Council for the Arab States of the Gulf. Consumer Price Index in GCC States. On 30 Aug 2009 Available At: http://www.gccsg.org/eng/index.php?action=Sec-Show&ID=270

The last indicator in this section is the United Nations Development Programme's Human Development Index (HDI). The HDI combines three basic dimensions of well-being: life expectancy, knowledge and education, and standard of living. A HDI of 0.8 or more is considered to represent "high development." Table 5.1 shows that Qatar ranks 35 out of 177 countries with a high index of 0.875. This indicates that Qatar has noticeable achievements in the area of human development. In particular, it appears that GDP per capita and education contributed to this achievement.

Table 5.5 shows that the GDP per capita has quadrupled in 18 years. Obviously, the return on LNG projects investments can be seen as a major influence on GDP per capita, beginning around 2005. The American State Department estimated that Qatar had a population of about 650,000 in 2002, of which 150,000 were Qatari nationals. If the annual rate of population increase is 4%, then Qatar's native population will reach around 180,000 in 2007. If the calculation of the GDP per capita were based on the real population of Qatar and did not include the expatriates, the GDP per capita would total US$ 400,000, a figure that has not been reached anywhere in the world. Why is GDP calculated in a manner that includes temporary labour? More broadly, the use of temporary labour as part of the population will result in misleading economical, social and environmental statistics. For example, when temporary labourers are included, the figure for CO2 emissions per capita is reduced.

Table 5.5: Qatar's GDP per Capita Trend

Years	**1990**	**2000**	**2005**	**2006**	**2007**
GDP per capita (US$)	15,004	27,214	49,228	57,330	61,528

Source: General Secretariat for Development Planning. Advancing Sustainable Development: Second National Human Development Report. GSDP, 2009.

The 2007-2008 Human Development Index (HDI) report did not include any of the values that are listed in Table 5.6. However, among the high human development countries, the average expenditures on education are as follows:[23]

1. Education budget as a percent of GDP = 5.1 %
2. Education budget as a percent of government spending = 14.2%

Qatar's education spending is lower than the average among high human development countries.

Table 5.6: Qatar's Budget for Education

Years	**1990**	**2000**	**2005**	**2006**	**2007**
As % of GDP	4.24	2.98	3.49	2.30	3.24
As % of Government Spending	10.18	9.41	12.71	8.04	11.23

Source: General Secretariat for Development Planning. Advancing Sustainable Development: Second National Human Development Report. GSDP, 2009.

The global community has demonstrated overwhelming acceptance of the HDI as a measure of human development advances. The index is simple, provides a summative measure of human development, and has brought the global community together. However, the measures adopted in the HDI can also invite debate on the meaning of development. The HDI has received criticism for the manner in which it weights items, for distribution and measurement issues, and for its intended goals. With respect to sustainable development, this dissertation has two concerns in relation to the HDI. First, the inadequacy of the HDI's ecological assessment is a major drawback and mandates that it be strengthened with other data to adequately represent each country's environmental development status. Another concern is related to educational attainment. To judge educational output, the HDI uses literacy rates and enrollment in schools. However, these figures will not reflect real absorptive capacity. There is a need to compare educational achievements through assessments like the OECD's Programme for International Student Assessment (PISA), Progress in International Reading Literacy Study (PIRLS), and Trends in International Mathematics and Science Study (TIMMS). The 2006 PISA and PIRLS results show that Qatar is way down the list with scores of 353 in reading, 318 in math and 351 in science achievements. TIMMS results reinforced the math results with a score of 296 for Qatar. The OECD's average score is about 500 in every subject tested in PISA, TIMMS or PIRLS.[24]

Economic growth and economic welfare are two different concepts. GDP has been used for a long time as a normative benchmark for economic and social performance. Over the years, economic researchers have noticed a widening gap between economic growth and quality of life and have created alternative indicators to measure economic welfare, of which the Index of Sustainable Economic Welfare (ISEW) is the most widely accepted.[25] The ISEW indicator is measured in three steps. The first step measures the consumption base. In other words, it measures what could be consumed given the actual extent of production. The consumption base consists of private and public consumption, household production and future welfare increase due to investment. The second step subtracts environmental and social defensive costs and future welfare reductions from the first step. These are economic activities that do not contribute to economic welfare or are required for protection. In the third step, the result is weighted by an index for the inequality in the distribution of income and labor.

The most obvious obstacle to using the ISEW indicator is that of data availability. As a result, errors in calculations may take place.[26] Daly acknowledges the difficulties in constructing a better indicator of welfare, but also sees that the ISEW's promise to measure welfare and sustainability is not credible.[27] Therefore, this study recommends that, because of the absence of data, the ISEW be augmented with other social indicators specifically intended to measure social sustainability.

With regard to social sustainability in Qatar, this dissertation found that Qatar is not yet on the path of social sustainability (see Social Capital under section 4.5.5 page 4-40) and has to manage the population growth that currently interferes with the day-to-day wellbeing of its citizens. The ultimate goal of social development is to improve and enhance the quality of life of all people. The Misery Index and the CPI suggest that good social governance is needed to increase social opportunities, welfare, and participation in civil society, and to strengthen supportive institutions and policies that promote social equity.

5.3.2 Effectiveness of Qatar's Environmental Sustainability Initiatives

Chapter two recommended the use of the following indicators to measure environmental sustainability (see section 2.2.3 page 2-4):

1. Ecological Footprint
2. Environmental Space
3. Net Primary Production (NPP)

The Ecological Footprint measures humans' impact on the planet in terms of the land and water needed to produce the resources used and to absorb the waste produced.[28] A country's footprint is the sum of all the arable land, grazing land, forest and fishing grounds required to produce the food, fiber and timber it consumes. In 2005, the single largest demand humanity put on the planet was its carbon footprint, which grew more than tenfold from 1961. Carbon footprint is the total amount of greenhouse gas emissions caused directly and indirectly by an individual, organization, event or product.[29] Data limitations prevented the production of a valid ecological footprint calculation for Qatar. However, the average citizen in Qatar is estimated to produce 11.4 tonnes CO_2 with an ecological footprint of 5.5 global hectares.[30] If everyone on this planet lived like a Qatari, we would need 3.4 planets to support global consumption. Industries' and other businesses' carbon footprints can be calculated through specialized agents or through calculators available online.

In the absence of a reliable measure of Qatar's ecological footprint, this study will estimate the "use of renewable energy" portion of the ecological and water footprint. Growth in the use of renewable energy is nonexistent in Qatar. There is no growth in the use of wind power, hydroelectricity, solar energy, or bio-energy. There are also no plans to use carbon sink to phase out the remaining emissions from conventional industrial fossil fuels.

The water footprint of a country is the total volume of water used to produce the physical goods and intangible services consumed by its population. The total water footprint of a country is made up of a combination of internal and external water footprint. Qatar experiences severe water stress. Qatar's total water footprint consumption in 1997-2001 was 1087 m^3/person/yr, which raises the stress on water resources to 546% (100% is considered severe stress).[31]

The environmental space concept "reflects that at any given point in time, there are limits to the amount of environmental pressure that the Earth's ecosystems can handle without irreversible damage to these systems or to the life support processes that they enable."[32] It suggests that sustainability policies should consider reducing resource consumption and should encourage the production of more efficient resources. Qatar's total carbon emissions from fossil fuels have increased considerably over the last two decades. Qatar's carbon footprint can be expected to expand over the next decade, with potential long-term negative consequences for human development unless a radical solution is implemented. The carbon emissions will lead to losses in agricultural production and food security; water stress and water insecurity; rising sea levels and exposure to climatic disasters; damage to ecosystems and biodiversity; and negative impacts on human health.[33] Looking at the carbon dioxide emission by sector for the year 2006, it is found that the oil and gas industry accounted for about 70% of the total national emissions; about 60 percentage points are due to upstream operations. Two other major sources of carbon dioxide emissions were the electricity and water sector, which significantly increased its contribution to the national total, and the road transport and building and construction sectors. Both of these increases can be attributed at least in part to population growth.

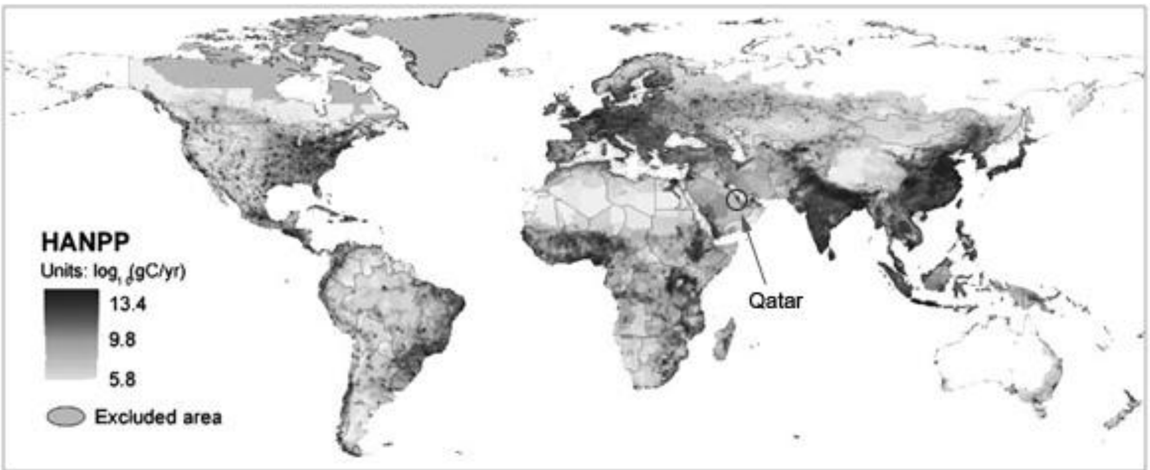
Table 5.7: Carbon Footprint

	Qatar Ranked 60th for Total Carbon Dioxide Emission in 2006, But Ranked 1st for Per Capita Emission Because of its Small Population			
Country	Total CO_2 Emission (thousand metric tonnes per year)	World Ranking	Per Capita CO_2 Emission (metric tonnes per year)	World Ranking
Qatar	12,598	60	12.1	1
Kuwait	23,618	42	9.4	2
UAE	38,060	32	9.0	3
Bahrain	5,807	79	7.8	4
United States	1,568,806	2	5.2	9
Oman	11,285	66	4.4	13
Saudi Arabia	104,063	15	4.4	14
Brunei	1,612	111	4.2	15
Singapore	15,332	54	3.4	21

Source: General Secretariat for Development Planning. *Advancing Sustainable Development: Second National Human Development Report*. GSDP, 2009. p. 104

The intensity of land use is a major indicator for measuring sustainability in our ecosystems. Gross primary production (GPP) is "the rate at which an ecosystem's producers capture and store a given amount of chemical energy as biomass in a given length of time."[34] A small part of this energy is used for cellular respiration. The remaining fixed energy is referred to as net primary production (NPP). NPP, then, is equal to GPP minus respiration. Both gross and net primary production are measured in units of mass / area / time. For global ecosystems, mass of carbon per unit area per year (g $C/m^2/yr$) is used most often as the unit of measurement. This study is interested in the human effect on the NPP, or what Hebrel calls "Human Appropriation of NPP" (HANPP)[35], which can be calculated by subtracting the remaining biomass after harvest from NPP. In the absence of tabulated data, a creative way of reading the world's HANPP is available through satellite image and presented in Figure 5.1 below.

Figure 5.1: Map of Global HANPP

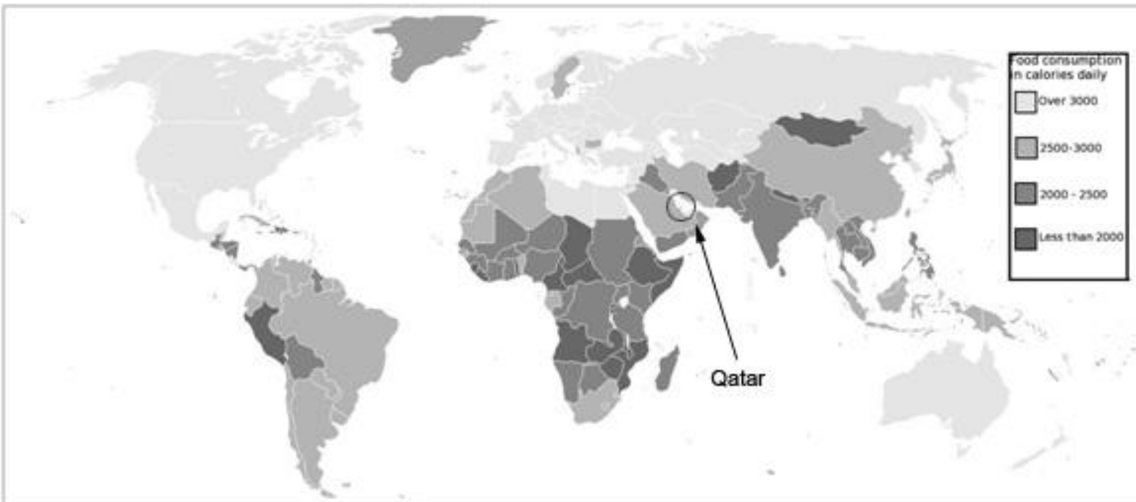


Note: Darkest areas indicate where human demand is highest**.** Marc Imhoff, a biophysical scientist, measured HANPP using satellite data from the Advanced Very High Resolution Radiometer instrument.
Source: Imhoff M, Bounoua L. Exploring Global Patterns of Net Primary Production Carbon Supply and Demand Using Satellite Observations and Statistical Data. *Journal of Geophysical Research,* 2006, 111

When mapping the above with regard to the average daily calories consumed (Figure 5.2), it is noted that Qatar's production of biomass is almost nil, whereas its consumption of food is very high. This indicates Qatar's reliance on other countries for food, creating pressure on the global ecosystem. However, it is also noted that other countries such as India and some African and Asian countries produce more than they consume, indicating a surplus that is expected to be exported.

Climate footprint is a representation of the human effect on the climate in terms of the total amount of greenhouse gases produced. Although the term is identical to carbon footprint, the term is preferred because it focuses the discussion on climate change. The Intergovernmental Panel on Climate Change has established a consensus that climate change is clearly linked to human activity and the focus is on strategic action involving national and international cooperation.[36] Because of human activity, the panel predicts that changes in temperatures, sea levels and weather patterns are likely to continue to change in the future. Industrial activity using fossil fuel has resulted in significant increases in the concentration of atmospheric carbon dioxide. Climate change can hinder sustainable development through its impact on human and natural systems.[37]

Figure 5.2: Average Daily Calorie Consumption



Source: Wikipedia, the Free Encyclopedia. *Food*. [online]. [cited 2 September 2009]. Available At: http://en.wikipedia.org/wiki/Food

Arable land and water resources in Qatar are scarce; it will be difficult for the country to develop carbon sinks and forests. Therefore, Qatar is vulnerable to climate change impacts. Rising temperatures will increase water demand and water salinity. This, in turn, will threaten water security and affect the efficiency of desalination plants, which are the main sources of water in Qatar. Furthermore, according to Dasgupta, Qatar is ranked among the top ten countries in the world that will suffer land loss as sea levels rise. [38]

The issue of climate change is addressed on both global and national levels. Globally, the UNDP allocates certain cuts of CO_2 emissions for both developed and underdeveloped countries.[39] Also, the United Nations Framework Convention on Climate Change (UNFCCC) is a treaty designed to decrease CO_2 emissions by further reducing flaring (the burning of natural gas wastes).[40] Furthermore, the Kyoto Protocol places a heavier burden of responsibility on developed countries and stipulates that a country’s actual emissions have to be monitored and precise records have to be kept.[41] At the national level, in addition to developing its National Vision 2030, Qatar has invested in research and development, become an active participant in the UNFCCC, and formed the National Committee for Climate Change under the Ministry of Environment.

In order to mitigate the causes and effects of climate change, Qatar will have to overcome many technical, economic, political, cultural, social, and institutional barriers. Comprehensive policies that limit CO_2 emissions would be the most effective response. These policies must be integrated with local entities' objectives to achieve long term sustainable development. Qatar must conform to international treaties and coordinate its actions with those of other countries to help reduce mitigation costs, competitiveness concerns, and potential conflicts with international rules. To achieve this, Qatar should promote innovation in manufacturing technology, encourage the development of industrial clusters with integrated resource management systems, seek innovation in materials management, and promote social economy groups and networks for recycling where relevant.

In sum, if Qatar hopes to address environmental concerns, it should pursue population control, reduce individual consumption (see section 3.3.2 page 3-8), encourage the development of technological innovations that increase the efficiency of resource use (see section 4.5.2 page 4-16), optimize the relationship between the distance food is transported and the efficiency with which it can be locally produced, work toward energy efficiency in residential and commercial buildings, increase recycling, and develop alternatives to fossil fuels (see section 2.2.3 page 2-4).

5.3.3 Effectiveness of Qatar's Economic Sustainability Initiatives

Surging GDP growth has made Qatar one of the richest countries in the world. In 2007, per-capita GDP was estimated at US$ 70,754. The IMF predicts impressive growth rates for the Qatari economy. Between 2008 and 2012, the average annual growth rate is projected to be 12.3%, which would grow the real GDP to US$ 134.4 billion by 2012.[42] However, Qatar's economic growth has led to inflation, higher annual energy consumption, and increased industrial solid waste. This is an indication that the state is depleting its environmental resources and hence, current economic development is not on a sustainable path. It can be argued, then, that indicators of Qatar’s economic well-being – whether they are published by local organizations like the GSDP or by international organizations like the UNDP, World Bank, or Standards & Poor's - do not account for the sustainability of Qatar’s economic condition.

Qatar needs to ensure that its development will not compromise the ability of future generations to meet their needs. Economic sustainability focuses on stable economic growth. Generally, Qatar uses GDP as an indicator of economic growth. This study found that GDP falls short as a measure of economic growth because it does not indicate whether or not growth is sustainable, it does not account for the depletion of natural capital, and it does not consider environment damage. Therefore, if GDP is relied upon, future generations will inherent much depleted resources and an inferior quality of life. It is necessary, then, to look for more accurate measures of economic growth. This study found that there is no single indicator that accurately measures economic sustainability and therefore, it recommended that an integrated set of economic measures be used to achieve this goal (see section 2.2.4 Page 2-5). The indicators are:

1. Green Net National Product (Green NNP)
2. Genuine Savings
3. Safe Minimum Standards
4. Natural Capital Stock

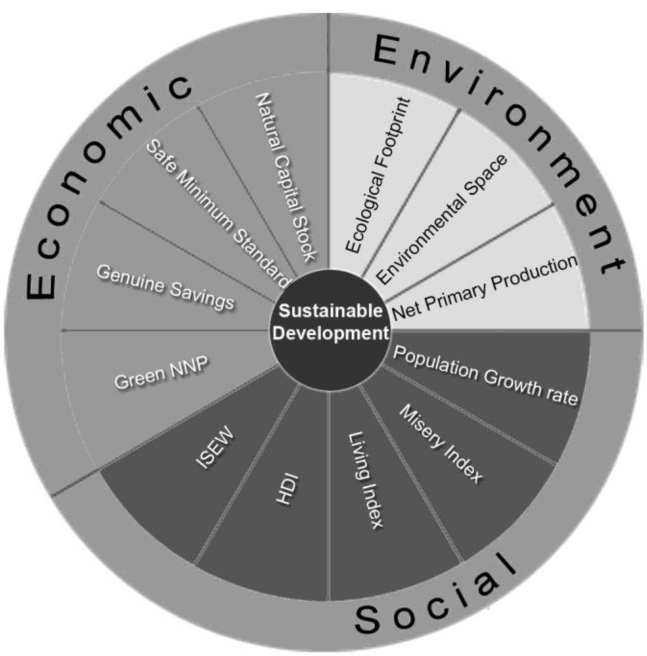
Green NNP is more accurate than GDP for two reasons: it accounts for net changes in the stock of natural capital, and it accounts for the value of environmental damages. This indicator measures sustainability and changes in welfare accurately. It can also calculate consumption levels that do not reduce wealth. If the Green NNP is high, it indicates sustainability. However, it is not a good measure of lack of sustainability. For this reason, the study has integrated Genuine Savings (GS) with it.

GS measures savings with change in capital stock and environmental damage. If GS is negative, development is unsustainable. As a solution to negative GS, countries can either reduce consumption, increase investment or both.[43] The problem with GS is that it may reflect non-negative figures even when natural capital is being depleted if adequate man-made capital exists. To correct this, natural capital stock is integrated with the set of indicators.

Natural capital stock establishes a constant amount of natural capital stock that yields a flow of valuable ecosystem goods or services into the future. With Safe Minimum Standard levels, natural capital stock levels will be monitored. Therefore, these two indicators must be viewed simultaneously to accurately assess economic sustainability.

With respect to social, environmental, and economic sustainability in Qatar, then, this dissertation reviewed the consistency and meaningfulness of ten sustainability indices that are widely used in policy practice (Figure 5.3):

Figure 5.3: Sustainable Development Indicators Recommended for Qatar



Source: Sustainable development indicators recommended in this study

Although the sustainability indicators are intended to be concise and transparent, they fail to meet fundamental scientific principles with respect to normalization, weighting, and aggregation.[44] Normalization and weighting of indicators are done both subjectively and randomly, while for aggregation, rules of consistency are seldom taken into account. As a consequence, the sustainability indicators currently used are useless if not misleading. As for Qatar, this study attempted to treat the above deficiency through the integration of several indicators to ultimately present the most accurate assessment of sustainable development possible. Unfortunately, even with field surveys, this dissertation did not gather sufficient information to measure sustainable development using the optimum set of measures. The government of Qatar does not publish some data for undeclared reasons. This does not mean that other measures should be substituted; the measures chosen above must be presented in concert to provide an accurate understanding of sustainable development in Qatar. It is up to Qatar, then, to pursue the establishment of a national-level database to monitor the above recommended sustainability development indices.

Qualitative analysis within this study helps to explain Qatar's attitude towards governing sustainable development and technology transfer. The next paragraphs will discuss governance in the country and the reasons behind Qatar's attitude towards development.

5.4 Good Governance and Internal Environment Influence

Qatar has many positive aspects; these include extensive natural resources, a strong economy, excellent policies and initiatives, international agreements and treaties with regard to sustainable development, good laws, ambitious industrial plans, and a vibrant market. The political and economic environments are catalysts to development and technology. Qatar is now faced with a responsibility to use its strengths to secure a high quality of life for both current and future generations. Human and natural resources must be developed responsibly in order for Qatar's growth to be sustainable. Applying principles of sustainability would increase prosperity, strengthen human rights, protect the environment, and enhance employment. Table 5.8 summarizes the weak areas of the internal environment, as discussed in chapter three.

After presenting a thorough analysis, chapter three ended with the conclusion that most government laws related to sustainable development and technology transfer do not increase sustainable development or technology transfer; rather, they focus on economic growth. Qatar has no long-term industrial policy. It controls its oil and gas industry only through medium-term plans. In fact, the most beneficial policy changes related to globalization appear to be the result of international pressure. Other reforms relate to rivalries with neighbouring states. Each policy is subject to further change or suspension should social or regional pressures change. These government-driven changes prevent the development of indigenous absorptive capacity, value chain, value networks, and R&D (see section 2.4.5 page 2-35). Therefore, as a result of secondary research, it may be concluded that Qatar does not govern its sustainable development and technology transfer efficiently. This conclusion may seem surprising in light of the fact that many internal and external analysts believe Qatar's development to be impressive.

Table 5.8: Weaknesses within the Internal Environment

No.	**Weak Area of Internal Environment**
1	Reluctance to Globalize
2	Protectionist Trade Policy
3	Small Private Sector
4	Limited Foreign Direct Investment
5	Low Human Capacity
6	Struggle Between Preservation of Traditions and Modernization
7	Destructive Management Attitudes
8	Lack of Quality Statistics
9	Weak R&D
10	Inadequate Labour Regulations

Source: Summary of Discussion in Chapter Three

Practicing good governance entails reducing state intervention in economic decision-making, making the public sector more efficient and transparent, freeing markets, eliminating unnecessary public subsidies, and increasing integration into the world economy generally. This includes economic liberalization, transparency and accountability, democratic reforms, elimination of corruption, the promotion of a civil society, freedom of expression, freedom of assembly, freedom of arbitrary imprisonment, and the adoption of policies to safeguard education, health and the environment.[45]

One indication of a movement toward good governance is a reduction in the state's role in the economic life of the private sector and the lives of public citizens. However, reducing the role of the state in society's economic life definitely creates strong power centers outside of government control. The government instead becomes another economic player that must negotiate terms with these power centers, and this inevitably leads to more openness and accountability. However, this reduction of government interference must not apply to areas related to Qatar's development, such as sustainability. The development model must include a balanced government that directs the development process and controls the means of production, particularly in the industrial sphere, but that still allows the private sector to assume its role in the development process.

Historical sociopolitical and socioeconomic circumstances in Qatar played a direct role in increasing state control over social life. Because the Qatari government's major revenue source is derived from its natural resources, and not taxes, it is less obliged to respond to the demands of the people. Qatar's monarchy is hence isolated from its society by virtue of rent.[46] Without taxes, the government can pursue its agenda without accountability because of decreased political participation. The bourgeois have also limited the state's accountability to its people by aligning themselves with the state. Some measure of true democracy, then, may need to be added to the set of sustainability indicators. To a lesser extent, economic liberalization might indicate that the societal preconditions exist for democratic reform.

Luciani argues that countries with access to oil rent naturally discourage political participation, but agrees that financial crises press for some sort of democratization.[47] This works because the state "buys off" its population through expensive services such as health care, an expansive educational system, subsidized housing, electricity, and a number of other services. However, what Qatar needs is real reform, not services. Internationally and domestically, the perception is that the changes Qatar has made are sincere and will lead to the interdependence with the global economy. However, the actual reforms that have been implemented thus far have tended to be "superficial, very selective and can easily change."[48] Reform has been driven by dissatisfaction with unprofessional leadership, lack of management skills, exponential population growth and fluctuations in oil prices. The state has also responded to pressures for a strong reassertion of traditional Islamic values.

Traditional modernization theory fails to account for the incompatibility between Western and Islamic cultures. Some Western institutions regard Qatar's local institutions as weak and unproductive. In self-defense and as a means to shy away from confronting such allegations, Islamic extremists criticize Western political and social institutions on cultural grounds. However, moderates will hear criticisms as long as Islamic principles are not threatened. Thus, the Western countries have opened the door to critique.

Western countries are not blameless themselves. Often, they advocate good governance, economic liberalization and globalization because it suits their economic interests. At the same time, they create trade barriers that protect their own producers and impose greater standards on less developed countries. Furthermore, these developed economic powers often overlook human rights abuses, detrimental environment policies, corruption, and other governmental misconduct.

Irrespective of the above, it remains that good governance has led to successful reforms in other countries. Good governance needs basic political and social reforms to facilitate and secure economic changes, even though these may jeopardize the West's economic interests. The key message emerging from this discussion is that Qatar's development strategy needs to move beyond mere talk about sustainability and actually deliver it. The vision must focus on creating a better quality of life for this and future generations. Development policies must guide actions to allow competition within sustainable limits and must empower society to participate in its own governance. Many municipalities and civil sectors have to take important steps towards better understanding and implementing sustainability strategies within their communities. Qatar's immediate priorities must be the sustainability of its population size, consumption, and production, with attention to climate change, natural resource protection, and human capacity building. Without the right indicators, decision makers will act in an environment of great uncertainty. The process of designing sustainability measures must balance policy relevance and scientific accuracy; otherwise, decision makers will fail to respect the policies they are expected to serve (see section 2.2.2 page 23).

Sustainable development policies must be comprehensive and able to accommodate social, economic and environmental objectives. The myth that sustainable development refers only to the preservation of the environment must be dispelled. The Ministry of Environment alone will not be able to enforce sustainability policies due to its limited resources and inability to bring a variety of stakeholders to the table. Therefore, the responsibility for achieving the sustainability portion of National Vision 2030 resides in every entity in Qatar. Under the overarching national sustainability vision, existing arbitrary actions will be replaced by long term plans and investment in new technologies that solve problems and enhance efficiencies. Policies must also integrate international efforts to achieve sustainability in development.

Sustainable development governance is similar to crisis management in that the highest authority in the country needs to mitigate its impacts and coordinate its response. Therefore, the Ruler (the Emir) or the next in command (Heir Apparent) or better still, the Prime Minister, should lead representatives and heads of other institutions (who will be appointed as sustainability development committee presidents heading their sub-committees). All ministries and departments are then required to develop sustainable development action plans that align with National Vision 2030. The government's responsibility is to strengthen leadership capacity and skills for all departments through training, knowledge sharing and networking with experts at the national, regional and international levels. The objective is to encourage firms to develop the tools necessary to measure the social and environmental impact of their activities. Then, these departments must share their sustainability measurements through a national database using the integrated sets of indicators recommended earlier. Finally, the government must work with community stakeholders to improve access to information, develop community learning capacity with regard to sustainable programmes, include sustainability standards in work policies, and increase volunteer work.

5.4.1 Corporate Governance

Good governance is also needed at the corporate level. Porter believes that environmental policies, when designed well, may produce innovations that can offset their implementation costs.[49] Qatar's government can serve as a networking hub through which businesses can collaborate and share innovations. This is achieved through flexible sustainable development policies. For example, the Japanese established the Environmental Partnership Organizing Club in 2000. Since its inception, all business leaders and companies have worked together to reduce the environmental impact of their operations. Through the club, industry, government, universities, and citizens have cooperated as equal partners. In addition to forming a hub, firms can encourage communication about sustainable development initiatives through their annual reports or through the creation of certification and standards.

For many business leaders in Qatar, the concept of sustainable development remains abstract and theoretical. Business leaders must translate sustainable development into opportunities that fit well with their current business strategies. Promoting sustainable development is an excellent business strategy in itself. Firms with "green eco-efficient products" and environmentally safe materials and processes will have a competitive advantage.

Aside from exploring the "fit" between sustainable development and business, this dissertation asks, "What should Qatar's firms do to respond to environmental problems, population change, globalization and poverty?" While there are other business challenges related to sustainable development, these societal issues have been chosen because each entity must confront them.

With respect to the environment, business leaders need to understand environmental challenges and the trends towards innovative technologies. Then, it must engage stakeholders to design innovative technologies and to advocate for policy solutions.

Businesses must invest in green technologies, drive down costs and increase capabilities. Finally, in addition to profitability, they can measure each strategy's success through its impact on the environment and future markets.[50]

When looking at Qatar's population, business leaders need to understand the educational system and assess the educational needs of the country's growing population. Collaborating with stakeholders, business leaders can design company-led solutions to increase skill levels in both the company and the community. Finally, each business leader can use the educational attainment of its workforce as an indicator of the health of his or her company (see section 2.4.5 page 2-38).

To integrate globally, business leaders need to understand global workforce responsibility and must engage stakeholders in a plan to make the most of each employee's talents. Each business needs to develop policies and practices that eliminate discrimination and advance employees based on their merits. Success in this realm can be measured through diversity and employee attitudes.

In order to address poverty, business leaders must come to an understanding of the needs of low-income individuals so that they can design affordable products and seek opportunities to build markets. Then, companies can develop new business models and invest in new markets. This strategy can be measured through future potential and current sales.

Integrating the findings and discussions in chapter two, three, and four, and the above on good governance, this study concludes that with respect to the indicators of good governance, Qatar's current state is as follows:

1. Accountability: Qatar lacks key performance indicators.
2. Participation: Qatar evinces high state control.
3. Transparency: There is only low level sharing of sustainable development (SD) & technological information.

4. Legal Framework: No policies exist for promoting technology transfer, sustainable development, or innovation.
5. Public and Private Enterprises' Effectiveness: These lack business sophistication.
6. Social Development: The government supports society.
7. Culture and Modernization: There are incompatible values here.
8. Globalization: There is reluctance on the part of the government to globalize.
9. Democracy: There are stagnant initiatives in this realm.
10. Economic Liberalization: Financial crisis pressure has created a push for liberalization.
11. Vision and Priorities: Qatar has created National Vision 2030.
12. International Cooperation in SD and TT: There are low communication levels here.
13. SD Organization and Governance: There are uncoordinated organizational efforts on this front.
14. Leadership Capacity: Qatar's leadership capacity is underdeveloped.

5.5 Technology Transfer Indicators

Technology is important to long term growth. With innovative technologies, a country can raise its capital and internal resources, improve existing goods and reduce production costs. The discussion of the effects of external technology and resources on local corporate technology transfer effectiveness follows two trajectories: the external technology and resources, and internal technology transfer measures. The two trajectories share many similar effects, and therefore, for conciseness, the discussion under external technology and resources will focus solely on sources of technology transfer while the discussion under internal technology transfer measures will cover topics like the number of licenses, sources of technology transfer, the current number of technology transfer projects, the number of licenses for external technology, ratings of new technology success, ratings of organizations' information scanning systems, percentage of new products using foreign technology, sales due to products using foreign technology, profitability of products using foreign technology, degree of understanding of technology transfer, and barriers to technology transfer.

5.5.1 External Technology and Resources

The main sources for technology transfer within or to Qatar's enterprises are the employment of experts, technical consultancy contracts, the purchase of machinery supplies, joint ventures and the purchase of total process contracting (see section 4.5.1 page 4-15). These methods are evidence of the unwillingness or inability of most major industrial enterprises in Qatar to take risks. The use of these methods also leads to a lack of competitive commercial and technological skills. However, what is important here is to determine whether or not these methods will lead to sustainability in the field of technology. Thus, each technique will be examined with this as the focus.

As demonstrated in the survey responses, the employment of experts is temporary and costly. Technology is rarely transferred or sustained because the experts typically focus on sustaining operations rather than building sustainable technological skills. A similar argument can be made with regard to total process contracting and technical consultancy contracts. In most cases, the consultant will temporarily employ experts to operate the technology.

With regard to joint ventures, QP has the highest investment share in this domain. Foreign investors typically share no more that 25% of any venture. The benefits of joint ventures often include access to new markets and distribution channels, the sharing of risks and costs with a partner, and access to specialised staff, technology and finance resources. However, one major drawback to joint ventures is that the different objectives, cultures and management styles of each partner can result in poor integration and co-operation. Also, the partners do not transfer leadership and technical skills beyond the joint venture's initiation phases. Ultimately, then, the joint venture method, though suitable to leaders and managers in Qatar, has not produced self-reliance and sustainability because technology transfer is not happening effectively. Because the firms in Qatar that typically engage in joint ventures often lack many sustainable marketing and technological skills, and since local industries – particularly the energy industry - have been working with joint ventures since the fifties, it can be concluded that such arrangements have not worked in favour of transferring technology. Therefore, the number of joint ventures is not a good indicator of technology transfer. Unfortunately, trend analysis indicates that joint ventures are increasing.

Currently, the Qatari government hopes to substantially increase foreign direct investment (FDI). FDI replaces foreign loans and assistance. It also enhances the rate of technology transfer and gives companies access to the global market. Qatar does not publish information on FDI. However, the inflow of FDI into Qatar is typically a resource-seeking type focused on petroleum and LNG trade. In 2007, the World Investment Report ranked Qatar 110 of 141 for inward FDI performance and 25 for outward FDI. Qatar's inward FDI rose from US$ 159 million in 2006 to US$ 1.14 billion in 2007. Outward flowing FDI jumped 41 times to reach US$ 5.26 billion in 2007.[51] Collectively, the trade and service sectors account for the greatest share of foreign direct investment. Also, the government recently allowed FDI in the gas sector, prompting the initiation of a number of large projects. This may explain part of FDI inflow increase.

Kokko, Borensztein, Aitken and Harrison, and Xu have examined FDI as a channel of technology transfer. The empirical findings of their studies are substantially different from one another.[52] Kokko, Borensztein et al. and Xu show that positive spillovers are more likely if the technology gap between foreign and domestic firms is narrow and if human capital is available.[53] Aitken and Harrison find that the spillover is negative and gain from FDI is captured by joint ventures.[54]

The recent investment reforms to encourage FDI have helped build a legal and economic system consistent with free market values and an outward looking economy. Still, these initiatives may need time to develop, since this study finds that FDI in the short term is affected mainly by GDP and government spending. Government spending is strongly linked with fluctuating energy prices. This creates an unstable environment for investors. Moreover, the investment environment is still riddled with an inadequately educated workforce, an inefficient and bureaucratic government, restrictive labor regulations, an inadequate supply of infrastructure, inadequate access to financing, and a poor work ethic in the national labor force.[55] These topics will be examined further in subsequent sections in this chapter. The above indicates that Qatar should insist on creating an economic atmosphere that is attractive to foreign direct investment. However, because Qatar's technology gap is wide and studies indicate that spillover occurs when gaps are narrow, using FDI as a measure of technology transfer effectiveness is not recommended.

According to Barry Bozeman, the most effective way to measure the success of technology transfer from external sources is to track participation in research centers. Following this, one could also track sales of patents, copyrights, and licenses, and the use of cooperative R&D to measure technology transfer.[56] Translating this into a set of indicators, then, it is recommended that the following indicators related to external technology be used:

1. Number of staff in R&D
2. Patents income
3. Copyright income
4. License income
5. Return on R&D investment
6. The level of cooperation reached with each agreement between an institution and a R&D center on the following matrix: networking, cooperation, coordination, coalition, or collaboration.

This study has already assessed external technology using indicators one and six (see sections 4.5.5 and 4.5.6), but because either data was unavailable or the practice was not in use, the remaining indicators could not be assessed. Therefore, it is not possible to draw conclusions regard the effectiveness of technology transfer from external sources.

5.5.2 Internal Technology Transfer Measures

Technology transfer as a discipline is not even in its infancy in Qatar. Survey respondents interpreted the concept as transfer of equipment, transfer of knowledge, or both (section 4.5.2 page 4-16). Technology transfer projects in which employees or citizens are exposed to new technology and could absorb scientific or technologic skills are an important indicator of internal technology transfer. The survey results revealed that every organization had at least one ongoing project in which the organization could absorb the technology it was using. It was noted that the information technology infrastructure is thriving with many projects.

This indicator has to be included among many others. One of these is licenses income, a measure that replaced the more desirable “number of licenses” indicator due to lack of data. License revenue for local entities was generally from copyrighted computer software applications. More careful analysis revealed that these licenses produced income in the opposite direction: the income went to the (external) source and not the enterprise. The added value of an application may be an indicator that could offset the license rent, but this would be difficult to determine. To make the above point more concrete, it was noted that American Universities operating in Qatar, such as Carnegie Mellon, were the ultimate recipients of license revenue. Thus, in 2008 Qatar University registered no licenses while Carnegie Mellon registered 23 licenses.

Next, the study attempted to ascertain whether or not acquired technologies met organizations’ requirements. All respondents affirmed the value of technology, which presents a strong argument for the acquisition of technology. However, it is recommended that questions pertaining to the match between technologies and organizational needs be revised to allow for a greater range of responses. As it was phrased, the question only asked if the organization met with success, partial success or no success.

Another important indicator is environmental scanning. Environmental scanning means acquiring and using information from the external environment to plan an organization's future course of action. Organizations scan the environment to understand change and develop effective responses. Managers scan to gain competitive advantage and improve strategic plans.[57] Ninety-five percent of respondents indicated that their scanning systems are advantageous and useful. With regard to marketing, this result seems appropriate. However, with respect to science and technology, there is not evidence of scanning in enterprise output as there is in marketing. To gain a better understanding of environmental scanning, it is recommended that other measures replace this question; in particular, looking at the budget for each organization's scanning system (market research, database subscriptions, travel, library, information center, and records management) might be useful.[58]

Another way to assess internal technology resources is to ascertain the level of use of local technology. However, because almost all of enterprises surveyed use external technology, this measure was deemed ineffective.

Finally, the last important piece of any assessment of the internal technological environment is a catalogue of the factors that block technology transfer. Lack of knowledge and R&D effectiveness are the biggest obstacles in Qatar. Policy makers must immediately address technological and research skills gaps and emphasize them as national priorities (see Performance Management under section 4.5.4 page 4-34).

The results of the assessment of the internal technology environment in Qatar clearly demonstrates that the country is replete with inefficient enterprises that depend on external technology and joint ventures, have skill gaps, and lack innovation. This assessment procedure, with the few minor adjustment mentioned, would be easy to use and could produce valuable insights.

5.5.3 Absorptive Capacity

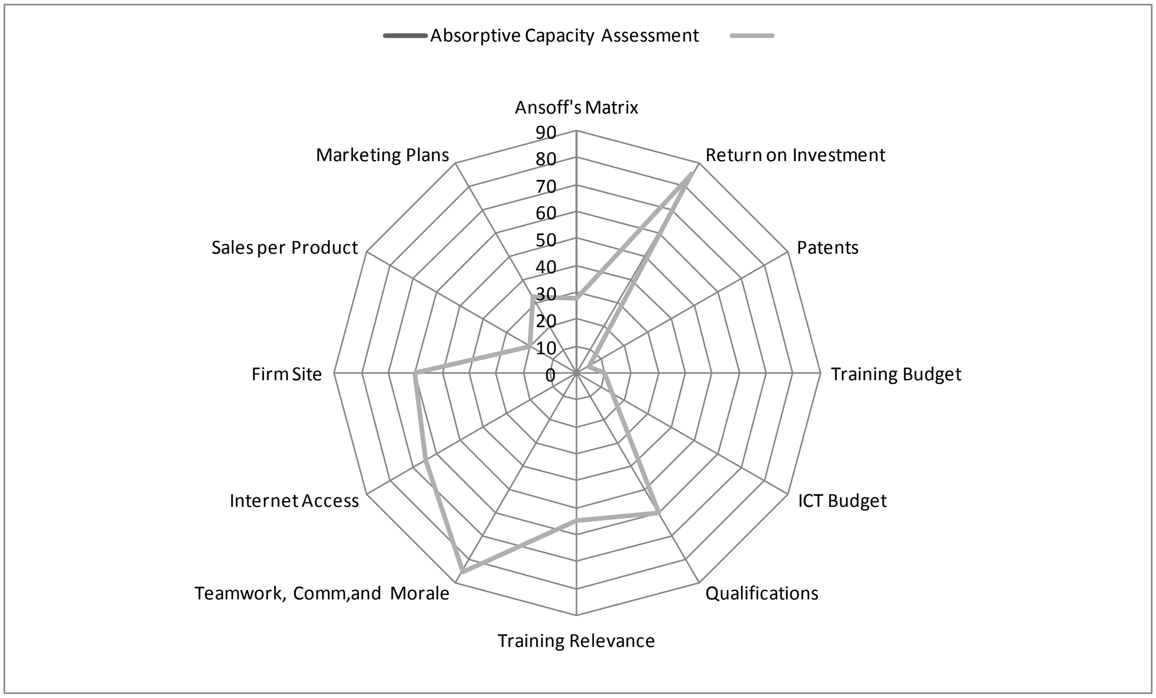
Many measures of absorptive capacity, including those that focus on human capital, R&D, management practices, and types of collaboration, focus on inputs rather than outputs. However, to measure effectiveness, this study looked at both inputs and outputs. Marketing capabilities, breadth of knowledge, learning by doing, and return on investment were deemed the most important measures to an assessment of the effectiveness of absorptive capacity, and each of these was measured with a set of indicators. R&D expenditure and return on R&D investment were solicited in the survey, but elicited no responses. Therefore, the study used overall return on investment as an indicator; however, it is recommended that R&D intensity and return on R&D investment supplant ROI in the future.

Figure 5.4 is the result of the discussion in section 4.5.3 page 4-21 and provides an overall representation of Qatar's absorptive capacity using international benchmarks. The marketing capability assessment revealed a lack of innovation, inferior marketing capacity and weak marketing strategies. The breadth of knowledge assessment showed adequate qualifications, but these were mainly due to expatriates' bachelor degrees. Furthermore, survey results revealed an inadequate environment available for capacity building. The learning by doing assessment revealed a good ICT infrastructure, adequate teamwork and relevant training. However, much of the training is limited. Finally, the return on investment assessment reflected a strong economic performance. Qatar's industrial initiatives have achieved very high returns on investment and the country is competing successfully worldwide in the energy sector. It is worth noting that had return on R&D investment been used as an indicator in Figure 5.4, the rating would have been much lower.

Looking at the findings holistically, it can be argued that investments on product initiatives only concentrate on products with a high market value and ignore essential ones. This will not sustain development in the long term. Local absorptive capacity is not sought; rather, huge numbers of expatriates are brought in to operate the industrial infrastructure. Science and technology patents are almost non-existent. Furthermore, Qatar focuses on manufacturing simple products and the GCI ranks Qatar very poorly on innovation.

Qatar has no innovation strategy, but its attempts to establish a framework are genuine, as described in Figure 3.2. Lack of local human skills is the most critical challenge facing the country because it hinders capacity building and innovation. The GSDP attempted to address this issue in 2005 by developing "Qatar's Capacity Building Strategy," but unfortunately, the implementation of this strategy has been unsuccessful to date. This is due to the lack of integration, coordination and/or interest by the different ministries and institutions. Capacity building is not a high priority for the private sector because it emphasizes Qatarization, which requires hiring expensive native labourers rather than importing cheaper expatriates.

Figure 5.4: Overall Absorptive Capacity Web



Note: Marketing capability is represented by marketing plans, sales growth by product, and Ansoff's matrix. Breadth of knowledge is represented by past patents and assessments of the ICT budget, employees' qualifications, and training expenditures. Learning by doing is represented by access to the internet, firm sites, teamwork, internal communication, staff morale, and the relevance of training to employees' jobs.

Source: Analyzing Qatar field survey findings.

Building absorptive capacity is a slow and cumulative. It is path dependent because new knowledge must be built upon past knowledge. Absorptive capacity success depends on the shared knowledge between the host and donor. This is why joint ventures in Qatar failed to transfer technology effectively; the capabilities for learning and integrating were missing. This is attributed to the fact that capacity building is neither easy nor quick. The above figure indicates that Qatar needs to do more to raise the level of absorptive capacity in order to retain the imported technologies. Presently, retention is very low.

Analysis of the labour market revealed that Qatar's local population is insufficient to support its energy sector's economic development. Most of the Qatari labour force is employed in the public sector. The ratio of Qataris to non-Qataris in the private sector is declining every year. Given the present levels of investment, the energy sector and other private sector industries in Qatar are producing around 400,000 employment opportunities, but Qataris can only occupy 25,000 of these jobs because they lack the qualifications needed for many of them. Achieving Qatarization, where each business would employ 20% Qataris, is almost impossible because the Qatari labour force's annual growth is 2000 while the non-Qatari population grows by 20,000 each year. The education system plays a direct role in the labour shortage. According to Qatar Petroleum (QP), the education system does not adequately prepare workers. QP management pointed out that the company has to reteach basic academic subjects like math and English to secondary school graduates for at least 26 weeks before they can be enrolled in special trade training. This results in huge production loss. The private sector cannot afford to pay equal salaries to adequate and inferior workers.

One part of the problem may be that while Qatar's main economy is based on oil and gas, school curricula do not address any subjects related to this. Moreover, there are no subjects in schools' curricula that focus on a particular career and there are no career guidance advisors. With respect to higher education, Qatar enrols six times as many PhD students in arts and education programs than in engineering programs. This means that only six doctoral level Qataris will join the industry sector in 2009.

These issues are the result of a weak link between the education and industry sectors. There are many vocational qualifications systems such as the Australian's Technical and Further Education (TAFE) (used by QP), the British National Vocational System (NVQ) (used by the Ministry of Labour), the Canadian system (used by the College of North Atlantic), and the German Technical Co-operation (GTZ) (used by the Secondary School for Industrial Technologies). Although education reform has started in Qatar, it will be more than a decade before the country can expect to see the results. Meanwhile, international experience shows that successful reforms need accurate and comprehensive information and analysis.

Although Qatar is one of the richest countries in the world, its local citizens' representation in the labour market is very low, even lower than its Gulf Cooperation Council neighbours. The GSDP invited experts from the World Bank to work out solutions to the labour market issues. Their studies recommended establishing a labour market strategy with the following main agenda items:

- Improve labour market information by collecting, managing and sharing comprehensive statistics related to the labour market and education
- Build capacity through human resource planning
- Reform the education system

The drawback of the resulting Labour Market Strategy (LMS) is that it only focuses, as an actionable solution, on reforming the education sector and ignores other areas like industry and the private sector, which are potential sources of innovation, sustainability, and technology transfer. The LMS study highlighted the disparity between ready labour and developed labour, asking whether Qatar should address the national labour requirement first or solve the expatriate labour force problems. However, deciding between the two is not necessary, because a sound population strategy would diffuse both tensions and respond to both challenges.

By 2009, most of the public schools in Qatar had been transformed into independent schools. This makes it appear as though reforms are progressing, but left unanswered is the question of whether or not the new educational system has increased efficiency and quality. Educational achievements in math, English and science would suggest that the new system is not an improvement on the old. No doubt, "Education for a New Era" is the right policy initiative, but effective execution is lacking. The lack of strong leadership that foresees the future and takes necessary actions has swayed the initiative away from decentralization, with its values of independence, accountability, and innovation, and has moved it towards a similarly centralized governance through the Ministry of Education; ironically, getting away from this centralization was the very reason the initiative was undertaken.

Qatar’s General Secretariat for Development Planning (GSDP) has been a strong government body in policy research and has initiated and recommended many development programmes, such as the Labour Market Strategy, the Capacity Building Strategy, the Second Human Development Report, service improvement initiatives, the Knowledge-Based Economy Campaign and more. It must be frustrating to the GSDP to observe that most of its initiatives are not progressing as planned. Although the GSDP attempts to act as a facilitator for these initiatives, it lacks the authority to oversee implementation. The Labour Market Strategy, for example, recommended improving the labour market information system, building the capacity for labour analysis and manpower planning, developing a national qualification system, and establishing a national entity for the coordination of workforce development. Most of these recommendations did not materialize. Many reasons can be attributed to these failures, including stakeholder conflicts, vague sub-requirements, skill deficiencies, and poor coordination. However, the two most important causes of the failures that must be addressed are organization and leadership. There is a lack of an executive body authorized with the legislative power to reinforce such development initiatives. In most cases, then, strong leadership that thinks globally is missing.

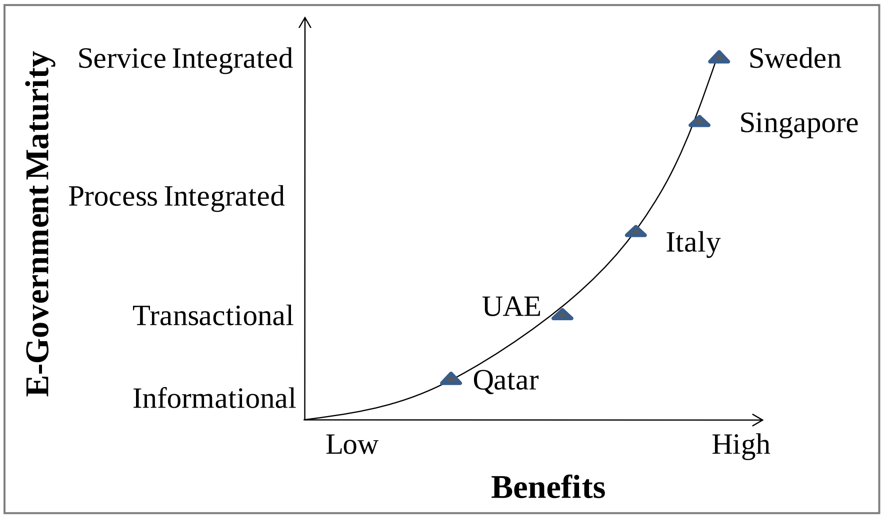
IctQatar started in 2004 to connect people, enrich lives and inspire confidence in the future. IctQatar is responsible for legislating ICT policies in Qatar. It has enacted a telecommunications law. No e-commerce law exists yet. Major initiatives in a number of areas, including government, education, health, financial, tourism, sports, transport, oil and gas, and manufacturing services, have been promised since IctQatar’s inception. IctQatar started implementing e-Government and e-education, although a much greater effort is needed to manage change. The e-education portal, or “KnowledgeNet,” suffered a setback for a couple of years due to technology and management issues, but was finally introduced to 37 independent schools in 2009. The cyber-security initiative, Q-CERT, a centre for information security, was established to work with government agencies and industry to form a risk management strategy. The initiate is running, but more awareness is needed to fully utilize such a valuable service. Apart from the above, other services have not yet been developed. Still, the above initiatives have met with success and deserve applause. However, in a competitive environment and with its available resources, IctQatar could do much more. In other words, the above achievements are not cost effective when value for the money is considered.

The public administration and its services face many modernization issues. The Public Service for the 21st Century (PS21) initiative was inaugurated in 2002 to reform the public sector and its services. After seven years, the public sector does not seem to have benefited greatly from these initiatives. To illustrate, it was recommended that performance–based pay be introduced, but cultural resistance to performance measurements inhibited this initiative. The involvement of many agencies in decision-making often results in role uncertainty. Accountability is also a major concern. Power struggles sometimes ensue if two or more government agencies are involved in a project. Instead of cooperating together, departments attempt to protect their domains rather than cooperating to accomplish the given task. Collaboration requires strong leadership that can respond to political issues and internal administrative and technical challenges. Leaders are needed to define visions, take ownership, settle differences, and handle difficult teams.

To enhance the public sector's performance, many governments elect to use e-government. Qatar has followed this route as well. Using ICT tools can create opportunities to optimize services and can lead to process innovations. There are four distinct levels of e-government maturity: informational, transactional, process integrated and service integrated e-government.[59] Informational e-government provides access to public information and publications, and allows the downloading of forms. Transactional e-government offers simple services, such as submitting forms or complaints online or using email in communication. Process integrated e-government allows larger business process workflows and repeated interaction. Service integrated e-government provides users with a "one-stop" portal offering a comprehensive menu of services. E-government is successful when the general population is ICT ready. Figure 5.5 uses the above concepts to represent Qatar's e-government initiative in comparison to other countries. It indicates that Qatar's e-government maturity is just above the informational level.

Moreover, the UN's 2008 e-government survey ranked Qatar 53rd with an index of 0.53 out of 1.00 on the e-Government Readiness Index.[60]

Figure 5.5: Ranking Qatar on e-Gov Maturity Curve



Source: Author

Qatar's low level of maturity is due to a combination of strategy, technology, policy and organizational barriers. Strategy barriers include overambitious e-government goals, a lack of shared objectives, and funding issues. Technology barriers include obstacles in architecture interoperability and incompatible metadata. Policy barriers stem from citizens' privacy concerns and data ownership issues. Lastly, organizational barriers include the slow pace of implementation of government initiatives, outdated processes, and lack of technical expertise.

Solutions to e-government maturity problems include:

1. On strategy: Offer unified e-Government services through a single access point.
2. On technology: Create a unified user interface (one screen) for using any service.
3. On policy: Offer unified guidelines to users.
4. On organization: Create a central contact for a given set of services.

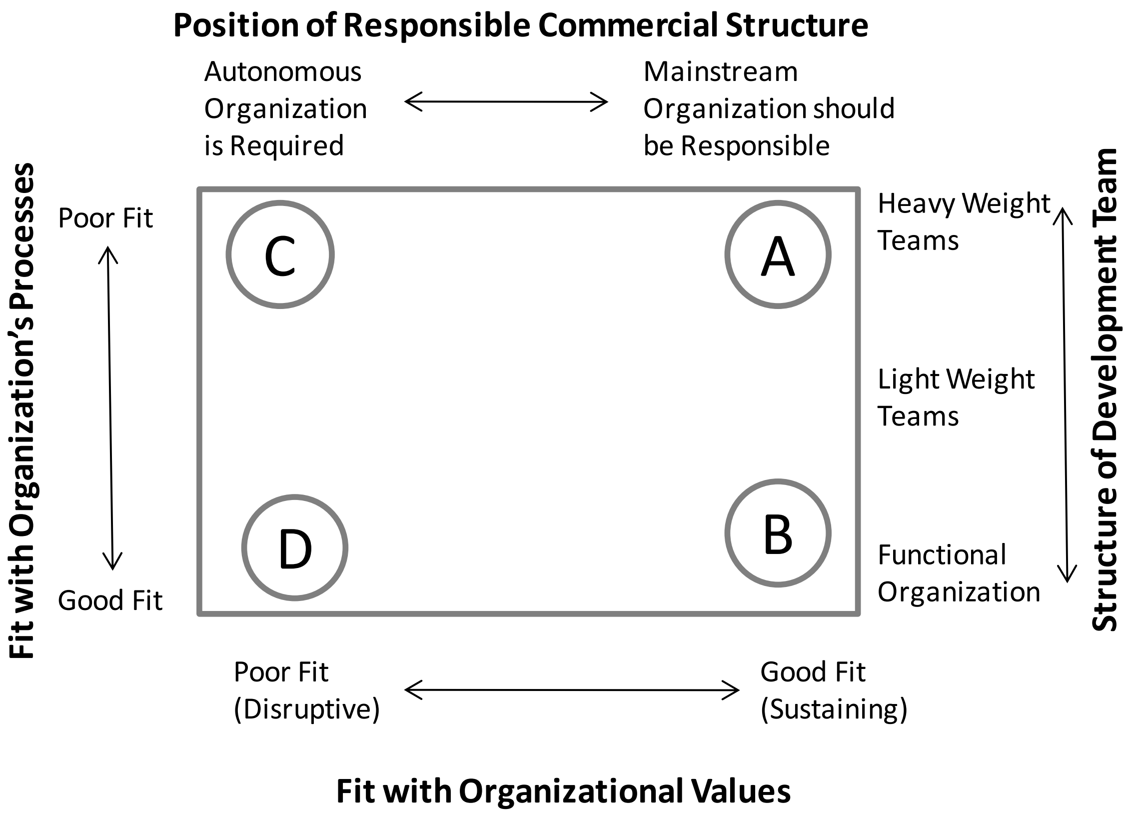
A surprising number of innovations fail because the responsibility to accomplish the tasks is given to people who do not possess up-to-task capabilities.[61] When this occurs, an organization's capability becomes its disability.[62] While current managers would be an appropriate source to look to for business growth or new ventures, they are not always up to the task. Managers in Qatar are selected because they are "good communicators." However, managers who have successfully worked their way up the organizational hierarchy are likely to have acquired the knowledge and skills needed to effectively manage the same business units that currently employ them. They typically have operational experience in business process improvement, technical problem-solving, quality requirements, and cost control. It is difficult, therefore, for a manager who is accustomed to leading a well-running plant to start up a new plant with a unique set of problems. Outsourcing managers, on the other hand, does not enable them to blend well into the organization. The solution to selecting the right person for a certain task is to look internally at the problems that are likely to be faced with the new venture and offer promising managers coursework in those areas.

Success will be sustainable if capabilities migrate from resources (mainly people skills) to processes (defined after repetition of work) and then to value (standards for making prioritization decisions). If an entity can develop its process and values capabilities, then the absence of resources will make little difference in its performance.[63] Acquisition is one way to gain capabilities. Acquisition mandates that the processes and values of acquired business not be integrated into the buyer's way of doing business. Instead, the buyer should infuse the acquired business's resources into the parent business. However, if the resources were the primary reason for the acquisition, then integrating the acquired business into the parent makes sense.

Figure 5.10 offers a framework that can help managers decide when to build internal capabilities or when to seek new capabilities.[64] For example, Dell Computers sold PCs over the telephone. The internet represented a sustaining innovation. This helped Dell increase revenues. In this scenario (B), Dell's processes and values were good fit with the new technological capability and therefore, the activity could be managed by the internal organization. IBM, on the other hand, depended on retailers. There was no room for internet distribution within their existing organization and hence, their efforts to sell over the internet were far less successful. Because of the process mismatch, the solution for

IBM was either to modify its processes or create an autonomous organization that could operate with new processes and values (A or C).

Figure 5.6: A Framework for Finding the Right Organizational Structure



Source: Christensen C, Raynor M. The Innovator's Solution: Creating and Sustaining Successful Growth. Massachusetts, Harvard Business School Press, 2003. p. 191

5.5.4 Value Chain

This study developed a performance framework that offered a holistic sense of value from all the participants and their integrated value-adding services (Table 2.2 page 2-41). The selected framework focuses on the accumulated benefits to customers and the interdependent processes, demands, and finances that are created along the value chain. In examining value chains, another goal was to simplify the findings and recommendations with regard to strategic outcomes.

This study finds that Qatar’s energy industries are characterized by excellent procurement processes, competitive product prices, high quality, and fast delivery times. The infrastructure is excellent because of state-of-the-art technologies. Adequate management systems are in place to plan, organize, monitor and control the supply chain cycle. The sales performance is excellent due to the utilization of available natural resources.

However, with volatile products, there is a risk of underperformance and there is a need to diversify beyond related energy products. Oil and gas are non-renewable. It is ironic when multinational oil and gas companies claim that they contribute to sustainable development because they are promoting consumption of energy sources at a rate that far exceeds the natural creation of these sources. Also, advocates of renewable energy as a replacement to the more efficient non-renewable energy sources, like oil and gas, fail to recognize the difficulties inherent in doing so. None of the countries that pursued renewable energy have reached their target goals because renewable energy is capital intensive and cost inefficient.

The issue here is striking a balance between economic growth and climate stabilization. However, the main reason for increasing energy demands is actually economic and related to population growth. Therefore, the choice of energy technologies is extremely important if a sustainable energy supply is to be developed to satisfy the long life cycle of an energy network, such as a country’s power grid. Liquefied natural gas may be the bridge to renewable energy. LNG is considered an environmentally-friendly fuel as it has the lowest carbon dioxide emissions per unit of energy of any fossil fuel. Qatar has invested heavily in LNG technologies that allow it to be transported at a lower cost than through pipelines. The state energy sector leadership acknowledges that LNG is environmentally friendly and Qatar can sustain clean energy through efficient utilization of its gas reserves, but fails to recognize that LNG sustainability is not achievable as it is a non-renewable source.

Aside from using renewable energy sources, population planning could be used to promote sustainable energy use. However, population control is a complex and volatile issue. Aguirre argues that population control cannot be used to promote sustainable development.[65] She provides both theoretical and empirical evidence that the idea is flawed on many levels. Population control policies have already failed in many countries, including Mexico, Brazil, Singapore, Taiwan and Korea. The population issue for Qatar is different, in that many temporary expatriates are counted in the population statistics, but are not considered permanent residents. This can be controlled through human resource population planning.

A third solution to Qatar's sustainability crisis would be to diversify into different products. Serious diversification in Qatar could focus on petrochemicals due to the abundance of raw material. Naturally, utilizing the available energy resources would give the state a competitive advantage. However, with fluctuating prices, it is recommended that Qatar stabilize itself economically by pursuing completely unrelated products and services, including renewable energy.

This study's value chain analysis projected a lack of innovation. This topic was discussed in the previous section. The inadequate skills of the workforce have slowed the success rates of many projects and have decreased the innovation index. Innovation is widely recognized for increasing the sustainability of national economic growth. With regard to value chain sustainability, innovation, if integrated into the overall operations of an enterprise, could generate sustainable value.[66] This calls for a commitment from leaders to support innovation and strategic planning. Furthermore, it calls for organizations to set as their long-term goals the achievement of dynamic capabilities and sustainable growth.

With the aid of conglomerate multinational companies, Qatar's industries have succeeded in achieving economic gains, but technological progress has not accompanied these gains. This may be due to weak technology transfer and failure to innovate. It may also be the result of limitations in contractual agreements, low bargaining power, or policy failures. The failure to progress technologically in spite of economic growth also explains why the quality of Qatar's business environment far exceeds its companies' sophistication. Earlier findings support the above analysis; technology has been imported, but use of this technology in business and daily life is still lagging behind. It has been four years since IctQatar began implementing its vision, including the education gateway, but to date, the initiatives designed to build human skills are deficient and need immediate attention. Although the ICT infrastructure is promising, there is a need to build an integrated network that connects businesses, government and education. The interview findings also highlighted the need for vocational training in order to respond to businesses' growing demands for a skilled labour force.

Most of the international organizations that have tracked innovation in Qatar do not present an accurate picture of what is occurring in the country. These international bodies used indicators that reflected the country's response to very specific problems rather than measuring what returns have been achieved. Thus, the reports they produced applauded development initiatives and infrastructure, which swayed Qatar's attention away from areas of need.

The government of Qatar controls the energy sector and the petrochemical industry; it also supports the latter by lowering the prices of intermediary feedstock used in petrochemicals. Therefore, Qatar's petrochemical companies can price their products more competitively. This would not be the case if the private sector was to operate the petrochemical industry. Of concern, government assistance may hide inefficiencies in the petrochemical industry, including higher production costs, inefficient processes, or the inability to use sophisticated technology. In so doing, it does not encourage these inefficiencies to be addressed. This is detrimental to building innovation in local industries, a problem that was discussed previously. The need for innovation invites the private sector to invest in gas–based industries.

To conclude the analysis of the energy industry, using Key Performance Indicators is very important. Key Performance Indicators (KPIs) are metrics that reflect the strategic performance of an organization. These should not be interpreted as Critical Success Factors (CSFs). Critical Success Factor for sustainable development might be the ability to keep it all going, but KPIs are the indicators that measure value chain in this dissertation, such as profit. It was surprising to note that the leading local energy enterprise – one that has worked with international conglomerates for over fifty years - did not introduce KPIs, CSFs, and Business Process Management (BPM) to its value chain until 2009.[67] Related industries are in similar shape. However, other industries, and particularly small or medium private sector enterprises, might not have similarly strong value chain performances because they do not enjoy the same government subsidies and support.

5.5.5 Value Networks

A value network is an environment of connected individuals, groups and organizations that create and exchange tangible and intangible value. These exchanges can occur across and within both public and private sectors. A value network is achieved through trust, collaboration, technology transfer, social networks, citizenship, human competence and ethics. Allee created a framework to map the "value exchanges" between providers and end users. The framework is simple, but requires detailed insight into the enterprise's relations. In other words, it requires the kind of knowledge that only executives and managers might possess. Therefore, the framework could not be utilized in this dissertation. However, this dissertation can draw from elements of Allee's recommendations for increasing tangible and intangible value exchanges. As far as technology, she recommends the use of the internet, databases, and portal systems. She also recommends the use of knowledge networks and communities of practice to measure business relationships. Finally, she stresses that intangibles are true strategic assets that are concerned with the purpose and creation of value and can be achieved through business modeling, system mapping, value assessment, and learning intensives. She believes that trust and leaders' ethics are two important elements in building lasting relationships.[68]

Chapter four translated the above five, mostly qualitative, components of value networks into measurable indicators. Asset utilization, conversion ability, value enhancement, perceived value, and social value were used to assess value networks in Qatar's industrial enterprises. The following paragraphs will discuss the findings that were articulated in the previous chapter.

Value networks incorporate both financial and non-financial values. This dissertation found that financial ratios were difficult to calculate due to data unavailability. For this reason, asset utilization was not calculated. Instead, it was replaced with return on investment. This is somewhat unfortunate, because what was really needed was a way to examine financial data over time and to show how various assets within the system contributed to the final value of the product or service. The return on investment only shows an aggregate figure and cannot be used as a strategic tool for decision-making at the operational or tactical levels. For example, the ROI calculations revealed that the petrochemical industry in Qatar enjoys lower production costs in comparison to similar international industries. However, it was demonstrated earlier that this does not mean that the assets are used effectively, but rather that other factors contribute to lower production costs, such as the low price of feedstock. What ROI has shown is economic growth and, to an extent, the overall utilization of assets in the industry. Within the energy industry, the utilization was excellent (ROI=60%).

With regard to non-financial values, this discussion will begin with technology transfer agreements. The number of technology related[69] agreements between enterprises and R&D centers was used to show that the number of enterprises with technology agreements in Qatar is very low. Even among organizations with agreements in place, there was a large range with regard to levels of communication and complexity of agreements. There were few agreements that afforded organizations a high level of communication. This reflects poorly on the internal capacities and capabilities of Qatari enterprises. Capacities and capabilities were already discussed and will not be repeated here. However, industrial clustering is suggested to improve individual, group and organizational relationships.

Developing industrial or business clusters in Qatar or in the region could alleviate competitive pressure and replace it with economies of scale, higher human capital availability, and greater technology transfer. The spillover from these clusters could increase productivity and reduce costs in the region. Cost and productivity benefits could be facilitated by using complementary products, sharing available human resources and information, and developing shared performance measures, infrastructure and input. Joint training centers could be established to further develop the workforce. This would raise skill levels and reduce transactional costs. Clustering is also a door to innovative practices that could enhance the value of products and services. In clusters, cooperation is facilitated through meetings between firms, suppliers and customers. It is also facilitated through chambers of commerce and trade associations. Community benefits may include higher wages and more spillover than through other forms of economic development.[70] In short, the benefits that could be accrued from industrial clustering are nearly unlimited.

Qatar could develop industrial clustering by first locating potential clusters in the region that focus on health, education, hydrocarbon, tourism, construction, infrastructure or ICT. The search should distinguish between export-oriented enterprises and local enterprises. Once the potential clusters are identified, the state or the nearby communities need to check to see if support infrastructure is available, including training facilities, business services, physical infrastructure, and workforce skills. The role of the government would not be to choose the clusters, but to support the initiative.

Another intangible value in a value network is the ability of an industry to add to or enhance the value of a product or to convert a particular product. This dissertation found that customers generally place a great deal of trust in Qatar's local products. Qatar's energy industry is advanced in the production of non-renewable fuel and petrochemicals. Other industries lag behind. In a value network, value is created through the conversion of raw materials into intermediary and finished products. It would be beneficial for Qatar to develop downstream industries by setting up more industrial enterprises that could utilize some part of the country's abundant gas resources. Here, it is essential to discuss what the local industries could achieve by addressing the levels of product value. First, there is presumed value, which the customer does not examine because its existence is assumed. Then, there is expected value, which the customer examines and compares with the value of competitors' products. Finally, there can be unexpected or delight features that can close the deal.[71] The combination of these values translates into successful products or services.

The last intangible value that was assessed in this dissertation is social value. The findings in chapter four (Social Capital page 4-40) revealed that Qatar needs to pursue competitive enterprises to strengthen trust in the community. Social development in Qatar is well below economic development. The impact of this is already felt in the inefficiency of technology transfer practices and in the lack of sustainable development. Collaboration and coordination between universities, private companies, research centers, and government agencies on science and technology issues is either non-existent or existent only at low levels. Human capital and the skills to innovate do not exist in the private sector. There is still much to be done to build social capital through improved relationships.

One of the most important recommendations to strengthen the value produced through networks is collaboration. Enterprises should collaborate to reduce costs, reduce risks, and promote learning. Normally, an organization's strategy and culture will determine which collaboration type is right for it, whether it be supplier relations, licensing, consortia, strategic alliance, joint venture or networking. Learning networks can be further classified into professional institutions, trade associations, best practice clubs, local learning cooperatives, regional development agencies, and practitioners' networks. The most important factor that affects the outcomes of collaborative product development is the establishment of ground rules. This includes clearly defining objectives and responsibilities, setting realistic aims, and defining project milestones.[72]

A policy that supports innovation and technology transfer needs to be established to address all of the above issues. This policy should encourage and support community understanding and acceptance of technologies through business networks and communication campaigns. This recommendation will be described in greater detail in the next chapter.

5.5.6 Research and Development

This study finds that Qatar has a shortage of skilled workers in the research and development (R&D) field, which puts limitations on the country's R&D capabilities. There is a scarcity of R&D centers, particularly those dedicated to Qatari industry. Further, there is no statistical data on R&D in Qatar. Most grants come from the government. The private sector does not invest in R&D initiatives, mainly because it cannot afford the sunk cost of researchers' salaries. Also, there is no real cooperation between the industries and the existing R&D centers. The number of patents generated in science parks as compared to the total number of patents is minimal. Only 16% of the research conducted in Qatar is carried out in the field of science and technology and involves only 11.5% of Qatar's researchers. Research is absent in the fields of environmental engineering, medical engineering, industrial biotechnology, nanotechnology, and animal science. See section 4.5.6 page 4-42.

The first serious R&D initiative in Qatar was the establishment of Qatar Science and Technology Park (QSTP) in 2004. The role of QSTP is to increase the local capacity to convert research into commercial value, and, in doing so, to accelerate economic growth through diversification and to create jobs. The governance of this initiative is characterized by excellent leadership and the initiative involves reputed R&D centres and companies. The allocation of 2.8% of the government's revenues to research and development and the creation of Qatar National Research Fund is promising. The National Research Fund provides grants to universities and research centres based on the results of a scientific evaluation that takes national priorities into consideration. QSTP's centralized governance structure is the right structure to pursue R&D as Centrally-controlled R&D has a greater impact on future technological development and invites more innovations from other participants than does decentralized R&D.[73]

At present, QSTP seems to be the only organization that could develop a science and technology vision for Qatar. However, QSTP is not entirely successful in this role because it fails to see the importance of establishing social connections to the development of innovation. Second, QSTP has not established a policy to promote innovation and technology transfer. An R&D policy exists, but is not closely aligned with education and vocational training policies. Investment in knowledge and skills should be a core strategy. Innovation, research, education, human capital and economic growth are interdependent. To sustain its competitiveness globally, Qatar must ensure that it attends to each area. This will require sustained investments and informed policies.

Turning to indicators, this dissertation finds that the total research and development expenditure in relation to GDP is an important measure in that it allows Qatar's R&D investments to be compared with those of other countries. Tracking the expenditures on research and development enables an assessment of enterprise input, while numbers of patents and R&D intensity facilitate evaluation of the output. To increase the accuracy of the analysis, this study also attempted to use the indicators listed in Table 4.15 page 4-45. However, the study found that most enterprises, even QSTP, could not provide sufficient R&D data to examine all indicators. For example, one useful indicator that could not be used in this study is the R&D expenditure within a particular sector in relation to that sector's output.

5.5.7 Competitiveness

To assess Qatar's overall competitiveness as well as the competitiveness of its industries, this study looked at the Global Competitive Index, the Human Development Index, and Qatar's marketing capabilities. The GCI and HDI revealed annual progress in the country's competitiveness. The marketing capability analysis showed that the energy market is competitive and cost-focused, as it uses its comparative advantage to reduce production costs and increase economies of scale. However, the analysis also showed that Qatar's infrastructure and business efficiency need further development. More specifically, Qatar needs business legislation to protect competition and it needs free trade and labour regulations characterized with equal employment opportunities.

With regard to Qatar's labour market, there is a sufficient pool of talent, mainly because immigration regulations are flexible, so employers can sponsor non-Qatari employees and bring them into the country. The problem with the sponsorship law is that a sponsor can hire and fire at any time, but the expatriate employee cannot move to another Qatari employer without the consent of his sponsor. Often, sponsors use their power to force labourers to work longer hours without a pay increase. Labour law reform should seek to liberalize the sponsorship law. However, influential business leaders lobby against such initiatives because of the competitive advantage cheaper labour offers. This indicates that the competitiveness of private enterprises is weak and unhealthy as far as sustainability is concerned.

The education sector illustrates a different problem with regard to labour. In the education sector, independent school operators can hire teachers and administrative staff. Most non-Qatari female teachers are under the sponsorship of their husbands. Thus, female teachers are free to move to other jobs when their contracts expire. This is a privilege that male expatriate staff cannot enjoy. In 2004, the basic pay of an expatriate female teacher was around US$ 1,000. In 2008, due to competition among independent schools for skilled teachers, this pay reached US$ 2,200. The living conditions of female expatriate teachers have also improved substantially. However, the improved salaries and living conditions were not accompanied by increases in teachers' abilities. This is an institutional weakness.

According to William Miller and Langdon Morris, developing institutional capabilities in complex competitive environments – something Qatar has difficulty doing - requires new core processes focused specifically on capability development to interact with strategy and product development.[74] Studying the "competitive architecture" shows how competition changes over time. Such a study should include three levels of focus: economic architecture, market architecture, and organizational architecture. Economic architecture refers to patterns of investment and development and the way markets change over time. Examining market architecture shows how markets respond to different industries and cultures. Organizational architecture is a set of internal functions and relations among different specialized individuals and groups working towards achieving their tasks. Qatari entities need to develop on all of these levels if they hope to establish effective innovation processes.

An enterprise's information scanning abilities refer to its capacity for learning about competitors. The survey found that industry representatives perceived this area to be satisfactory, but the study did not identify particular scanning systems currently in use to assess competitors' innovations. Chapter two, Table 2.1 provides an overview of some effective methods for learning about competitors' innovations.

5.6 Building the Final Picture

Appendix F and Figure 5.7 show holistically the results of the analyses in chapters three, four and five. Figure 5.7 illustrates the degree of risk to sustainability and technology transfer associated with current practices.

The risks to environmental sustainability posed by present practices are high and exist mainly because of the oil and gas sector. Social sustainability is at high risk as well because of uncontrolled population growth; as infrastructure and services are built to accommodate this growth, the environment also deteriorates. Economic growth is excellent at present, but its sustainability is questionable because of uncontrolled inflation and the dependence on non-renewable resources. Overall, then, the potential for sustainable development in Qatar is at high risk.

There are numerous threats to the achievement of good governance. The absence of performance monitoring instruments, the lack of sustainable development and technology transfer policies, high state control over private sector, lack of business sophistication, the reliance on government to support society, and the reluctance to globalize make it unlikely that any initiative to transfer technology will be successful. In addition to this, industry's reliance on outside experts and joint ventures to make use of external technology are not effective technology transfer measures. Collaboration with research and development labs should be prioritized. However, enterprises' internal practices are promising. Although the barriers to technology transfer here are categorized as medium, it would be easy to turn the needle to low. Successful internal practices could be achieved with better R&D investments and a more collaborative environment. What adds to this potential is a good value chain characterized by strong marketing, a high-quality production environment, and strong supply chain management. However, technology transfer can only be achieved if people absorb the technology. Unfortunately, absorptive capacity is low, mainly due to qualification and knowledge deficiencies in an otherwise sophisticated business environment.

Figure 5.7: Sustainable Development and Technology Transfer in Qatar: Risk Dashboard

Sustainable Development			**Government Policies and the Internal Environment**
 Environment	 Social	 Economic	 Good Governance Risks
External Technology and Resources	**Internal Technology Transfer Measures**	**Absorptive Capacity**	**Value Chain**
 Main Sources of Technology Transfer	 Internal Technology Transfer Risks	 Absorptive Capacity Risks	 Value Chain Risks
Value Network	**Competitiveness**		**R&D**
 Value Network Risks	 Competitiveness Risks		 R&D Risks

Source: Author, information extracted from Appendix F

Value creation cannot occur successfully unless the status quo changes. Currently, there is a lack of innovation for new product development, an absence of KPIs, an unhealthy reliance on non-renewable energy, few high-quality agreements with R&D labs, and a low number of R&D staff. All of the above mandates improvements. Chapter six will discuss this further and present some policy recommendations to eliminate these deficiencies.

In summary, this dissertation’s framework and themes were extremely helpful to an assessment of sustainable development and technology transfer effectiveness in Qatar. These enabled the diagnosis of problems preventing the country and its enterprises from moving further towards sustainability. They also demonstrated that both the technology environment and transfer practices are ineffective in moving Qatar forward in its mission to promote sustainable development.

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CHAPTER SIX

Conclusions and Policy Recommendations

"If you can imagine it, you can achieve it…"

William Arthur Ward

6.1 Introduction

This chapter summarizes the research, presents important findings, provides policy recommendations and discusses possible areas of future research related to Qatar's sustainability initiatives. Most importantly, it presents a final version of the framework and set of indicators for measuring technology transfer effectiveness as it pertains to sustainable development in Qatar.

6.2 Main Aim and Subsidiary Objectives of the Dissertation

The ultimate aim of this dissertation was to assess the effectiveness of technology transfer into Qatar, with particular attention to the ways in which technology transfer supports sustainable development in Qatar. The scope of the dissertation was confined to an analysis of certain institutions involved in technology transfer, including the government, industries and R&D centres. The subsidiary objectives included the establishment of measures of sustainable development and technology transfer, an up-to-date assessment of technology transfer in Qatar, and the establishment of a set of policy recommendations for industries, government sectors, and R&D laboratories related to technology transfer and sustainable development. When it is published, it is hoped that this study will build awareness of technological sustainability and will be used by policymakers to facilitate the measurement and review of technological capabilities, absorption and innovation. It should also enable organizations and their stakeholders to assess their progress using benchmarks developed for either local or international entities.

6.3 Research Summary

Over the past ten years, Qatar has seen an unprecedented boom in its economy that has placed the country to among the world's highest per-capita income countries for several years. However, economic growth derived exclusively from increased utilization of natural resources cannot be sustained long-term because of impending diminishing returns. Through its drive to invest in and develop its natural resources, Qatar's government has created intricate obstacles to sustainable development. Qataris have become minorities in their own country as a result of an influx of expatriate labourers. This has created complex political, economic and socio-cultural issues. This study could not address all of these domains, but it found technology to be a common variable amongst all of them.

Attention to technology transfer is important because technology will be an integral part of the economic growth that Qatar aims to attain and sustain. Technological capabilities are a central element of firms' overall capabilities. Fast-growing economies are usually built on technology-intensive businesses. Innovation raises productivity, increases knowledge, promotes collaboration with advanced countries, and helps to diffuse technology. Therefore, the real questions this dissertation sought to answer are:

- Does Qatar already possess advanced technologies? And if not, does it have the capacity and the motivation to import and make use of sophisticated technology options?
- Have Qatar efficiently and effectively implemented any sustainable development or technology transfer initiatives?
- Is Qatar on a path to sustainable development?
- What are Qatar's needs with regards to technology?
- What barriers must be removed in order to achieve effective technology transfer?

To sustain itself, Qatar must work to ensure that its political, economic, social, and environmental spheres complement and serve one another. This is essential, particularly given the fact that the surplus budgetary reservoir is in danger of being misspent in the face of conflicting needs, which would substantially decelerate or even stop Qatar's economic growth.

Though strong oil prices have allowed Qatar to implement a number of its development plans in recent years, the government has staked its future on LNG. It hopes that this change of focus will encourage foreign investment, promote technology sharing, and ensure that the country has another source of income to rely on when the volatile oil market does not provide adequately for the country. Qatar currently imports technologies, but there is no evidence to indicate whether or not these technologies can be woven into the fabric of society. Furthermore, there is no science and technology policy or industrial policy. Focusing on sustainable development and appropriate use of natural resources will be critical as the country moves forward. Developed countries that have already gone through the learning curve are now focused on conservation. Therefore, the technology employed in developing countries should be primarily state of the art, low- or no-waste technology.

To ensure that technology transfer is effective, technology performance must first be measured accurately. To develop sound measures, the most significant outputs must be identified with respect to the "critical dimensions" of quality, productivity, and cost. The literature review in this study revealed only fragmented approaches to the analysis of effective technology transfer. Most of the studies examined focused on a particular sector or context and were aligned with a particular author's philosophy and approach. Therefore, it was necessary to create a study methodology framework that facilitated an examination of technology transfer effectiveness on both the national and enterprise levels. This study methodology occurred in three phases. First, it used an exploratory deductive approach to review existing measures of technology transfer effectiveness. Second, using questionnaire and interview surveys, it applied descriptive deductive and inductive approaches to measure existing technology transfer processes and activities. Finally, a predictive deductive approach was used to provide policy recommendations designed to promote effective technology transfer and to present a framework to measure technology transfer effectiveness.

6.3.1 Sustainable Development: Summary of Secondary Research

Since 1972, the concept of sustainable development has grown and evolved. The Brundtland Report of 1987, a proclamation from the United Nations World Commission on Environment and Development, suggested that environmental considerations should be an integral part of all development policies and defined sustainable development as development that meets present needs without compromising future generations’ abilities to meet their needs. SD is important to the prevention of poverty, social injustice, violence, state failure, migration and the deterioration of the environment. At the same time, sustainable development policies move institutions in the direction of efficient utilization of physical resources, human capital, investment, and technology. SD is "a dynamic process of change" in which organizational activities are brought into alignment with both present and future needs. SD has economic, environmental and social components, and all three areas must be accounted for when measuring the success of development projects. To ensure that present and future development is sustainable, indicators are needed to monitor the progress of a country.

When selecting indicators, evaluators should choose economic, environmental, and social measures that are scientifically valid, representative of sustainability issues, responsive to change, relevant, understandable, analogous to targets, and cost-effective. The number of dimensions to be used, the relevant scales of measurement, the relevant weights to be added to observations, the errors surrounding the measures, and the robustness of measures must also be considered. There are countless indicators in the literature about sustainable development, but they are often unfocused and unrelated. Hence, using several indicators at once and attempting to interpret the findings may be difficult.

Unfortunately, it is very difficult to find indicators that satisfy the criteria laid out above. In response to this issue, certain trade-offs are suggested. For example, to measure economic sustainability, the study recommended four indicators: Green Net National Product (Green NNP), Genuine Savings (GS), Natural Capital Stock (NCS), and Safe Minimum Standards. Green NNP is a better indicator than GDP because it accounts for environmental damage and welfare, but it is not considered as a good a measure of sustainability. GS complements Green NNP by accounting for the depletion of natural resources and damage done to the environment. However, GS sometimes fails to capture the depletion of natural capital. To prevent this, establishing and tracking Safe Minimum Standards, a third indicator, sets a floor for the depletion of natural capital stock. To define such figures, natural capital stock must be calculated. Therefore, the four indicators must be measured together to assess economic sustainability.

6.3.2 Technology Transfer: Summary of Secondary Research

Technology transfer is defined as "the diffusion and adoption of new technical equipment, practices and know-how between actors within a region or from one region to another." This definition emphasizes diffusion, knowledge and skills transfer, and research and development collaboration. Technology transfer is achieved when innovation becomes a core business process. This involves scanning the environment for opportunities and threats, deciding how to respond, and transforming these ideas into goods and services that are of practical use in internal and external markets. Three situations in particular influence the transfer process considerably. First, in the failure of private industries to invest in R&D, which often happens because of uncertainty, hinders technology adoption. Second, even when firms do invest in R&D, the deficiencies in the innovation system prevent knowledge flow. Third, when knowledge flow does takes place, insufficient synchronization hinders technological absorption. These obstacles deserve further consideration. A strong research and design base, the availability of capital, a rich pool of technical talent, and a government science and technology policy designed to foster technology-based economic development are crucial to the success of technology transfer.

Literature offering measures of technology transfer effectiveness for particular countries is scarce and fragmented in scope. Even in globally-focused studies, the technology transfer measures are neither well defined nor universally accepted. This lack of agreement on the meaning of technology transfer effectiveness posed one obstacle to its study. Effectiveness could be defined in terms of technology's impact on the market, on political goals, or on personnel. Some practitioners look at technology transfer as a means to production and design, others view it as an innovation, and still others look for cultural changes as the outcome of technology transfer. Management and business scholars have focused on different aspects of technology transfer altogether, examining the stages of technology transfer, linking transfer with strategy, or correlating transfer with the strength of alliances. There are numerous models of transfer, yet none of these takes a holistic view of technology transfer. These complications make it difficult to measure overall technology transfer effectiveness.

There are many mechanisms for transferring technology, each of which will influence the effectiveness of the technology sought. There are also many measures that can be employed to assess the performance of technology transfer. The applicability of each measure depends upon how an organization defines its goals and the outputs it uses to measure these. Because technology transfer involves so many stakeholders and organizations with different needs, it is difficult to find universal measures of technology transfer effectiveness. To develop sound measures, the most significant outputs must be identified.

To combat these challenges, this study looks at technology transfer as a systematic process and, accordingly, it examines inputs, processes and outputs. The performance measures for such processes are abundant in the literature. This dissertation organizes technology transfer effectiveness into the following themes:

1. Sustainable development measures
2. External environment and government policies
3. External technologies and resources
4. Internal technology transfer measures
5. Absorptive capacity
6. Value chain
7. Value network
8. Competitiveness
9. Research and development

The choice of themes has been validated by content analysis of the relevant literature in chapter two and the categories contain almost all of the imperative variables examined in studies of technology transfer effectiveness.

6.3.3 Insights from the Field Survey

Using a structured questionnaire and semi-structured interviews, the researcher collected data from stakeholders involved in the processes that transfer technology and that promote sustainable development. The study measured the entire population of involved entities. The twenty-three entities studied included eight government bodies, four R&D centers and eleven industrial enterprises. The process of data collection lasted eleven months, which included time for a pilot study of five entities. Survey data was collected for all twenty three entities, but interviews were conducted at only eleven entities.

Data collection was a complex task; bureaucratic procedures, cultural and organizational issues, and a need to cover a census presented difficulties. Reassuring respondents that individual entities' performances would not be revealed helped in obtaining a 100% response rate on the survey. Data availability was another obstacle. Financial data was either unavailable or considered confidential. The absence of a data culture and lack of awareness of the importance of indicators and indices in policy making and strategy development significantly limited what was possible. To compensate for missing data, then, the researcher carefully triangulated collected data through available government data and through international publications containing credible analysis on Qatar.

Balancing reliability with availability was challenging. At the outset, the researcher designed a triangulation matrix to guide data gathering and verification. Triangulation was achieved through comparisons of questionnaire results, interview data and secondary research. It was also achieved through different forms of data analysis. Beyond the data itself, the lack of agreement in the literature regarding what constitutes effective technology transfer was another reliability concern. The researcher reviewed a rich body of literature in order to design a set of measures that fit Qatar's unique aspirations and concerns. Third, because of the unprecedented growth rates in Qatar, the researcher calculated that the applicability of the transfer and sustainability measures is approximately 18 months.

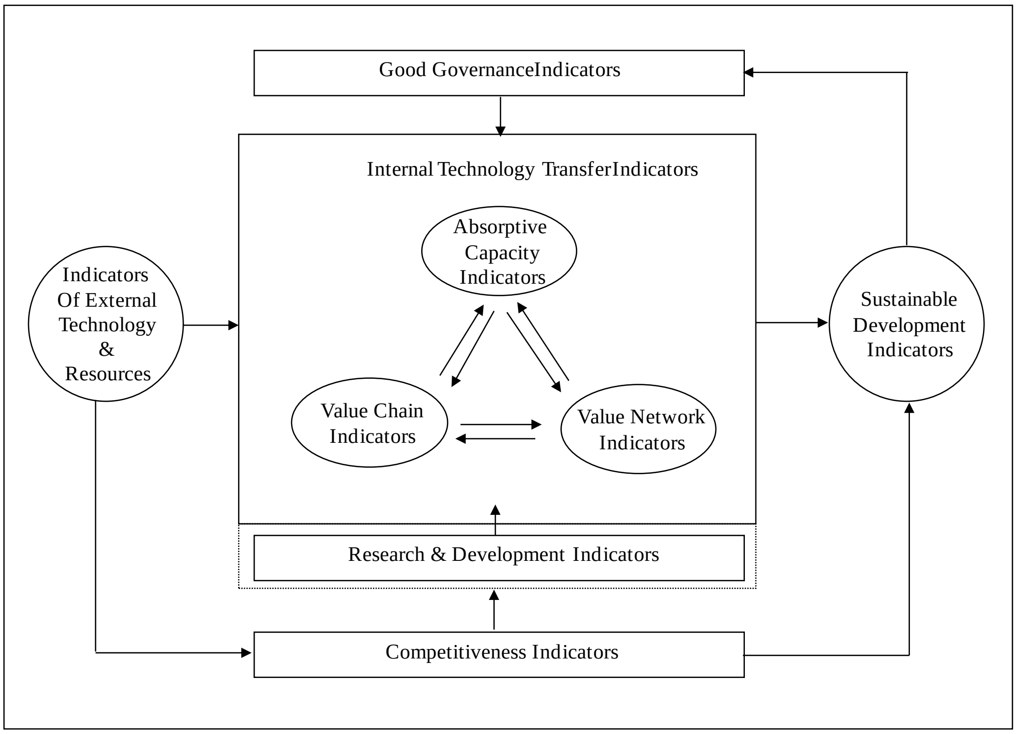
Validity was enhanced through the questions' design. The study used questions that were already tested in other studies, occasionally adjusting them to suit the context. Only a few questions were entirely original. The questionnaire was pilot-tested and further refined based on the feedback of participants. Then, the survey was carefully executed using an online questionnaire. Face-to-face interviews were also conducted; the interview used open-ended questions to reduce bias.

The results of the original research presented in this dissertation are more accurate than those published by other international research bodies. This accuracy stems from the fact that this research distinguishes between permanent citizens and temporary expatriates and that this study takes an in-depth look at absorptive capacity, value chain and value network. Moreover, rather than simply reporting out on the current situation, the researcher used logic to select and aggregate certain indicators in response to current problems on the ground, which facilitated the researcher's ability to offer recommendations for the future.

6.4 Conclusions and Policy Recommendations

The study presented a holistic framework for analyzing technology transfer in Qatar and ascertained the challenges Qatar currently faces in efforts to secure new technologies and promote sustainable development. (see Figure 6.1). The framework can be used to assess the effectiveness of technology transfer in Qatar's search for sustainable development.

Figure 6.1: Toward Sustainable Development: Technology Transfer Effectiveness Framework



Source: Author

Although most sustainability indicators are concise and transparent, they often fail to meet fundamental scientific principles with respect to normalization and weighting;

normalization and weighting are often done either randomly or in a biased manner. Sustainability measures also fail on aggregation grounds because rules of constancy are not considered.

Figure 6.2: Recommended Sustainable Development & Technology Transfer Indicators

1

Sustainable Development

Environmental Sustainability
Ecological footprint
Environmental space
Net primary production

Social Sustainability
Rate of population growth
Misery index
Living index
Human development index
Index of sustainable economic welfare

Economic Sustainability
Green net national product
Genuine savings
Safe minimum standards
Natural capital stock

2

Good Governance
Accountability
Participation
Transparency
Legal framework
Public & private enterprises' effectiveness
Social development
Culture and modernization
Globalization
Democracy
Economic liberalization
Vision and priorities
International cooperation in SD and TT
SD organization and governance
Leadership capacity

3

External and Internal Resources
Sources of external technology
Total number of R&D staff
Patent income
Copyright income
Licenses income
Return on R&D investment
Average of TT projects
Environment scanning budget
Percent product using foreign technology

4

Absorptive Capacity

Marketing Capabilities
Ansoff's matrix strategy
Marketing plans strategy
Average sales growth per product

Learning by Doing
Firm sites
Internet access
Teamwork
Communication
Morale
Training relevance

Breadth of Knowledge
Qualification analysis
Average ICT budget
Annual training budget
Number of patents
Average industrial return on investment

5

Value Chain
Environment analysis
Product and contribution analysis
Market assumptions
Financial management
Customer surveys
Sales performance
Performance management
Cost of production
IT management
New product development

6

Value Network
Asset utilization
Conversion ability
Number of agreements with R&D
Customer trust on local products
Collaboration between TT stakeholders
Presence of TT or innovation policies

7

Research & Development
R&D expenditure
Average gov. grants to R&D expenditure
Average R&D expend to total expenditure
R&D expenditure per sector to sector output
Return on R&D investment
R&D intensity
Number of patents
Number of licenses
Average % of commercially viable research
Number of startup companies
Ratio of public to private universities
Number of R&D staff in Qatar
Proximity of universities to R&D centres

8

Competitiveness
Global competitiveness index
Human development index
Infrastructure and business sophistication

Source: Final set of indicators recommended for measuring TT & SD in this study

To avoid choosing measures that could be misleading, the study integrated the most accurate available quantitative indicators for each module in the framework, and, in some cases, it relied on qualitative indicators. Through these indicators (see Figure 6.2), the study measured and analyzed sustainable development and technology transfer in Qatar.

6.4.1 Sustainable Development: Conclusions and Policy Recommendations

Qatar has employed the basic tenets of sustainable development, which are to respond to the needs of this generation and future generations, and to develop the social, economic and environmental realms. Although Qatar has signed on to international sustainable development treaties, it has been slow to implement the desired plans because of human and institutional capacity constraints and, more importantly, the absence of adequate sustainability indicators to highlight immediate challenges. Qatar is currently focused on its economy growth. Its performance on measures of social and environmental well-being is lagging. Socially, Qatar is not on the path to sustainability because of exponential population increases that negatively affect Qataris' quality of life. Environmentally, Qatar's total carbon emissions from fossil fuels have increased considerably over the last two decades. Qatar's carbon footprint can be expected to expand over the next decade, with potential long-term negative consequences for human development, unless a radical solution is implemented. To find such a solution, Qatar must focus on the energy sector, which contributes the greatest share of emissions.

Arable land and water resources in Qatar are scarce, making it difficult for the country to develop carbon sinks and forests. Therefore, Qatar is vulnerable to climate change impacts. Qatar is ranked among the top ten countries in the world that will suffer land loss when sea-levels rise.

Qatar has almost no production of biomass but its food consumption is very high. However, it has invested in research and development, and it formed the National Committee for Climate Change under the Ministry of Environment to respond to these issues. In addition, this study suggests promoting innovation in manufacturing technology, supporting the creation of industrial clusters, encouraging innovation in materials management, and creating social economy groups and networks for recycling where relevant. Also, actions are needed to address population growth, individual consumption, energy efficiency and climate change.

The following policy recommendations are designed to encourage public-private partnerships and improve the effectiveness of the Ministry of Environment's sustainable development efforts:

1. Articulate wide priorities for sustainable development efforts
2. Develop clear goals, benchmarks, and measures aligned with above priorities
3. Maintain a collection of sustainable development indicators and use it to develop innovative technology transfer efforts
4. Identify technologies with commercial value
5. Develop a web-based means of sharing information across laboratories and public and private entities to utilize the commercial value
6. Enforce sustainable development policies

6.4.2 Governance and the Internal Environment: Conclusions

This study used its own set of good governance indicators to assess Qatar's government policy and the external environment. These indicators assessed government effectiveness through accountability; participation; transparency of information; the presence of a legal framework; the effectiveness of public and private enterprises; social development; culture and modernization; globalization; democratization and economic liberalization; vision and immediate priorities; international cooperation in SD and TT; SD organization and governance; and leadership capacity. This analysis is deemed to be more accurate than the good governance indicators available in the literature because this set of indicators directly addresses every aspect related to sustainability and technology transfer.

The assessment of good governance revealed that Qatar has many strengths, including extensive natural resources, a strong economy, excellent policies and initiatives, international agreements, good laws, ambitious industrial plans, and a vibrant market. The political and economic environment is a catalyst to development and technology. On the other hand, most laws and regulations do not address sustainable development and technology transfer directly. There is no industrial policy. The significant policy changes in recent years have been due to international or social pressures, or rivalry with neighbouring states. This has resulted in failure to develop indigenous capacity, an efficient value chain, value networks, and R&D capabilities. Therefore, this study concludes that Qatar does not govern its sustainable development and technology transfer initiatives efficiently. Real reforms are needed, not minor changes; deliverables are desired, not rhetoric. For this to happen, the government must focus on establishing basic social and political reforms that facilitate and secure economic changes. More specifically, Qatar’s immediate priorities should be to manage population growth, to promote sustainable levels of consumption and production, to halt climate change, to protect natural, and to build sustainable human capacity.

Corporate Governance

Assessing corporate governance is as important as assessing overall governance. Qatar has the ability to create a business environment that spurs innovation. To do this, it must create flexible sustainable development policies, support the sharing of information, and create quality certifications. Business leaders can then convert policy obligations to profitable opportunities, particularly if they are focused on green products, which are more competitive. Environmentally, sustainable development can be achieved through the development of innovative “green” products that decrease cost and increase capability. It is important to note that during the initial phases of economic development, environmental conditions degrade, but then improve because using green technologies offset the increasing harmful activities on the environment. Socially, poverty could be eliminated through the design of profitable products affordable for the poorer. Globalization could be achieved through diversity of management and attention to policies that affect employee attitudes, and corporate capacity should be built through designing company lead solutions to develop globally oriented skill levels.

6.4.3 External Technology Resources: Conclusions

This study distinguished between external and internal technology resources. However, both sets of assessment measures included number of staff in R&D, patents income, copyright income, license income, return on R&D investment and the level of cooperation reached. When assessing external resources, the donor was considered whereas for internal technology resources assessment, the same set of measures was used to analyze the host.

The main sources for technology transfer in Qatar are employment of experts, technical consultancy contracts, the purchase of machinery supplies, joint ventures and the purchase of total process contracting. The methods industries in Qatar select indicate that most employ a strategy of risk avoidance, which may lead to lack of competitive commercial and technological skills. These methods are not focused on transferring technology, but on increasing production and revenue. Data analysis showed a prevailing presumption that technology transfer is a by-product that occurs naturally. Joint ventures, for example, have not produced reliance and self sustainability.

Foreign Direct Investment (FDI), a possible source of technology transfer, appears to be picking up momentum in Qatar. However, the FDI in Qatar is a resource-seeking type focused mostly on oil and gas. FDI in the short-run is affected mainly by GDP and government spending, and these, in turn, are influenced by fluctuating energy prices. This creates an unstable environment for investors. Moreover, the investment environment is marred with an inadequately educated workforce, an inefficient bureaucracy, restrictive labor regulations, inadequate infrastructure, inadequate access to financing, and a poor work ethic among the national labor force. Since Qatar's technology gap is wide, FDI as a measure of technology transfer effectiveness is not recommended.

The most effective strategy for measuring the success of technology transfer from external sources is participation in research centers, followed by sales of patents, copyrights, and licenses, and the use of cooperative R&D for technology transfer. Accordingly, this study emphasized the use of these indicators.

6.4.4 Internal Technology Resources: Conclusion

The study was unable to use the above set of indicators to assess Qatar's internal technology resources because of data unavailability. The only data that could be gathered was that Qatari organizations have generated no patents in science and technology. While some organizations listed licenses on the survey, these were mostly software licenses that benefited the donors. Otherwise, the study found an adequate marketing (not technology) scanning environment and a reliance on external technology. The barriers to technology transfer that organizations listed on the survey included lack of knowledge and lack of R&D effectiveness. Thus, in spite of sparse data, this study revealed that the internal technology resource environment is replete with inefficient enterprises. The study recommends that future analyses track environment scanning budgets rather than rely on the subjective measure used in this study's survey.

6.4.5 Absorptive Capacity: Conclusions and Policy Recommendations

Absorptive capacity is the single most important concept related to the success of technology transfer and even of sustainable development initiatives. Therefore, this study pursued an in-depth investigation of Qatar's absorptive capacity through twelve indicators categorized broadly into marketing capabilities, breadth of knowledge, learning by doing and return on investment. The marketing capability assessment revealed lack of innovation, inferior marketing capacity and weak marketing strategies. The breadth of knowledge assessment showed adequate expatriate qualifications, but an inadequate environment for capacity building. The analysis of learning by doing revealed a good ICT infrastructure, solid teamwork and relevant training, but it also noted that qualifying citizens is time-consuming and costly. Finally, the assessment of return on investment revealed a strong economic performance as a result of investment in the oil and gas sectors.

With respect to capacity building and innovation, lack of local human skills and quality training are the greatest challenges. Without the ability to learn and integrate, initiatives fail. Sheer numbers are also a problem; Qatar's local population cannot support its energy sector's economic development. Thus, the country's reliance on an expatriate workforce will continue for the foreseeable future. To remedy this, education and vocational training need to create stronger ties to the labour market. At present, there is no standardization in the vocational system. Although the education reforms instituted in 2004 may seem to be progressing, they have not increased efficiency or quality. This is a failure of execution and leadership, not of vision. Without an executive body that has the authority to reinforce development initiatives, their success will be uncertain.

To build infrastructure in Qatar, major initiatives in ICT, education, transportation, and health have been promised, as well as new labour and economic regulations. However, little has been accomplished. For example, e-commerce and antitrust laws still do not exist, and most of what has been achieved has not been cost effective. Cultural resistance to performance measurement has been a key factor in the inferior performance of the public sector. In addition, government agencies within the public sector frequently fail to coordinate their efforts due to role uncertainty and power struggles. The e-government initiative could be categorized as at the "informational stage" – it is not yet mature. Certainly, building capacity is neither easy nor quick. Obstacles to capacity building in Qatar can be categorized into strategy, technology, policy and organizational barriers. It is recommended that the Qatari government create the conditions for businesses to succeed by investing in knowledge creation, innovation infrastructure. This can be achieved by:

- Formulating a science and technology strategy and national innovation model that fits within a sustainable development framework and takes national priorities into consideration. The policies within this strategy will address skill gaps at both national and local levels.
- Retaining and investing in staff, because knowledge is cumulative, systemic, and dependent on people for its transfer
- Funding education, training, research systems, measurement systems, IPR bodies, and standards development.
- Strengthening the global capabilities of innovative small and medium enterprises through availability of financing and incentives for innovation
- Establishing a central information database
- Establishing more research and development institutes
- Creating strict immigration policies to invite expatriates with high tech skills only in roles that would allow local skills to develop.
- Improving regulatory frameworks to facilitate multiple mechanisms for extended learning beyond the formal education system
- Adjusting education and training to meet constantly changing needs
- Building capacity through education and vocational skills training

6.4.6 Value Chain: Conclusions and Policy Recommendations

The value chains in Qatari industries produce cost-effective and high quality goods. The value chain in Qatar's industry is excellent. Qatari industries are able to capitalize on excellent procurement processes, competitive prices, high quality raw materials and finished goods, and fast delivery times. The industry's infrastructure is excellent because of state-of-the-art technology. Adequate management systems are in place to plan, organize, monitor and control the supply chain cycle. The sales performance is excellent due to the utilization of available natural resources. However, the main question facing industry is how to balance economic growth and climate stabilization. Liquefied natural gas may act as a bridge since renewable energy is capital intensive and cost inefficient. LNG is not considered as harmful to the environment when compared with other fossil fuels because of its low CO_2 emissions.

Another concern found in the discussion of value chain is the lack of innovation that is needed for sustainability. This calls for business leaders to support innovation and strategic planning. The choice of innovation processes must both support the long-term goals of the enterprise and help the organization achieve dynamic capabilities and sustainable growth.

To encourage enterprises to access and participate in value chains and enhance competitiveness, Qatar's government should:

1. Raise awareness of the concept of value chain
2. Increase private sector participation in joint consortia for joint marketing and procurement and provide financial support to improve accounts receivables
3. Encourage businesses to implement key performance indicators to create more efficient value chains
4. Increase energy efficiency
5. Increase the use of the e-government portal "Hukoomi"
6. Provide low-cost, high quality infrastructure for establishing industrial clusters
7. Encourage environment-friendly energy and material consumption
8. Create new specialist requirements within existing employment policies
9. Provide investment and working capital support to SMEs
10. Provide incentives for SMEs to invest in R&D and technology development

11. Privatize the petrochemical sector
12. Gather and publish data on industrial production capability
13. Provide incentives to encourage manufacturing investments that improve value chains

6.4.7 Value Networks: Conclusions and Policy Recommendations

Asset utilization, conversion ability, value enhancement, perceived value, and social value were used to assess the value networks in Qatar's industrial enterprises. Analysis of these indicators revealed that greater coordination and social skills would improve network values for corporations, industries, and R&D centres. Recommendations in this area included industrial clustering in areas such as health, education, hydrocarbon processing, tourism, construction, infrastructure development and ICT.

The most pressing need, however, is for an innovation and technology transfer policy to address the above issues. Governed by an overarching task force, the policy must be directed towards the creation of the collective intangible assets to produce innovation and reduce technology gaps. Table 6.1 outlines components of an innovative organization and lists key features for each component.

Table 6.1: Components of the Innovative Organization

Components	**Key Features**
Shared vision, strong leadership and the willingness to innovate	Clearly articulated and shared sense of purpose Stretching strategic intent Top management commitment
Appropriate structure	Organization design fosters creativity, learning and interaction. Not always a loose 'skunk works' model Appropriate balance between 'organic and mechanistic' options for particular contingencies
Key individuals	Persons within the organization become promoters , champions, gatekeepers and other roles that energize or facilitate innovation
Effective team work	Appropriate use of teams at local, cross-functional and inter-organizational level to solve problems Investment in team selection and building
Personnel development	Long-term commitment to education and training to ensure high levels of competence
Extensive	Communication structures exist internally and externally and between the

Components	Key Features
communication	organization and outside Internal communication goes in three directions - upwards, downwards, and laterally
High involvement in innovation	Participation in organization-wide continuous improvement activity
External focus	Internal and external customer orientation Extensive networking
Creative climate	Positive approach to creative ideas, supported by relevant motivation systems
Learning organization	High levels of involvement within and outside the firm in proactive experimentation, finding and solving problems, communicating and sharing experiences, and capturing and disseminating knowledge

Source: Tidd J, Bessant J, Pavitt K. Managing Innovation: Integrating Technological, market and Organizational Change. 3rd Edition. West Sussex, UK, John Wiley and Sons. 2005. p 469

6.4.8 Competitiveness in Qatar: Conclusions and Recommendations

This study used the Global Competitive Index, the Human Development Index, and an analysis of marketing capabilities to assess competitiveness in Qatar. Both GCI and HDI revealed high levels of competencies. To an extent, the study's marketing capability analysis supports the notion that the energy market is competitive and cost focused, as it uses its comparative advantage to reduce production costs and increase economies of scale. However, the analysis showed that Qatar's infrastructure and business efficiency need further development. This includes business legislation and labour regulations. Currently, there is no legislation to prevent the unlawful competition that restricts free trade. It is recommended that Qatar establishes a competition law and that it modify current labour laws to eliminate sponsors' tight control over imported labour. It is also recommended that corporations take advantage of available e-infrastructure to improve their business sophistication.

6.4.9 Research and Development: Conclusions and Policy Recommendations

This study finds that Qatar has a shortage of skilled workers in the R&D field, which puts limitations on developing the country's R&D capabilities. There is also a scarcity of R&D centers, particularly in Qatari industry, and there is no statistical data on R&D in Qatar. Most grants come from the government, as the private sector lacks R&D initiatives and cannot afford R&D expenditures. In other words, research and development is scarce in industry. There is no real cooperation between the industries and R&D centers, and the number of patents generated in science parks is almost nonexistent. Finally, only 16% of the research conducted in Qatar is carried out in the field of science and technology, with only 11.5% of Qatar's researchers involved.

At present, a number of factors make it possible to strengthen R&D in Qatar. The government now allocates 2.8% of its revenues to research and development, which is promising. Qatar Science & Technology Park has a centralized governance structure, which should enable it to have a greater impact on future technological development and to invite more innovations from other participants. However, QSTP seems to be the only organization that can develop a vision related to science and technology development in Qatar. This is problematic because QSTP does not focus on the social side of technological innovation. Additionally, QSTP has not yet established a policy related to innovation and technology transfer. Finally, the study did not find evidence that QSTP is creating close relationships between R&D, education, and vocational training.

Qatar's enterprises need to invest in three types of research: independent, product development, and product improvement. Independent research is the basic technology research conducted at QSTP and enterprise labs. This research is funded by QSTP. Product development research can also be located in both places, but funding is shared. Product improvement research must be located in the development department of the enterprise and must be funded from the enterprise's budget. The enterprise may choose to be a technology leader, product innovator, a follower, or some combination. Internally, the enterprise may choose to be centralized or decentralized in accordance with its own strategies.

6.5 Final Conclusions

Ultimately, this dissertation has shown that the technology transfer environment and practices in Qatar are ineffective in promoting sustainable development. Therefore, <u>Qatar is not on a path to sustainable development</u>. Furthermore, the results indicate that:

- Sustainable economic development cannot stand separate from social, environmental and technological development.
- Technology transfer positively influences organizational sustainability.

- The absence of R&D funds and the opportunity costs associated with this absence contribute significantly to the "underdeveloped" state of certain industries.
- Organizational directions determine the success of any technology transfer scheme.
- Qualified people are the most important asset for any successful technology transfer initiative.
- The educational and vocational systems in Qatar (or lack thereof) have contributed to the underdevelopment of the labour force.

6.6 Limitations and Future Research

This research project is the first of its kind in Qatar. The researcher faced tremendous difficulties in his efforts to address the main questions in this dissertation. These included:

- Issues with data collection and availability
- Scarce literature on technology transfer effectiveness generally and an absence of literature on technology transfer in Qatar,
- Disagreement on the appropriateness of particular sustainability indicators between scholars and practitioners
- Scarcity in literature on causal links between government and corporations
- Data reliability issues presented by the many obstacles that the researcher had to overcome. The resolution of these obstacles is summarized under the section "Insights from the Field Survey," paragraph 6.3.3 and within chapter five.

Moreover, the duration of the research project - over four years - presents significant data reliability issues, particularly in light of Qatar's rapid economic growth. During the course of this research, he researcher witnessed changes in priorities, such as a new emphasis on FDI. In response to this new emphasis, FDI has more than doubled within the last two years. Also, organizations and policies changed. The Supreme Council for Environment and Natural Sanctuaries was replaced by the Ministry of Environment, and the Planning Council changed to the General Secretariat of Development Planning.

Future researchers must not only consider the above but should also prepare for the fact that data is unavailable for many key indicators of sustainability and technology transfer. Sustainability indicators should include environmental (ecological footprint, environmental space and net primary production), social (living index and index of sustainable economic welfare), and economic (green net national product, genuine savings, safe minimum standards, and natural capital stock) indicators. The set of technology transfer indicators advocated within this dissertation suffers the most from data unavailability; this set includes measures of patent, copyright, and licenses income; return on R&D investment; environment scanning budgets; R&D expenditures; return on R&D investments; and R&D expenditures on a sector in relation to that sector's output. The researcher alone cannot measure all of these indicators; rather, every organization must develop its own KPIs. Enterprises can and should conduct their own research related to technology transfer and sustainability.

Finally, one means of extending this research is through a case study methodology. A case study could be used to examine sustainability and technology transfer in one of Qatar's oil and gas industries, non-fossil fuel industries, or an industrial cluster. This might provide rich insights that would ultimately assist Qatar in finding a path to sustainable development.

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Appendix A:

TECHNOLOGY TRANSFER EFFECTIVENESS IN QATAR

QUESTIONNAIRE (Original)

TECHNOLOGY TRANSFER EFFECTIVENESS IN QATAR

Dear Respondent,
The aim of this research of the dissertation is confined to an analysis of government agencies involved in technology transfer such as industries, universities and the Government sector. The ultimate objectives of the study are to:
• Establish measures of technology transfer
• Provide an up-to-date assessment of technology transfer in Qatar
• Suggest policies for implementation in industries, government sectors, and R&D laboratories in Qatar related to technology transfer and sustainable development
You have experience of considerable value to this study and I need to know your views on what it takes to manage change.
I am aware of the need to treat the findings with the utmost confidentiality. No source, individual or organizational will be identified or comment attributed without the express permission of the originator.
I hope you are able to contribute your help and should be pleased to receive any information or clarifications requests. Please do not hesitate to get in touch.

Sincerely,
Rashid Ali Mohammed Al-Saadi
S. Brig Engg DIS, QAF
PO Box 11711
Doha – Qatar
+974 5509123
+974 4650915
Email: itdc@qaf.mil.qa

General Information

Respondent Name =

Position =

Department=

Organization=

Mobile=

email=

Office Tel=

Fax=

Year Established

Type of Ownership

- (•) sole proprietorship
- ( ) partnership
- ( ) limited partnership
- ( ) limited liability company
- ( ) corporation
- ( ) nonprofit corporation
- ( ) cooperative

Local or Foreign Establishment

- ( ) Local
- ( ) Foreign
- ( ) Mixed

Section 1: External Resources
Q.1 What are your sources of technology transfer?

- [ ] Technology acquisition
- [ ] Licensing
- [ ] Joint venture
- [ ] Foreign Direct Investment
- [ ] Purchase of corporations
- [ ] Sale of technology data
- [ ] Technical personnel
- [ ] offset programmes
- [ ] Total project contracting
- [ ] Total process contracting
- [ ] Major process contracting
- [ ] Know-how contracts
- [ ] Patent contracts
- [ ] Trademark agreements
- [ ] Franchise agreement
- [ ] Engineering services contracts
- [ ] Technical consultancy contracts
- [ ] Purchasing machinery supplies
- [ ] Employment of experts
- [ ] Use of technical publications
- [ ] Use of personal contacts
- [ ] Others, (Please indicate strategy):

If you market products or services, what is the strategy/ies followed?

- Participation in Research Centers
- Sales of Patents
- Sales of Copyrights
- Sales of Licenses
- On-site seminars and conferences (seminars)
- Fliers, newsletters, or other mailed correspondence (mail)
- Person-to-person contacts of our scientific and technical personnel with persons in technology-recipient organizations (contacts)
- Presentations at scientific meetings sponsored by professional organizations (professional conferences)
- Presentations at scientific meetings sponsored by government organizations (government conferences)
- Membership in research consortia, university, or government centers (consortium)
- A central office with responsibility for technology transfer (office)
- Encouraging informal, on-site visits (visits)
- Personnel exchanges (exchange)
- Cooperative R&D (as a technology transfer strategy, rather than other possible purposes)
- Contractual relations for direct R&D funding between a lab and the organization receiving the technology (contract)
- Permitting persons from other organizations access to a laboratory's equipment and facilities (equipment access)
- Others, (Please indicate strategy):

Section 2: Your Organization

Q.3 What is the number of technology transfer projects currently underway that should diffuse unavailable technology in the organization?

Q.4 What is the number of licenses signed for external technology in the last year?

Q.5 Rate the success of the new technology at meeting its intended requirements.

- Success
- Partial success
- Failure

Q.6 How do you rate the efficiency of the organization information scanning systems?

- Optimal
- Advantageous
- Useful
- Not useful

Q.7 What is the percentage of new products using technology developed outside the organization?

Q.8 What is the percentage of sales due to products using technology developed outside the organization?

Q.9 What is the profitability of products (as percentage of all profits) due to products using technology developed outside the organization?

Q.10 Rate the degree of understanding within the organization of the technology-transfer process.

- Novice
- Intermediate
- Advance

Q.11 Rate the success of the organization at producing ultimately successful projects (i.e. on time, within budget, meeting specified requirements, accompanied by full documentation.

- Successful
- Partially successful
- Failure

Q.12 Rate the of successful team-working.

- Successful
- Partially successful
- Failure

Q.13 Rate the internal communication

- Successful
- Partially successful
- Failure

Q.14 Rate the staff morale.

- Highly motivated
- Motivated extrinsically
- Complacent

Q.15 There are several factors that hinder the process of technology transfer or cause projects to fail. Please select those that you think are a barrier to your business and rank them top- down.

☐ Lack of awareness: many organizations are not aware of available technology.

☐ Lack of knowledge: if an organization is short of skills and knowledge, it may be unable to use the technology offered.

☐ Lack of funds: organizations may be unable to purchase or develop technology.

☐ Lack of common interest: organizations may exhibit a lack of motivation to reach agreement or settle differences of opinions about available options.

☐ Conflict of interest: competing organizations may be unwilling to collaborate.

☐ Poor coordination: individuals within an organization or collaborating organizations fail to effectively coordinate about activities, processes, goals and directions of the venture.

☐ Lack of resources: this can include both physical resources and loss of a key member.

☐ Lack of time.

☐ Lack of trust.

☐ Technical problems

☐ Changes in the project structure

☐ Organizational problems

☐ Management attitudes

☐ R&d effectiveness

☐ Short-term pressure

☐ Resistance to change

☐ Poor information flow

☐ Weak links between customers and suppliers

☐ Dependency on public r&d institutions

☐ Cultural differences

☐ Geographic difference

☐ Legal constraints

☐ Administrative burdens

Section 3: Competitiveness

Q.16 Please evaluate from your perspective the effectiveness of methods for learning about competitors' innovations by indicating a value from 1, not at all effective to 7, very effective)

	Processes	Products
Consultation with employees of the innovative organization		
Independent R&D		
Patent disclosures		
Reverse engineering		
Licensing		
Hiring employees from innovation organizations		
Publications or open technical meetings		

Q.17 What are the major three activity fields this institution is focusing on?

Q.18 What is the organization's type of management?

Public

Private

Other

Section 4: Absorptive Capacity

Q.19 What is the information and communication technology budget as a percent to the organization annual budget?

Q.20 What is the amount of Sales by product?

	Annual sale volume (in 000 USD)
Product (A)	
Product (B)	
Product (C)	
Product (D)	

Q.21 Refering to Ansoff's product market growth mix, Where do you place your products?
for more information on the Matrix see:
http://en.wikipedia.org/wiki/Product-Market_Growth_Matrix

	Market Penetration	Market development	Product development	Diversification
Product (A)	☐	☐	☐	☐
Product (B)	☐	☐	☐	☐
Product (C)	☐	☐	☐	☐
Product (D)	☐	☐	☐	☐

Q.22 What is the amount of annual sales by service?

	Annual sale volume (in 000 USD)
Service (A)	
Service (B)	
Service (C)	
Service (D)	

Q.23 If you deal with Services, where do you place your services on Ansoff Matrix?

	Market Penetration	Market development	Service development	Diversification
Service (A)	☐	☐	☐	☐
Service (B)	☐	☐	☐	☐
Service (C)	☐	☐	☐	☐
Service (D)	☐	☐	☐	☐

Q.24 What are your three recommendations to drive market plans to success?

Q.25 What is your organization's Rate of Investment? Use this formula:ROI=((Gain from Investment - Cost of Investment))/(Cost of Investment)

Q.26 What is the organization's Liquidity Ratio (if applicable)? Use the formula of current assets / current liabilities

Q.27 What is the Return on Marketing Investment ROMI? Use ROMI=(Annual Revenues)/(Annual Marketing Expenditure)

Q.28 List the number of employee with respect to their qualifications in the grid below.

	Number of employees
PhD degree	
Masters Degree	
Bachelor Degree	
Higher Diploma	
Diploma	
Secondary Level	
Below secondary	
No qualifications	

Q.29 What is the employee turnover rate?

Q.30 What is the average training expenditure per employee?

Q.31 **What is the return on human investment ratio?** Use the formula HIR= Revenue – (cost-total remunerations)/ total remuneration

Q.32 Does the organization apply International Quality standards?

- Yes
- No
- If Yes, please list the Accreditation body

Q.33 What percentage of your employees has access to the internet from their desks?

- 100%
- 75%- 99%
- 50%-74%
- 25%-49%
- 10%-24%
- Less than 10%

Q.34 If your organization uses the internet, do you use it for

	Yes	No
Email		
Research		
Selling		

Q.35 Does your organization have a homepage site on the internet?

- Yes
- No

Q.36 What is your maximum capacity compared to your actual output? Maximum Capacity =

Actual Output =

Q.37 Does the tendering regulation enhance the internal business operation of our organization?

- Yes
- No

Q.38 For the past one year, how many surveys were conducted to elicit customer satisfactions on…

	Number of surveys
Product / service quality?	
Delivery?	
Staff service?	
Organization's reputation?	
Price value for money?	

Section 5: Value Networks

Q.39 If your organization engages in cooperative agreements, please indicate the level reached with each agreement between your organization and the overseas or local R&D institution.

	Number of R&D institutions
Networking: little communication	
Cooperation: formal communication and exchange of information	
Coordination: shared information and decision making	
Coalition: shared resources and frequent prioritized communication	
Collaboration: members belong to one system and census is reached on all decisions	

Q.40 How many cooperative agreements do you have with

	Number of cooperative agreements
Small and Medium Enterprises	
Larger Organizations	
Other R&D institutions	

Q.41 How well is the organization leveraging the followings?

	High value	Medium value	Low value
The financial and non-financial assets	○	○	○
Converting a competitors ideas into value added	○	○	○
Contribute ideas to other business partners	○	○	○
Access to ideas for other partners	○	○	○
Convert competitors intelligence into tangible value	○	○	○
Value output perceived by the recipient	○	○	○

Q.42 What variables, properties, or constraints might be affecting a participant's ability to create or add value?

Section 6: Organizational Culture

Q.43 Our organizational Culture is:

- Innovative
- Supportive
- Bureaucratic
- Effective

Q.44 Our organization runs its business through a culture of:

- Managing
- Leading
- Performance oriented
- Success oriented

Q.45 Technology diffusion channel here is:

- Formal
- Informal

Q.46 The interaction mechanism is:

- Intra-organization
- Inter-organization

Q.47 The technology transfer source is mainly:

- Assets (Hardware, Software)
- Capability

Q.48 The R&D sources here is:

- Human resources
- Ambitious of R&D staff
- Experience
- Staff
- Administrative support

Q.49 Technology absorptive ability adopted is:

- Adaptation
- Application
- Production

Q.50 Our organization has a leadership development programme

- Yes
- No

Q.51 The training is relevant to employee job and his level of expertise.

- Yes
- No

Q.52 After such training, employees immediately put what they learned into action

- Yes
- No

Q.53 After each training programme, trainees evaluate officially the programme then the training department takes action based on such feedback.

- Yes
- No

Q.54 Employee performance review is the base for selecting a training program for the employee.

- Yes
- No

Q.55 Rate the atitude of your organization.
1=Strongly disagree
7=Strongly Agree

	1	2	3	4	5	6	7
The trainee expects that the skills, knowledge and competencies acquired will be relevant for his/her job performance and career development.	○	○	○	○	○	○	○
The trainees receive the rewards as a result of their applying on their jobs the skills, knowledge, and competencies acquired in the programs.	○	○	○	○	○	○	○
Trainees are motivated to learn in a program.	○	○	○	○	○	○	○
The employees have the Opportunity to transfer their skills on their jobs	○	○	○	○	○	○	○
Our employees discuss new practices with their colleagues to promote the adoption of new ways to do our jobs	○	○	○	○	○	○	○
Our employees are always happy to tell their colleagues of their involvement in finding new ways to do things.	○	○	○	○	○	○	○
We check on the reputation of others providing us with information before we try to adopt new ways of doing things	○	○	○	○	○	○	○
To protect our reputation, we share information cautiously with others regarding new ways of doing things.	○	○	○	○	○	○	○
There is significant cooperation and collaboration among employees across functional roles	○	○	○	○	○	○	○
The number of years an employee worked in an organization and in a department	○	○	○	○	○	○	○
When we adopt new ways of doing things, we are in constant contact with workers in other areas.	○	○	○	○	○	○	○
Before we adopt new ways of doing things, we retrain our employees in the necessary skills	○	○	○	○	○	○	○

Section 7: Research & Development
Q.56 Does your organization allocate any resources (funds, time or effort) to research and development (R&D)?

○ Yes

○ No

Q.57 What Percentage of Research is classified as having some degree of commercial viability?

Q.58 Generally, investment in manufacturing is directed towards national priorities.

○ Yes

○ No

Q.59 What is the Government grants as percentage of total R&D expenditure?

Q.60 What is the ratio of global gross expenditure on R&D to total expenditure?

Q.61 Please indicate the proximity to other universities or R&D centers

	Number of Universities/ R&D centers
Next door	
Within5 kilometers	
Within 10 kilometers	
More than 10 kilometers	

Q.62 This question is only for Science Parks or independent R&D institutions: please fill in the table below:

	Number
Number of patents generated in science parks as compared to the total number of patents	
Number of scientific and technical publications	
Number of startups	
Number of products in development	
Number of products in the market	

Q.63 Fill in the Technology Transfer Indicators below:

	Number/ value
R&D Expenditure	
Number of Staff In R&D	
Number of Invention Disclosures	
Number of new patent application	
Number of Licenses	
License income	
The Ratio of Public To Private Universities	
Return On R&D Investment	
Number of start-up companies	
Land Grants	
Royalties Paid To R&D Staff	
Average Faculty Salary	
Number of jobs, supported by technology transfer from academic institutions	
Number of technology licenses to small companies	

Q.64 The number of faculty staff in this institution is:

	Number
Professor	
Assistant Professor	
Lecturer	
Teaching Assistant	
Associate Professor	

Appendix B:

TECHNOLOGY TRANSFER EFFECTIVENESS IN QATAR

QUESTIONNAIRE (Revised After Pilot Test)

Text of the Letter

TECHNOLOGY TRANSFER EFFECTIVENESS IN QATAR

Dear Respondent,
The aim of this research of the dissertation is confined to an analysis of government agencies involved in technology transfer such as industries, universities and the Government sector. The ultimate objectives of the study are to:
• Establish measures of technology transfer
• Provide an up-to-date assessment of technology transfer in Qatar
• Suggest policies for implementation in industries, government sectors, and R&D laboratories in Qatar related to technology transfer and sustainable development
You have experience of considerable value to this study and I need to know your views on what it takes to manage change.
I am aware of the need to treat the findings with the utmost responsibility. No source, individual or organizational will be identified or comment attributed without the express permission of the originator.
I hope you are able to contribute your help and should be pleased to receive any information or clarifications requests. Please do not hesitate to get in touch.

Sincerely,
Rashid Ali Mohammed Al-Saadi
S. Brig Engg DIS, QAF
PO Box 11711
Doha – Qatar
+974 5509123
+974 4650915
Email: itdc@qaf.mil.qa

The Questionnaire

General Information

Respondent Name =

Position =

Department=

Organization=

Mobile=

email=

Office Tel=

Fax=

Year Established

Type of Ownership

- sole proprietorship
- partnership
- limited partnership
- limited liability company
- corporation
- nonprofit corporation
- cooperative

Local or Foreign Establishment

- Local
- Foreign
- Mixed

Section 1: External Resources

Q.1 What are your sources of technology transfer?

- [ ] Joint venture
- [ ] Foreign Direct Investment
- [ ] Total process contracting
- [ ] Technical consultancy contracts
- [ ] Purchasing machinery supplies
- [ ] Employment of experts
- [ ] Others, (Please indicate strategy):

Q.2 If you market products or services, what is the strategy/ies followed?

☐ Others, (Please indicate strategy):

Section 2: Your Organization

Q.3 What is the number of technology transfer projects currently underway that should diffuse unavailable technology in the organization?

Q.4 What is the number of licenses signed for external technology in the last year?

Q.5 Rate the success of the new technology at meeting its intended requirements.

- Success
- Partial success
- Failure

Q.6 How do you rate the efficiency of the organization information scanning systems?

- Optimal
- Advantageous
- Useful
- Not useful

Q.7 What is the percentage of new products using technology developed outside the organization?

Q.8 What is the percentage of sales due to products using technology developed outside the organization?

Q.9 What is the profitability of products (as percentage of all profits) due to products using technology developed outside the organization?

Q.10 There are several factors that hinder the process of technology transfer or cause projects to fail. Please select those that you think are a barrier to your business and rank them top- down.

- ☐ Lack of awareness: many organizations are not aware of available technology.
- ☐ Lack of knowledge: if an organization is short of skills and knowledge, it may be unable to use the technology offered.
- ☐ Lack of funds: organizations may be unable to purchase or develop technology.
- ☐ Lack of common interest: organizations may exhibit a lack of motivation to reach agreement or settle differences of opinions about available options.
- ☐ Conflict of interest: competing organizations may be unwilling to collaborate.
- ☐ Poor coordination: individuals within an organization or collaborating organizations fail to effectively coordinate about activities, processes, goals and directions of the venture.
- ☐ Lack of resources: this can include both physical resources and loss of a key member.
- ☐ Lack of time.
- ☐ Lack of trust.
- ☐ Technical problems
- ☐ Changes in the project structure
- ☐ Organizational problems
- ☐ Management attitudes
- ☐ R&d effectiveness
- ☐ Short-term pressure
- ☐ Resistance to change
- ☐ Poor information flow
- ☐ Weak links between customers and suppliers
- ☐ Dependency on public r&d institutions
- ☐ Cultural differences
- ☐ Geographic difference
- ☐ Legal constraints
- ☐ Administrative burdens

Section 3: Competitiveness

Q.11 What are the major three activity fields this institution is focusing on?

Q.12 What is the organization's type of management?

- Public
- Private
- Other

Section 4: Absorptive Capacity

Q.13 What is the information and communication technology budget as a percent to the organization annual budget?

Q.14 What is the amount of Sales by product?

	Annual sale volume (in 000 USD)
Product (A)	
Product (B)	
Product (C)	
Product (D)	

Q.15 What are your three recommendations to drive market plans to success?

Q.16 List the number of employee with respect to their qualifications in the grid below.

	Number of employees
PhD degree	
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Higher Diploma	
Diploma	
Secondary Level	
Below secondary	
No qualifications	

Q.17 What is the average training expenditure per employee?

Q.18 What percentage of your employees has access to the internet from their desks?

- 100%
- 75%- 99%
- 50%-74%
- 25%-49%
- 10%-24%
- Less than 10%

Q.19 If your organization uses the internet, do you use it for

	Yes	No
Email		
Research		
Selling		

Q.20 Does your organization have a homepage site on the internet?

- Yes
- No

Q.21 Does the tendering regulation enhance the internal business operation of our organization?

- Yes
- No

Q.22 For the past one year, how many surveys were conducted to elicit customer satisfactions on…

	Number of surveys
Product / service quality?	
Delivery?	
Staff service?	
Organization's reputation?	
Price value for money?	

Section 5: Value Networks

Q.23 If your organization engages in cooperative agreements, please indicate the level reached with each agreement between your organization and the overseas or local R&D institution.

	Number of R&D institutions
Networking: little communication	
Cooperation: formal communication and exchange of information	
Coordination: shared information and decision making	
Coalition: shared resources and frequent prioritized communication	
Collaboration: members belong to one system and census is reached on all decisions	

Q.24 How many cooperative agreements do you have with

	Number of cooperative agreements
Small and Medium Enterprises	
Larger Organizations	
Other R&D institutions	

Q.25 What variables, properties, or constraints might be affecting a participant's ability to create or add value?

Section 6: Organizational Culture

Q.26 Our organizational Culture is:

- Innovative
- Supportive
- Bureaucratic
- Effective

Q.27 Our organization runs its business through a culture of:

- Managing
- Leading
- Performance oriented
- Success oriented

Q.28 Technology diffusion channel here is:

- Formal
- Informal

Q.29 The interaction mechanism is:

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- Inter-organization

Q.30 The technology transfer source is mainly:

- Assets (Hardware, Software)
- Capability

Q.31 The R&D sources here is:

- Human resources
- Ambitious of R&D staff
- Experience
- Staff
- Administrative support

Q.32 Technology absorptive ability adopted is:

- Adaptation
- Application
- Production

Q.33 Employee performance review is the base for selecting a training program for the employee.

- Yes
- No

Section 7: Research & Development

Q.34 Does your organization allocate any resources (funds, time or effort) to research and development (R&D)?

- Yes
- No

Q.35 What Percentage of Research is classified as having some degree of commercial viability?

Q.36 Generally, investment in manufacturing is directed towards national priorities.

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	Number
Number of patents generated in science parks as compared to the total number of patents	
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Number of startups	
Number of products in development	
Number of products in the market	

Q.41 Fill in the Technology Transfer Indicators below:

	Number/ value
R&D Expenditure	
Number of Staff In R&D	
Number of Invention Disclosures	
Number of new patent application	
Number of Licenses	
License income	
The Ratio of Public To Private Universities	
Return On R&D Investment	
Number of start-up companies	
Land Grants	
Royalties Paid To R&D Staff	

Average Faculty Salary

Number of jobs, supported by technology transfer from academic institutions

Number of technology licenses to small companies

Q.42 The number of faculty staff in this institution is:

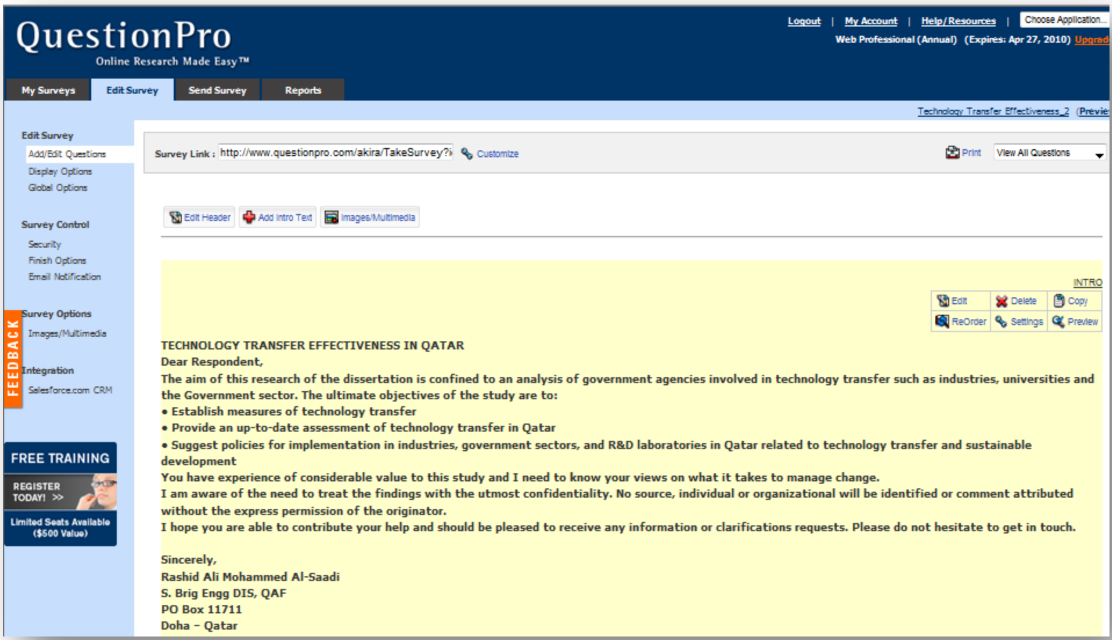
	Number
Professor	
Assistant Professor	
Lecturer	
Teaching Assistant	
Associate Professor	

THANK YOU FOR YOUR COOPERATION IN COMPLETING THE QUESTIONNAIRE

Appendix C:

QUESTIONPRO SCREENSHOTS OF THE QUESTIONNAIRE

First Screen



A Sample of Question Types

Section 1: External Resources

Q.1 What are your sources of technology transfer?

- ☐ Joint venture
- ☐ Foreign Direct Investment
- ☐ Total process contracting
- ☐ Technical consultancy contracts
- ☐ Purchasing machinery supplies
- ☐ Employment of experts
- ☐ Others, (Please indicate strategy):

Q.2 If you market products or services, what is the strategy followed?

Section 2: Your Organization

Q.1 What is the number of technology transfer projects currently underway that should diffuse unavailable technology in the organization?

Cranfield UNIVERSITY

Appendix D:

TECHNOLOGY TRANSFER EFFECTIVENESS IN QATAR

INTERVIEW QUESTIONS

General Information

Respondent Name=

Position=

Department=

Organization=

Mobile=

email=

Office Tel=

Fax=

Year Established=

Type of Ownership=

Local or Foreign Establishment=

Interview Questions

Q1. What are the challenges facing your organization that influences technology transfer?

Guide the interviewee to sources of technology transfer: rating new technology success, rating organization information scanning systems, percentage of new products using foreign technology sales due to products using foreign technology, profitability of products using foreign technology degree of understanding of the technology-transfer, barriers to technology transfer and current number of technology transfer projects.

Q2. How dependent is your production on foreign technology? What are you doing about it?

Guide the interviewee to assess allocation of resources to research and development, percentage of commercially viable research, Recommendations to drive market plans to success, return on human investment ratio, rating successful team-working, rating internal communication, and rating staff morale.

Q3. How does competition affect your organization?

Guide the interviewee to marketing strategies, effectiveness of methods for learning about competitors, major activity fields under focus, organization's type of management?

Q4. What are the most significant accomplishments of this organization?

Q5. How various agreements with international partners have impacted your market?

Cater for number of cooperative agreements related to technology, variables, properties, or constraints affecting adding value, organizational culture, technology diffusion channel, technology absorptive ability adopted

Q6. How do you compare your supply chain with other competitors?

Success of the organization at producing successful project, Efficiency of tendering systems

Q7. How can current legal legislation be improved to improve continual growth in is sector?

Environment Laws and regulations and government policies related to industry and technology

Appendix E:

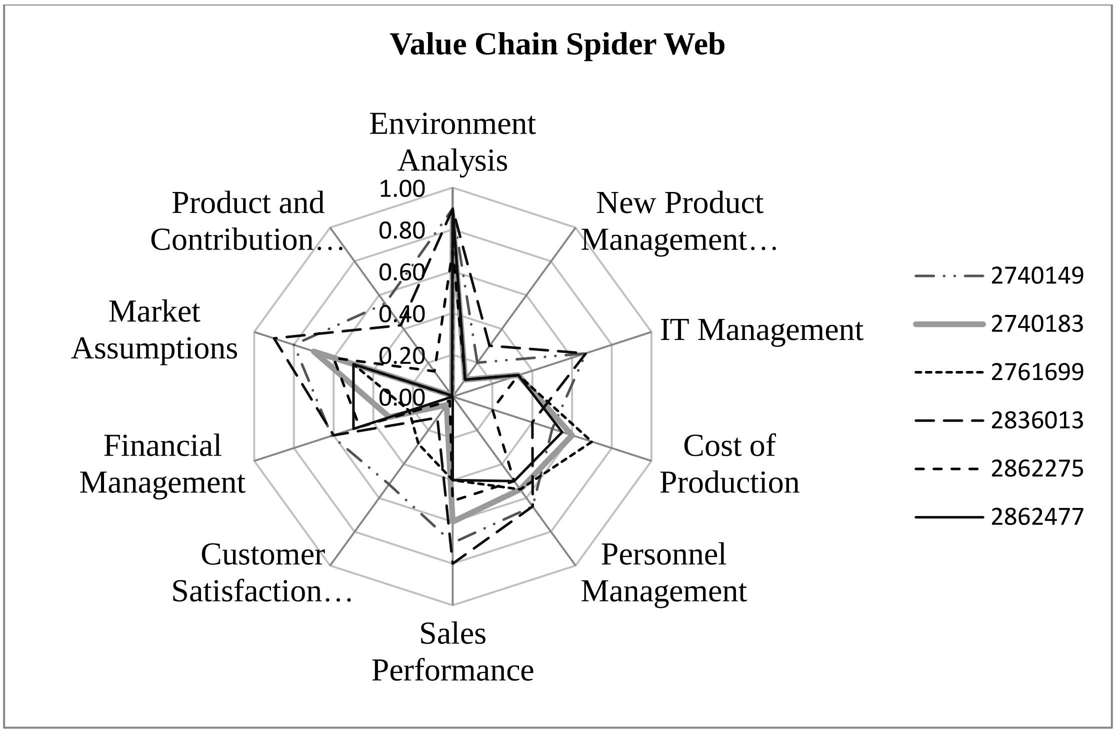
Calculating Perceived Value Chain of Major Qatar Industries

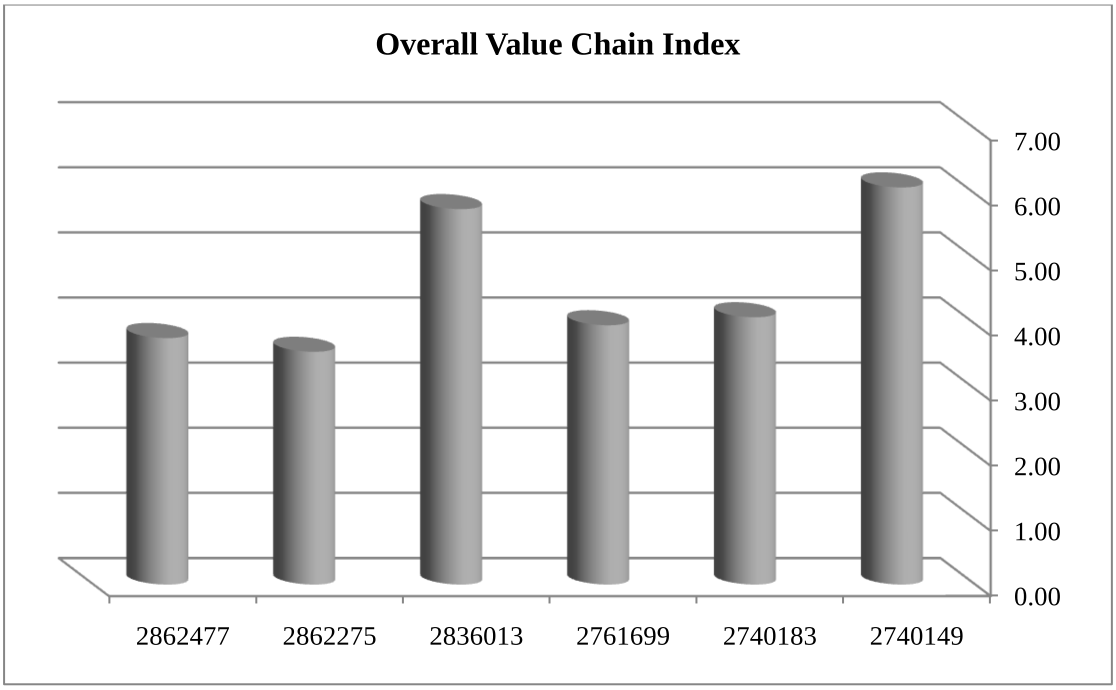
Based on the results of interviews and questionnaires survey, this study calculates perceived value chain of major Qatar Industries. The way this study calculates value chain indicators by comparing enterprises at each area is as follows:

1. Environmental Analysis: Assessment of Tendering Regulations: perceived
2. Contribution Analysis made towards GDP in percentage ratio: calculated
3. Market Assumptions: competitiveness and marketing capabilities: perceived
4. Financial Management: Return on Investment in percent: calculated
5. Customers Satisfaction Surveys: Benchmark comparison of variety of surveys towards the value chain: calculated
6. Sales Performance is judged by the number of contracts signed: perceived
7. Personnel management measured the KPI in-place: perceived
8. Cost of Production given a scale 0-1, 0 is high cost: perceived
9. IT management: IT policies and infrastructure: perceived
10. New Product Management measures innovation on a scale of 0-1, 1 is an innovative enterprise: perceived

Each area was given a point between 0 & 1, 0 being the lowest value unless indicated otherwise above. Then the aggregate of each enterprise resembled an overall value chain Index.

Enterprises		Environment Analysis	Product and Contribution Analysis	Market Assumptions	Financial Management	Customer Satisfaction Surveys	Sales Performance	Personnel Management	Cost of Production	IT Management	New Product Management Development	Overall Value Chain Index
1	2740149	0.90	0.55	0.80	0.61	0.52	0.70	0.65	0.50	0.67	0.20	6.10
2	2740183	0.85	0.01	0.70	0.32	0.05	0.60	0.55	0.60	0.33	0.10	4.11
3	2761699	0.90	0.00	0.50	0.22	0.28	0.40	0.55	0.70	0.33	0.10	3.98
4	2836013	0.90	0.42	0.90	0.60	0.13	0.80	0.65	0.40	0.67	0.30	5.77
5	2862275	0.70	0.015	0.60	0.47	0.03	0.50	0.50	0.20	0.33	0.10	3.58
6	2862477	0.90	0.01	0.50	0.50	0.00	0.40	0.50	0.55	0.33	0.10	3.79





Maximum value of the index = 10

Appendix F:

Summary and Risks to Sustainable Development and Technology Transfer Indicators in Qatar

No	Theme	Measure	Quantitative Indicator	Qualitative Indicator	Substitute Indicator	Risk to SD & TT Effectiveness
1	Sustainable Development	Environment Sustainability	Ecological Footprint=na		EF per Person = 11.4 tCO2 Water Severity =546%	High
			Environmental Space= na		Per Capita CO_2= 79.3t	High
			Net Primary Production=na	HANPP=no biomass Food Consumption =high		High
		Social Sustainability	Rate of population growth= 16%			High
			Misery Index =14.4%			High
			Living Index =na		Consumer Price Index =153.7% (2007)	High
			Human Development Index= 0.875			Low
			Index of Sustainable Economic Welfare=na	Economic growth is high, consumption is higher		High
		Economic Sustainability	Green Net National Product= na	GDP= high Inflation= high Investment =high Industry Productivity =increase Dependence on non-renewable sources= high		Economic Growth Risk = Low Economic Sustainability Risk = High
			Genuine Savings= na			
			Safe Minimum Standards= na			
			Natural Capital Stock= na			

No	Theme	Measure	Quantitative Indicator	Qualitative Indicator	Substitute Indicator	Risk to SD & TT Effectiveness
2	Government Policies and the Internal Environment	Good Governance		Accountability =no KPIs		High
				Participation =high state control		High
				Transparency =low level sharing of SD & TT information		High
				Legal Framework =no TT, SD, or innovation policies		High
				Public and private enterprises effectiveness =lack business sophistication		High
				Social development = government supports society		High
				Culture and modernization =not compatible values		High
				Globalization =reluctance		High
				Democracy =stagnant initiatives		Medium
				Economic Liberalization = financial crises pressure push		Medium
				Vision and priorities =Vision 2030		Low
				International cooperation in SD and TT =at networking low communication levels		High
				SD organization and governance= uncoordinated organizational efforts		Medium

No	Theme	Measure	Quantitative Indicator	Qualitative Indicator	Substitute Indicator	Risk to SD & TT Effectiveness
				Leadership capacity = under-developed		High
3	External Technology and Resources	Main Sources of Technology Transfer		Experts employment Consultancy contracts Machineries import Joint ventures Total process contracting		High
4	Internal Technology Transfer Measures	R&D staff	Total number of R&D staff in science & Technology = 110*			High
		Patent	Patent income =na		Number of patents =0	Medium
		Copyright	Copyright income =na			Medium
		Licenses	Licenses income =na		Average number of Licenses =1 Total number of licenses in Qatar=44	Medium
		R&D investment	Return on R&D investment =na			Medium
		Ongoing TT Projects	Average of TT projects= 1			Medium
		Environment Scanning	Environment scanning budget =na	Environment scanning = adequate		Medium
		Utilisation of Foreign Technology	%product using foreign technology= 86%*			High
5	Absorptive	Marketing		Ansoff's Matrix =market		High

No	Theme	Measure	Quantitative Indicator	Qualitative Indicator	Substitute Indicator	Risk to SD & TT Effectiveness
	Capacity	Capabilities		penetration		
				Marketing plans= price and production focus		High
			Average sales growth per product= 15%			Low
		Learning by Doing	Firm sites= 100%			Low
			Internet access=50%			Low
				Teamwork= very good		Low
				Communication= very good		Low
				Morale= very good		Low
			Training relevance= 67%			Low
		Breadth of Knowledge		Qualifications= majority workforce are Bachelors degree expatriates (39%)		High
			Average ICT Budget= 1.1%			High
			Annual training budget= US$ 2,400			Medium
			Number of Patents=0			High
		Return on Investment	Average industrial ROI = 27%*			Low
6	Value Chain	Environment Analysis		Environment analysis= excellent tendering regulations		Low
		Product and Contribution		Product and contribution analysis= 97% export depends on oil and gas		High

No	Theme	Measure	Quantitative Indicator	Qualitative Indicator	Substitute Indicator	Risk to SD & TT Effectiveness
		Analysis				
		Market Assumptions		Market assumptions= LNG sector will grow rapidly		Low
		Financial Management		Financial management= NA		
		Customer Surveys		Customer surveys= based on product $ service quality		Low
		Sales Performance		Sales performance= high ROIs		Low
		Performance management		Performance management= no KPIs		High
		Cost of production		Cost of production= low for petrochemicals, high for others		Medium
		IT management		IT management = at information level		High
		New product development		New product development= lack of innovation		High
7	Value Network	Asset utilization	Asset utilization=na	ROI is high		Low
		Conversion ability		High in oil & gas industry, low in others		Medium
		Value enhancement		Low number of agreements with R&D, no industrial clustering		High
		Perceived value		High customer trust on local products		Low
		Social value		Enterprises not competitive in TT Collaboration between TT		High

No	Theme	Measure	Quantitative Indicator	Qualitative Indicator	Substitute Indicator	Risk to SD & TT Effectiveness
				stakeholders is scarce No TT or innovation policies		
8	Competitiveness	Global Competition	Global Competitiveness Index= 4.95			Low
		Human Development	HDI= 0.875			Low
		Marketing capability		Competitive energy market Underdeveloped business and infrastructure efficiencies		High
9	Research and Development	R&D Expenditure	R&D expenditure= na			
			Average Gov. grants to R&D expenditure =81%*			Low
			Average R&D expend. to total expenditure =1.63%*			Medium
			R&D expenditure on a sector in relation to sector output =na			
		R&D returns	Return on R&D investment =na			
			R&D intensity =low			Medium
		Innovation output	Number of patents= 0			High
			Number of licenses=44			Medium
			Average percentage of commercially viable research= 32%*			Low
			Number of startup			High

No	Theme	Measure	Quantitative Indicator	Qualitative Indicator	Substitute Indicator	Risk to SD & TT Effectiveness
			companies= 2*			
			Ratio of public to private universities= 1 to 6			Low
		Researchers and location	Number of R&D staff in Qatar= 110*			High
			Proximity of universities to R&D centres= most within 2km			Low

na = data not available. *=see Appendix G

Source: Extract of measures from the measures and analysis of chapters 3, 4, and 5. For calculation of some figures, see Appendix G

Appendix G:

Calculations for Appendix F

G.1 Calculating the Total number of R&D staff in science & Technology

Because only 11.5% of the researchers (total 953) involved in science and technology research, then the S&T researchers are = 0.115 x 953 = 110

G.2 Calculating the percentage of product using foreign technology

Number of Respondents	Utilization of Foreign Technology
13	100%
4	60-80% approximately 70%
3	50%
Average	(13x100 + 4x70 + 3x50) / 20 = 86%

G.3 Calculating the Average ICT Budget

Enterprise	%ICT Budget
2718385	0.08000
2923089	0.05000
2923147	0.04000
2820527	0.02500
2709390	0.01000
2866351	0.01000
2923383	0.01000
2835486	0.00600
2862275	0.00300
2836013	0.00200
2740149	0.00120
2862458	0.00100
2820664	0.00060
2740183	0.00010
2820503	0.00010
2761699	0.00008
2862370	0.00005
2820488	0.00001
2862477	0.00001
2862500	0.00001
Average	0.01196

G.4 Calculating the Average ROI

Average industrial ROI for Industries Qatar has been taken since it represents over 6 industrial enterprises. Therefore, IQ's ROI = 27%

G.5 Calculating the Average Gov. Grants to R&D Expenditure

Entity	% Grants
ictQATAR	30%
Qatar Science and Technology Park	100%
Texas A&M University	90%
Carnegie Mellon University	85%
Qatar University	100%
AVERAGE	81%

G.6 Calculating the Average R&D Expend. to Total Expenditure

Entity	Ratio of R&D Expenditure
Energy Enterprise Number 2740149	0.03%
Energy Enterprise Number 2835486	0.30%
Texas A&M University	2.50%
Carnegie Mellon University	2.50%
Qatar University	2.80%
AVERAGE	1.63%

G.7 Calculating Commercially Viable Research

Enterprise	% of Commercially Viable Research
QP	100
QSTP, RasGas, Texas A&M, and Carnegie Mellon	75
ictQatar	30
QU	20
Total	225
Average (divide by 7 enterprises)	32.14286

G.8 Number of Startup Companies

Only QSTP has started two ventures locally.

Appendix H:

Participants in Field Survey

No.	Department	Organization	Pilot Test	Interview
1	DIS	Qatar Armed Forces		√
2	Government Information Office	ictQATAR	√	√
3	Information System Department	Ministry of Interior		√
4	Info. Technology	Qatar Petroleum	√	√
5	Qatar Fertilizer Company	QAFCO	√	√
6	Qatar Petrochemical Company	QAPCO		
7	QSTP	Qatar Science and Technology Park		√
8	GSDP	General Secretariat for development Planning	√	√
9	Ministry of Energy	Ministry of Energy		
10	Education Institute	Supreme Education Council	√	√
11	IQ	Industries Qatar		
12	RasGas	RasGas Company Limited		
13	Production	Qatar Gas		
14	QASCO	Qatar Steel Company		
15	QChem	QChem		√

No.	Department	Organization	Pilot Test	Interview
16	IT	Qatar Vinyl Company Ltd		
17	QAFAC	Qatar Fuel Additive Company		
18	Production	Qatar Electricity & Water Co		
19	Commercial organizations	Ministry of Economy and Commerce		
20	Information System Department	Ministry of Municipality and Urban Planning		√
21	Science	TEXAS A&M University		
22	R&D	Carnegie Mellon University		
23	QU	Qatar University		√