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Incorporating the Delphi Technique to investigate renewable energy technology transfer in Saudi Arabia

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INCORPORATING THE DELPHI TECHNIQUE TO INVESTIGATE
RENEWABLE ENERGY TECHNOLOGY TRANSFER IN SAUDI ARABIA

An Abstract of a Dissertation
Submitted
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Industrial Technology

Approved:

Dr. John Fecik, Committee Chair

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ABSTRACT

Saudi Arabia is a major oil-producing nation facing a rapidly-growing population, high unemployment, climate change, and the depletion of its natural resources, potentially including its oil supply. Technology transfer is regarded as a means to diversify countries' economies beyond their natural resources. This dissertation examined the opportunities and barriers to utilizing technology transfer successfully to build renewable energy resources in Saudi Arabia to diversify the economy beyond oil production. Examples of other developing countries that have successfully used technology transfer to transform their economies are explored, including Japan, Malaysia, and the United Arab Emirates. Brazil is presented as a detailed case study to illustrate its transition to an economy based to a much greater degree than before on renewable energy.

Following a pilot study, the Delphi Method was used in this research to gather the opinions of a panel of technology transfer experts consisting of 10 heterogeneous members of different institutions in the Kingdom of Saudi Arabia, including aviation, telecommunication, oil industry, education, health systems, and military and governmental organizations. In three rounds of questioning, the experts identified Education, Dependence on Oil, and Manpower as the 3 most significant factors influencing the potential for success of renewable energy technology transfer for Saudi Arabia. Political factors were also rated toward the "Very Important" end of a Likert scale and were discussed as they impact Education, Oil Dependence, and Manpower. The experts' opinions are presented and interpreted. They form the basis for recommended

future research and discussion of how in light of its political system and its dependence on oil, Saudi Arabia can realistically move forward on renewable energy technology transfer and secure its economic future.

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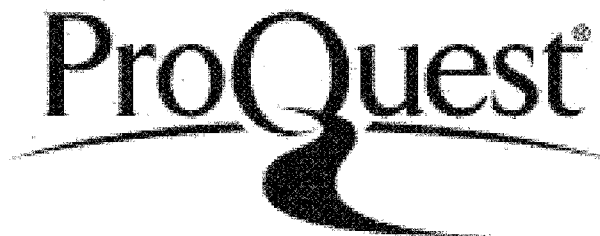


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CHAPTER 1

INTRODUCTION

Technology is one of the evolving applied sciences in the 21st century. In order for people to understand this evolution, they should look at everything surrounding them and how new technologies came to be. Most man-made products have evolved from the invention of the wheel in Mesopotamia, which is considered the world's first civilization (Harms, 2003), through the development of the wheel that we use in our mouse to scroll down the pages of electronic documents on our personal computers (PC's). The technology has evolved from ancient history to the cyber world of the Internet, where people from different cultural and religious backgrounds can freely communicate and conduct their business in virtual data rooms, where contracts and information are stored in secured data centers. After negotiation and agreements, technological products are shipped from one continent of the world to another in fewer than 21 days, and the money is transferred from one bank to another electronically. These technological products are transferred within countries and from one country to another, and adapted and distributed for specific applications.

Technology transfer is regarded as a means to diversify countries' economies beyond their natural resources. Most countries in the world today are facing the depletion of natural resources in the face of growing populations, the threat of climate change, and the challenge of developing sustainable economies and energy resources. Major oil-producing nations like Saudi Arabia are no exception. According to Al-Saleh (2011), "Not only do such countries need to consider adopting such sustainable energy means to

further secure their energy and economic futures but the potential key role that these countries could play in achieving a healthier future for generations to come should not be overlooked” (p. 303). Al-Saleh made the point that while Saudi-initiated research and development in renewable energy resources is lagging, there is promise in the fact that “the generation of technological capability within developing nations tends to be a matter of absorbing products and services developed in other countries and developing their knowledge about them over time” (p. 311). This dissertation explores opportunities and barriers to the use of technology transfer to build renewable energy resources in Saudi Arabia.

In recent years technology has been transferred from developed regions such as North America, Western Europe, and Japan to developing and undeveloped countries. The only difference between the developing and undeveloped countries is the ability to utilize that technology. A summary of technology transfer in several developing countries will serve as a foundation for a discussion of Saudi Arabia’s technology transfer challenges and opportunities.

Japan’s Technology Transfer Experience

In the last few years, Asian countries such as China have been competing in the world of technology transfer. Most Asian countries have adopted Japan’s system to develop their country in the competitive world of technology. After World War II, Japan was demolished, and they had to come up with a new strategy to revive their economy. The best way to do that was with technology:

Technology is what separates us from the Middle Ages; indeed it is what separates us from the way we lived 50,000 or more years ago. More than anything else

technology creates our world. It creates our wealth, our economy, our very way of being. (Arthur, 2009)

One of the most interesting topics in the world of industrialization is the Japanese experience and how it developed its technology transfer in the last four decades to become a top-flight player. Some types of technologies involved in Japan's production included cars, tires, industrial equipment and many other goods. For the Japanese to accomplish their objective, they decided to spend a lot of money on new technologies and license agreements from Europe and the United States with a training package from the host countries to train their manpower and managers how to operate and utilize that technology.

In addition, the Japanese government has invested a great amount of money in developing technology transfer organizations that support established manufacturers that collaborate with universities in research and development (Batarseh, 1994). An article called, "The Japanese Experience in Technology Transfer and How it may Apply to Saudi Arabia" was devoted to addressing the factors that optimized technology transfer in Japan as well as the obstacles encountered. Lack of manpower and highly educated personnel were some of the obstacles identified in the study, but Japan succeeded in overcoming these obstacles with their commitment to succeed in this area. To a great extent, some of the Asian countries such as China and Malaysia have adopted the Japanese system and have succeeded in the world of technology transfer, and the rest of the world is now relying on their technology. Japan is a country that desires to invest in undeveloped countries, even those without advanced technology, and the reason for that is to market its own products.

Malaysia's Technology Transfer Experience

Malaysia is another of the countries in the Far East that have witnessed a lot of technological development since the early 1970's as well as some political changes in their system. Malaysia differs from the rest of the Asian countries in that their economy was dominated by foreigners while native Malaysians focused on agriculture. Two of the biggest foreign populations in the Malaysian economy at that time were Chinese and Indians, while the Malaysian (Bumiputra) population controlled only about 1.9% of the economy (Henderson et al., 1977). Malaysia never succeeded in implementing their first economic plan of lifting up the standard of living for its citizens, due to the domination of foreign hands, which led to a race riot in 1969. That's when the government decided to restructure their system with the second economic plan along with the New Economic Policy (NEP). The NEP aimed to reduce reliance on foreigners and improve Malaysian manpower to switch ownership of the economy from 2.4% local ownership to 30 % (Shuid & Yunus, 2001). "With Japanese investment, heavy industries flourished and in a matter of years, Malaysian exports became the country's primary growth engine" (China Road and Bridge Corporation [CRBC], 2008). The plan has faced a lot of obstacles, but the main goal for the Malaysian government was to rebuild the country's infrastructure through education and manufacturing, which both collaborated in research and development (R&D).

Under Prime Minister Mahathir bin Mohammad, the country's economy dramatically grew in the years from 1980-1990 and continues to grow (Spaeth, 1996). The second economic plan has shown great success under his administration with many

development projects completed by Malaysian nationals. Visitors flying into Kuala Lumpur, the capital of Malaysia, see one of the most significant monuments of new construction, symbolized by two of the tallest towers in the world (Petronas Twin Tower). This is a sign of Malaysian success.

United Arab Emirates' Technology Transfer Experience

In contrast to the economic development in Malaysia and in other parts of the world where skyscrapers are competing, in the middle of the hot desert is Dubai. Dubai is one of the biggest states in the United Arab Emirates (UAE). In addition it has the most expensive cost of living in the region. The city has transformed since the 1990's, moving to development and construction in diversifying their economy and not relying totally on oil production. Their main focus was to improve tourism and real estate to attract foreign investors by declaring a free trade zone and port (Christopher, 2005).

The country has been importing a lot of foreign construction companies and equipment to build one of the most beautiful cities in the world. Emirates are estimated to be the minority of approximately 90,000 of the whole population, or 8% of the majority of expatriates mostly from South Asia who do the menial jobs. With European management and the funding of the government, the country has been constructing resorts and skyscrapers and even an indoor ski resort to make it one of the most attractive tourist attractions in the world (Christopher, 2005). Unfortunately, due to the global economic crisis, fewer tourists have been visiting the city, and a lot of investors have sold their real estate properties and fled the country: "A longer-term assessment of Dubai's

property market . . . showed depreciation; some properties lost as much as 64% of their value from 2001 to November 2008” (Dubai’s Palm, 2008).

By 2009 Dubai had taken a big economic hit as foreigners fled to nearby countries looking for jobs; construction has slowed down and devaluation of property values has occurred (Worth, 2009). “As of February 2009 Dubai's foreign debt was estimated at approximately USD 100 billion, leaving each of the Emirates’ 250,000 UAE nationals responsible for 400,000 USD in foreign debt . . . ” (Dubai Economy, 2008). The factor that has most affected Dubai’s investments is the greater focus on development and less on the infrastructure, including education, manpower, and R&D.

United Arab Emirates’ and Malaysia’s Technology Transfer: Comparison

Looking at both countries, the UAE and Malaysia, we can understand the differences as well as their shared backgrounds. Both of them are small Islamic countries and very involved in construction and tourism as another source of their economic income. Malaysia spends a lot of money building their infrastructure in manpower, education, R&D, and diffusing technology. In addition, they utilized that technology and produced a manufacturing industry. On the other hand, the UAE relied on tourism, real estate, foreign manpower, foreign education, and foreign research and development. This comparison proves that technology is the base of any economy. The better they do in transferring technology and diffusing other technology, the more efficient the economy will become especially in the technological era. The difference between the countries is that one has adopted the Japanese system and invested in technology while the other has not.

Saudi Arabia's Technology Transfer Experience

Saudi Arabia is located in the center of the Middle East, and some say it is the center of the world; most cargo travels between the East and the West via the Red Sea, which makes it a unique trade platform for investors. In addition to its location, Saudi Arabia is considered to be the largest exporter of oil, and it is an important member of the Organization of Petroleum Exporting Countries (OPEC).

The petroleum sector accounts for roughly 80% of budget revenues, 45% of Gross Domestic Product (GDP), and 90% of export earnings. About 40% of GDP comes from the private sector. Roughly 6.4 million foreign workers play an important role in the Saudi economy, particularly in the oil and service sectors (Central Intelligence Agency, 2009).

Since becoming a member of the World Trade Organization (WTO) in 2005, the country has been heavily investing, trying to build their infrastructure and compete in the world of industrial technology. Technology has been transferred from most parts of the world to Saudi Arabia. As the country attempts to build its infrastructure such as manpower, education, research and development, manufacturing, and technology transfer, at the same time they are building six large economic centers in different parts of the region. The idea of diversifying the economy and not relying on oil production is one of the strategies the country is beginning to pursue (Central Intelligence Agency, 2009). This strategy has attracted more foreign workers and investors to the area. These economic centers or cities are mentioned in some research as *technopoles*, which consume time and enormous financing. Technopoles are built for three simple reasons.

First is to reindustrialize the country, second to develop undeveloped regions, and finally to help the country become more innovative (Hall, 1993). The most important question to be asked is if the Kingdom is too focused on the technopoles, or if it is ready to use technology transfer as part of a serious commitment to developing renewable energy resources.

In the early 90's, Japan was interested in transferring most of their technology process developments to Saudi Arabia because of its reserve of oil (Batarseh, 1994). Japan now recommends that Saudi Arabia should diversify its economy and not rely 100% on oil, because of the risk of decreasing demand. Furthermore, it recommends improving information technology, manpower, R & D, education, industries, cooperation with developed nations, financial resources, and free enterprise under government guidance.

Statement of the Problem

Saudi Arabia still relies on oil production for 90% of its income in spite of the need to diversify the economy. Mouawad (2005) reported that the Kingdom was beginning to make changes to make its economy less dependent on oil due to the risk of a collapse in oil prices. The James A. Baker III Institute for Public Policy of Rice University prepared a detailed report on energy supply, security, and pricing that described this risk in great detail (Jaffe, 1996). The report was based on the idea that “there are special economic and geopolitical risks associated with addressing the world’s thirst for oil by accepting expanded reliance on a single geographical area—the Middle East Gulf, which is fraught with political instability and socio-economic challenges”

(p. 3). The risks presented were not just for the consumer nations, but for the global economy including the producers. The global economy has only worsened and political instability in the Middle East only increased since then, and specific warnings in Rice's report have come true, such as competition with Asian countries for oil supply and the military implications of this, along with threats to the Straits of Hormuz, through which Saudi Arabia's oil exports must pass ("We Will Not Tolerate It," 2011).

Saudi Arabia has one of the largest oil fields in the world (Ghawar), a major part of Saudi Arabia's oil production, but it has shown signs of flagging (Rubin, 2009).

Engineers have been pumping sea water into the oil pipes to increase the pressure that forces the oil up, which is a sign of decreasing production. As cited in Rubin (2009), this finding comes from an "alarming study of the world's oil reserves called *The Coming Oil Crisis*, by Dr. Colin Campbell, a Cambridge-educated retired senior geologist who had spent the better part of his life exploring the world for new reserves" (p. 8). Rubin noted that the title of Campbell's book pretty much gives away the ending. In another study cited by Rubin, a book called *Hubert's Peak*, the author predicted that oil production would increase from 2008 to 2010 and then would start decreasing until it is gone. Saudi Arabia has been relying on oil production for most of their energy sources such as electricity and water, at a time when oil production is decreasing. At CleanTechnica.com, Chadha (2011) summarized a Wikileaks cable in which a Saudi oil executive warns the U.S. that Saudi Arabia may have overestimated its oil reserves by as much as 40% (300 billion barrels). A reduction in production capacity is taken by various sources as an indication that Saudi Arabia should consider alternative sources of energy (*Scientific*

American, 2007). The only possible way of doing that is by transferring the right technology to the country and utilizing it in a more effective way.

Throughout the Arab world, oil meets about 53% of energy demand, gas about 43%, and hydropower, coal, and renewables only about 2% (Gelil, 2009). Saudi Arabia is leading the world in population growth rate and enormous new construction projects, with the result being an annual estimated 6.4% rise in electricity consumption and the possibility that demand for electricity will outpace the Kingdom's ability to build new power plants and distribution systems (King Abdulaziz City, n.d.). Most of Saudi Arabia's energy is based on oil-fired plants, which produce around 3,000 megawatts of power a year. This production is equivalent to three nuclear power plants in North America. The country is also planning to increase the production of the plants to reach 5,000 megawatts by 2020 (Rubin, 2009). This plan proves that Saudi energy is currently more reliant on oil and natural gas than on the possibility of switching to alternative energy.

Saudi Arabia's massive economic development projects, the technopoles or Economic Cities, are an effort to make the culture more global and less dependent on oil, meanwhile creating a million or more new jobs. The drawback is that the country's infrastructure is crumbling, and some see the Economic Cities' innovations in technology and energy use as unlikely to trickle outward to benefit the country as a whole.

Several people here expressed outrage that the government was pouring billions of dollars into the creation of entire new cities while large areas of existing ones had deteriorated into slums. Jidda, for example, already has a port in desperate need of upgrading. Its historic center is a medieval slum inhabited by foreign laborers. The city has no sewer system, only septic tanks that regularly spill into the streets. (Ouroussoff, 2010)

Such description suggests the potential difficulty of transferring and evenly distributing renewable energy technology throughout the country. A study by Al-Thawwad (1999) summarized a number of additional factors that affect the transfer of technology. These factors included culture (knowledge, skills, training, etc), physical environment (adapting to local conditions), and geographical location (availability of parts and raw materials). The factors are “directly linked to the success of technology transfer and its sustainability” (Al-Thawwad, p.13). Al-Saleh (2011) pointed out that since the publication of a national science and technology policy for Saudi Arabia in 2002, “no major work has been undertaken to translate the aim into strategies, programmes, and detailed projects . . . there are no announced national targets for renewable energy or even carbon emissions reduction” (p. 312). Ouroussoff’s (2010) article in the *New York Times* on Saudi Arabia’s Economic Cities quoted Bernard Haykel, an American professor and Saudi Arabia scholar, on the risk of Saudi Arabia’s current approach:

If these cities don’t work, and they can’t produce jobs and, say, the price of oil drops, you could have masses of people mobilizing against the government, and it could take the form of religious extremism. But in the long run if they don’t produce an economy that’s not dependent on oil, the country itself becomes unviable. (Ouroussoff, 2010)

The consensus among the experts reviewed for this literature review is that Saudi Arabia is not investing enough time, attention, and resources in the right areas to match its growing energy needs.

All the problems described here are happening in a region of the world that is “particularly vulnerable to climate change” (Gelil, 2009). Before Saudi Arabia can diffuse and utilize the right technology such as alternative energy, it must eliminate

barriers to the successful transfer of technology. The problem in the present study is to identify those barriers and their relative importance through literature review and primary research with a panel of experts. Reducing the Kingdom's oil dependence is an opportunity too important to delay.

Statement of Purpose

The purpose of this study is to investigate expert opinions regarding factors that may affect technology transfer in Saudi Arabia as a means to diversify the economy of Saudi Arabia beyond oil production. The Delphi Method will be used in this research to gather the opinions of a panel of experts whose expertise the validity of the research depends on.

Need and Justification for the Study

There is some published information on the need for Saudi Arabia to expand its industrial focus to renewable energy, but no research could be located that focused exclusively on renewable energy and technology transfer in Saudi Arabia. This study is intended to help improve the transfer of technologies in a growing economy in order to industrialize and diversify the country's consumption and production beyond oil. The development of renewable energy resources has the potential to reduce Saudi Arabia's high unemployment rate and the reliance on foreign manpower and to rebuild the country's infrastructure as collaboration in R&D of renewable sources of energy improves.

Research Questions

The following research questions were developed from the review of published literature presented in this chapter and were addressed during the course of this research project:

1. What is the importance of improving the transfer of technologies into and within Saudi Arabia?
2. What are the factors that have affected the transfer of renewable energy technologies to Saudi Arabia?
3. What is necessary to improve the transfer of technologies in Saudi Arabia?

Assumptions

The assumptions of the study were as follows:

1. Collecting perspectives from a variety of technology-related institutions within Saudi Arabia will provide the best background information about the transfer of technology in Saudi Arabia.
2. Applying the Delphi Technique is an effective method to investigate the factors that affect the technology transfer process.

Delimitations

The study, first of all, is limited only to the role of renewable energy technology transfer as a means to diversify the economy of Saudi Arabia beyond oil production. The Delphi methodology was applied to determine what factors affect the technology transfer process. The whole process of the technique is based solely on the panel of Saudi experts and their opinions.

Procedures

This project identified issues related to technology transfer in Saudi Arabia. The researcher conducted a pilot study to test the questions and then finalized a panel of experts and a set of research questions. The questions were answered by a total of ten experts in three rounds based on the outcomes of each round.

Definition of Terms

The following terms are used in this study. Although they are not unique, they are defined here so that all readers may have a common understanding of their use within this study.

Delphi Method: Delphi is as a method for structuring a group communication process so that the process is effective in allowing a group of individuals to deal with a complex problem (Linstone & Turoff, 1975).

Technology: The study, development, and application of devices, machines, and techniques for manufacturing and productive processes (TechMotivator, 2009).

Technology Transfer: Technology transfer refers to the process of commercializing the products of research for economic and social benefit (“Intellectual Property,” 2010).

Technology Diffusion: The spreading or utilizing technology within organizations, individuals, or the society is termed diffusion (Markert, 1993).

Technopoles: Technopoles are economic and industrial cities that are built for three simple reasons, first to reindustrialize the country, second to develop un-developed regions, and finally to become innovative (Hall, 1993).

A comprehensive literature review follows this chapter; it will discuss technology transfer and the challenges for developing countries, especially Saudi Arabia, in their technology transfer efforts. The literature review includes a case study describing Brazil's success in moving toward reliance on renewable sources of energy, a case which may apply as a model for oil-dependent countries like Saudi Arabia. Chapter 3 explains the Delphi method used in this study, and Chapter 4 presents results of the pilot and major studies, which were carried out over approximately two months. The dissertation concludes with discussion and recommendations in Chapter 5.

CHAPTER 2

REVIEW OF LITERATURE

Technology Transfer

Technology transfer has been described by many researchers in recent years. Existing technology from one area is transferred to some other geographical, cultural, political, or technical setting, and those accepting the transferred technology utilize it. Groups that know how to use the technology can process and apply it and have the ability to be engaged in the production, marketing, accounting or management sides (Rogers, 1995).

Choi (2009) recognized that one of the problems in understanding and effectively accomplishing technology transfer is defining technology in the first place, because as he explained, “Technology is situation and value specific” (p. 49). To take into account that technology and technology transfer mean different things in different times and places, Choi favored a definition of technology as including not just one component, but three: object, process, and knowledge. This means that successful technology transfer, according to Choi, depends on integrating all of the major facets of the technology. The process then continues until the technology spreads and is fully utilized, a process termed *diffusion* by Markert (1993). Choi (2009) emphasized that diffusion has not really happened until the technology adopters start changing and adapting the technology to best fit their own needs and applications.

Researchers write of the fundamentals of technology transfers including items, a developer, channels for utilizing the technology, and a receiver (Asheghian & Ebrahimi,

1990), with the main focus on the technology's producer; however, diffusion is specifically concerned with the end user (Rogers, 1995). Knowledge, skills, and resources are critical to achieve the end user's ultimate goal, which is "commercializing the products of research for economic and social benefit" ("Intellectual Property," 2010).

Because technology is a means of accomplishing a purpose that is socially viable for a population, its objective is dual in nature, i.e. intellectual and technological (U.S. Air Force, 2009). Coordinated technology and markets must be developed and partnered with other recognized bodies that have the same underlying objectives, for example manufacturing and construction. These entities must have the economic capabilities to interact. Distribution marketing is mandatory for there to be profitability and longevity in the population. The above-mentioned entities must maintain interconnectedness so that all the parameters relating to the business at hand is capable of attaining the goals. The goals, on the other hand, are totally dependent on the market. Choi (2009) went a step beyond the idea of successfully developing markets for transferred technology in arguing that success can really only be measured when it begins to stimulate even more new innovations:

Technology transfer should not be seen as an end in itself. It is a means to increase the rate of technological innovation and to stimulate new innovation. Thus, today's recipients can be tomorrow's donors through a successful transfer of technology. (p. 55-56)

Factors Influencing the Success of Technology Transfer

There are five key factors in the successful transfer of technology, according to Rogers (1983):

1. When comparing performance, capabilities, and reliability of the current technologies, the technology involved must have an advantage. It must in some way exceed instead of just competing with the others.
2. New technologies should be capable of interfacing with existing technologies for the new technologies to succeed. For example, language is extremely important. If English was the primary communication tool of a transferred technology, then the technology must be adapted to the language of the host country. Because technological transfers are important for developed, industrialized nations, the relevance of English as the main communicating tool would no doubt play a role in these transfers. Success would depend on whether the country that requires or needs the transfers is able to communicate effectively in English. If not, the technology's usability and maintainability, along with the feasibility of training required to use it, would all be in question.
3. Technology transfer should show concrete results to the recipients of the transfers in order to demonstrate viability.
4. If the transfer fails to produce results in economic development, then it will be seen as not worthy of investing in and no further progress will be made in developing it.

Choi (2009) concurred with Rogers' (1983) analysis in that transferred technology has to have tangible benefits for the country adapting the technology and lead to increased competitive advantage in that area of technology. According to Choi and others,

this beneficial scenario is only possible if all the complexities of technology transfer are considered and planned for, the most important of these being the human element: the ability of people to learn the technology, collaborate with all the relevant parties involved, promote the technology in the larger culture, and so on.

Technology Transfer Drawbacks

Technological transfer has some drawbacks as countries try to make it effective for proliferation in the domain it was planned for (U.S. Air Force, 2009). Numerous parties can be involved, but the consumers will always be affected. The high cost of licenses and agreements needed to transfer a new technology to another party can make it more expensive at the consumer level. Ultimately, entities or private enterprises developing new technologies should have relationships with other recognized bodies that could improve their position in the markets.

Developers of the technology need to access partners to make technology available and expedited for public use. Sometimes, developers of a technology realize the probability that the technology might have no commercial value because the developer is a research institute or a university and would be unable to commercialize it. In this situation, partnering with others that have the capability could fix the problem. Developers, and ultimately consumers, often see additional benefits in making their technology accessible to others instead of utilizing it themselves if they do one or more of the following, according to Mendes (2009): (a) Partnering with companies that have an expansive market, (b) Making sure that all phases of their technology can be completed, (c) Finding companies that can produce results, (d) Marketing and distributing in ways

that make the main components of the technology economically viable, (e) Realizing the entire scope of the technology, so that there is an ability to diversify into other areas, i.e. diagnostics to implementation, and (f) Utilizing the technology for diagnostic purposes and then giving consent to others to commercialize its implementation possibilities.

Mendes's recommendations could apply both to companies transferring technologies in, or to companies finding applications and markets for technologies they have developed. Lichtenthaler and Lichtenthaler (2010) verified Mendes's recommendations, but pursued a more detailed look at the challenges and often missed opportunities involved, especially for companies looking to partner with other companies that can produce results and appreciate the entire scope of the technology's potential. Lichtenthaler argued that companies often fail to identify the full range of transfer opportunities and profitable applications possible with a technology. For this reason, he argued that "a firm needs both technological and market knowledge."

Case Study: Brazil

Saudi Arabia shares some important similarities with Brazil. Brazil's economy was once almost totally dependent on oil (Chiong Meza & Dijkema, 2009) as Saudi Arabia's is now. Like Saudi Arabia, the population of Brazil is growing at a rapid rate of 1.4 % per year, which is only a little less than the 1.5 % population growth the rest of Latin America is experiencing (Cavaliero & Peres daSilva, 2005). With population growth comes increased energy consumption per capita. Unlike Saudi Arabia, Brazil has made a successful transition to an economy based much more on renewable sources of energy,

especially ethanol, to the degree that 46% of its energy now comes from renewable sources (“Latin America,” 2011).

Several factors motivated Brazil to initiate this change. The unsustainability and unreliability of utilizing the natural resources it had depended on before was very important; these included gold, coffee, and rubber (Friedman, 2009). The problem with gold was that it was in remote areas where economic activity could not be sustained for long periods of time, and gold mining was destroying the environment (Burns, 1998). For coffee, the amount of time it took for the newly planted coffee trees to grow large enough to produce beans was a hindrance, and the competition with other coffee growers in the Caribbean along with world oversupply became greater and greater challenges (Burns, 1998). The turning point in the rubber industry came after seeds were smuggled out of Brazil and brought to Indonesia, and then the invention of synthetic rubber (Woods Hole Research Center, 2007). These developments led to high competition in the production of rubber and shrinkage in Brazil’s income.

An even more important development that caused Brazil to look at its energy security situation and focus on renewable forms was an oil crisis and a major drop in oil prices in the early 1970s (Chiong Meza & Dijkema, 2009). At that time, the military government began promoting bio-ethanol as an oil substitute along with taking steps to strengthen the sugar industry. Brazil’s government, which has moved from military regimes to a more democratic form of government since then, has continued to take direct measures as outlined by Chiong Meza and Dijkema, such as investment programs, tax policies, ethanol mandates for gasoline, and other regulatory steps.

Another important factor in Brazil's transition has been manpower, which the present study identifies as a major problem for Saudi Arabia. For Brazil, local manpower enabled Brazil to transfer renewable technologies and to manufacture most of their renewable energy in the country and at a low cost (Muylaert de Araujo, 2006). In other words, Brazil's own people are able to produce renewable energy and utilize it at a fraction of what it would cost to import it.

Besides the measures already mentioned, funding for research has been a strong point for Brazil. Brazil's science and technology research is often developed at public universities, as well as research institutes. With all of the government regulations and policies, investments in research towards technology have been rapidly growing over the past decades in universities and many local companies. The majority of the funding comes from government sources (Chiong Meza & Dijkema, 2009). It is believed that Brazilian information technology is comparable to the quality one would get from China or India, but with more limitations on its software exports. Brazil has made grants available to companies involved in the effort to develop sustainable energy, as well as allowing forgivable loans for any companies producing these energies (Innocenzi, 2008).

One of Brazil's major steps in the direction of producing a sustainable energy economy came in 2000. That was when they first started producing completely Brazilian-made wind turbines. The switch to completely Brazilian-made wind turbines not only reduced the cost of the turbines, which were manufactured at a small part of the cost, but it also improved an already growing industry in Brazil (Lenzen & Wachsmann, 2004). By 2001, 35 wind turbines had been installed in the states of Ceara and Parana,

producing 17.5 megawatts, which eventually accounted for 81% of the total wind power produced in Brazil (Muylaert de Araujo, 2006). Wind turbines are an excellent solution to Brazil's rising energy needs.

Hydro-electric power makes up to 90% of Brazil's electrical power today (Inderscience, 2007), but bio-fuel has been possibly the most important step towards the development of Brazil's sustainable energy economy. Brazil is the number one producer of Bio-fuels in the world. With a steady sugar cane crop, which is Brazil's raw material for making ethanol, it has been one of the main energy types that the country can rely on now and in the future.

Brazil has taken steps to make the transportation in its country biofuel capable. In 2003, Brazil agreed to import German cars from Volkswagen, which is one of the first car manufacturers to produce cars with the flex fuel option. Since then, 70% of all cars sold in Brazil run on the type of fuel that the driver prefers or is the cheapest, whether it is Gasoline or Ethanol (Berg, 2004). For the most part, ethanol has been the cheaper fuel option, less expensive than gasoline in Brazil.

Today in Brazil, over 60% of vehicles on the road have the ability to run on ethanol and 35% of the vehicles (approx. 4.5 million) use only ethanol (Goldenberg, 1996). Biofuels have another distinct advantage aside from being renewable, that is their positive impact on the environment. In a list that no one wants to be at the top of, The Top Ten Greenhouse CO₂/Gas Emissions, Brazil is not to be found. According to Goldenberg, The country's 12 million plus autos are making less of a negative impact on

the environment because of Brazil's early recognition of ethanol as a profitable product that can be produced from the key natural resource that is sugar cane.

In determining what can be learned from countries like Brazil when considering the renewable energy future of Saudi Arabia, Chiong Meza and Dijkema (2009) cautioned the following:

Historical developments demonstrate that societies with similar objectives achieve different results or follow different transition paths because their past experiences, geographic location, social structure, technical knowledge, natural resources, and stage of development are unique. This means that a transplantation of a success story from a particular location would not ensure a promising result elsewhere. (n.p.)

The authors stated, however, that other countries can benefit from the experiences of nations like Brazil if three general factors are kept in mind: the countries' unique geography, economy, and culture; the role of the countries' government; and the importance of focusing on only a few new alternatives that don't threaten current industries. How these factors relate to Saudi Arabia will be considered in the following sections.

Saudi Arabia's Technology Transfer

Saudi Arabia's technology is mostly transferred from Europe, North America, and East Asia. King Abdulaziz City for Science and Technology (KACST), an independent scientific organization administratively reporting to the Prime Minister for Economy and Planning, has identified specific renewable energy technologies needed by Saudi Arabia. KACST identifies itself as "both the Saudi Arabian national science agency and its national laboratories" (King Abdulaziz City, n.d.). The KACST's report "Strategic Priorities for Energy Technology Program" identified its list of energy-related

technologies based on factors such as ability to generate jobs, capability to generate investment, potential to reduce electricity costs and energy waste, and ease of technology transfer. The technologies list included a wide range of equipment and systems from solar collectors and photovoltaic systems, to steam and gas wind turbines, to electrical transformers and air conditioning parts.

In his study, Al-Thawwad (1999) mentioned some factors affecting the transfer of technology in Saudi Arabia. These factors include culture, geographical location, and physical environment. More important is a lack of technicians and shortage of spare parts as well as the high numbers of expatriates who mainly operate these technologies: “The reliance on an expatriate work force will affect technology transfer. The workers acquire the knowledge, but they are not a permanent fixture of the country’s infrastructural network; therefore, their leaving creates a void in technological process” (Al-Thawwad, 1999). According to Ali Khan (2012), foreign workers hold 90% of private sector jobs according to 2010 government figures, and Ali-Asmari (2008) noted that “the more highly qualified the job seeker, the more difficult it is to secure employment” (p. 54). The King Abdulaziz City report (n.d.) also acknowledged human resources as a “critical barrier” (p. 32) to innovation in energy, one of their main goals being to recruit and develop the necessary workforce at all levels including researchers, technicians, and managers.

Saudi Arabia has taken some constructive steps in linking technology transfer, the composition of the labor force, and the development of its economy. The Saudi government has initiated development plans to increase jobs for Saudi nationals,

especially in the field of technology, to reduce reliance on the expatriate and skilled foreign laborers. One such plan had some positive results but progressed slowly and cost \$16 billion a year (Olayan, 1999). According to Ramady (2005a), The long-term aim of the Saudi government is to create high value-added technology based jobs for Saudi nationals to reduce high levels of unemployment, estimated to be between 9% and 15% for Saudi males alone: “At the same time, an effective job creation program in such high value technology sectors could reduce dependence on expatriate skilled labor and cut back on remittances, estimated at around (16 billion) per annum” (Ramady, 2005b, p. 54)

In Olayan’s (1999) study, he noted that one of the greatest barriers to the transfer of technology in Saudi Arabia is the education system, which needs to produce the right talents for the right industries. The general outlook for management positions in technical fields by students and society makes it difficult to fill technical jobs in the country (Olayan, 1999). Al-Saleh (2011) confirmed that Saudi universities at present are isolated from industry and technology and need a much better IT infrastructure to pave the way for education about renewable energy. Gelil (2009) likewise reinforced the need to involve every layer of Saudi culture and in addition “catalyze cooperation and public-private partnerships with regulatory agencies and other major players” (p. 13). The KACST report appears to attempt to address these assessments. In the report (King Abdulaziz City, n.d.), a centerpiece of its technology transfer plan was a partnership between universities and industry, in which university research centers create knowledge that can be transferred to industry through students who industry would want to hire because the students have been trained in dealing with relevant problems.

If the country is not focusing on science and engineering-based education as well as R&D, it will never stop relying on foreign workers, which means it won't benefit from technology transfers (Ramady, 2005b). Saudi Arabia is not the only developing country where industrialization suffers because of a drought in experts in technological and information sectors, but only 18% of Saudi college students pursue science and engineering degrees (Al-Saleh, 2011), one of the lowest percentages in the world. These sources create a convincing argument for why Saudi educational programs need to be attuned with technology. For this very reason, the Kingdom has taken some steps to restructure its educational system (Al-Wakeel, 2001).

According to Al-Saleh (2004), a reason Saudi Arabia has not fully realized the potential of its education system is that it isn't taking advantage of the telecommunication technologies it has. Some of the specific problems in this area, according to Altowajry (2005), have included (a) many students not accessing the full potential of the library, i.e. electronic resources, and (b) limited computers, labs, and libraries impeding students' progress. This situation has resulted in a failure of Saudi university libraries to fully contribute to the education system because students' technology needs are unmet.

Science and technology information cannot be understated as valuable assets for the success of technological development and research; without access to pertinent and relevant information, technicians and scientists will be unable to perform in their areas of expertise, according to Ali (1989). Another way to gauge the seriousness of the problem is to look at how little research is being produced regarding renewable energy. The

KACST report (n.d.) noted that “publications and patents strongly correlate with scientific research capacity” (p. 13). In reviewing publications related to Saudi Arabia’s energy goals, they found that the United States dominated in production of articles; Saudi Arabia was ranked 43rd. Saudi Arabia filed only one patent application related to renewable energy between 2002 and 2006 (King Abdulaziz City, n.d.). These statistics aren’t surprising in light of Gelil’s (2009) report, which stated the following:

Expenditure on R & D by Arab countries is at best one-tenth of that spent in industrialized countries. This enormous underfunding of the research and development is a major impediment to technology transfer. Non-Arabs produce most of the literatures, on which the IPPC [Intergovernmental Panel on Climate Change] reports are based. Additionally, the number of Arab scientists contributing to the IPCC reports is very few. (p. 17)

Gelil (2009) and the KACST’s (n.d.) report on publications and patents shows that developed countries have the needed information, so collaboration with countries who have the expertise is essential. However, countries throughout the Mideast are juggling the difficulties of modernizing and being recognized as developing countries, at the same time dealing with world economic and social changes (Al-Roubai & Al-Zayer, 2006).

Developing countries have also come to understand that a successful correlation between growth and technology transfers and good relationships between governments and private and social enterprises creates employment. If there are no interrelationships between these groups, the process of development will be retarded. The KACST report (n.d.) emphasized the need for “stakeholder interdependencies” (p. 31), backed up by a communications management plan to encourage networking and partnerships. These stakeholders include Ministries and Governmental Institutes, Research and Educational Institutes, the Private Sector, and Society in general. Al-Saleh (2011), in his study of

renewable energy as a sustainable innovation, argued that there are currently “insufficient linkages between the actors involved” (p. 317) and that new technology can’t flourish if parties have too strong of a self interest in maintaining the status quo. Saudi Arabia’s rulers maintain tight control over information and finance and the oil sector has a huge financial stake and could try to thwart any effort to transition to a renewable energy industry. Al-Saleh, Upham, and Malik’s (2008) Delphi study of specific energy scenarios for Saudi Arabia reinforces this idea: “In any monarchy, where authorities have considerable power and considerable financial resources, this situation is entirely controllable by the authorities, and thus is a policy choice” (p. 23).

Saudi Arabia has been seen by some authors as an example of changing political policy and changing economic and social trends. Al Ankari (2009) argued that in some ways it has been on the forefront of social changes because it has recognized that changes cannot occur if they are not done at all levels. As the first country in the gulf region to initiate new investment programs, the Saudi Arabian government has imported technology from other countries to expand its focus on human capital and enhance the economy through the creation of more consistent employment. To accomplish this objective, Saudi Arabia has tried to mix capitalism and socialism. Other factors have to be considered, i.e. the environment and location (Al-Thawwad, 1999). The distance between locations and the metro centers is a drawback to accomplishing the goal. The free market itself can be an obstruction to developing markets in that countries have been unable to agree on what a free market is. At least some elements in Saudi Arabia have realized that the core of its economy can only be transformed from petroleum based to

human and technological services (Ramady, 2005a). There are additional potential obstacles to technological transfers in underdeveloped countries, a major one being language (Al-Tayyeb, 1982). A Saudi researcher in his study on technology transfer in Saudi Arabia found out that other social, cultural, and technical impediments are obstructions to the progress of information technology. Problems these countries confront include economics and infrastructure that are directly connected to government policies and rules (Hamade, 2009). For the transformation of this sector to come to its full potential, governments must be more open democratically, protect intellectual property rights, and provide for greater freedoms.

Transformation of Saudi Trade Partnerships from West to East

Saudi Arabia has been importing technology from the United States (U.S.) since the late 30's and especially following the discovery of oil. Their business and political relations date back to that time period. During that period most of the technology that was transferred from the United States to Saudi Arabia mostly dealt with the oil sector. That transfer of technology and information has boosted the Saudi economy. Saudi Arabia's second language is English, and the U.S. and Saudi Arabia have always maintained an educational relationship that could be capitalized on in transferring renewable energy technology. In fact Saudi Arabia in recent years had established a scholarship program with the United States for their students where more than 20,000 students were attending U.S. universities (Sfakianakis, 2009).

In spite of the close relationship between the U.S. and Saudi Arabia, another factor that could cause Saudi Arabia problems in developing technology transfer for renewable

energy is that they are focusing much more on the Far East in their trade relationships than before: “The Saudis are shopping for a new strategic patron in the region and the Chinese are keen to be that patron” (Denning, 2012). Denning argued that the energy relationship Saudi Arabia and China are building could “change history every bit as much as the U.S./Saudi relationship.” CNN Business360 (“China Looks To Saudi Arabia,” 2012) quoted Saudi Aramco’s CEO, who said, “China . . . is the engine of the global economy. . . We need China as much as China needs us. ” He cited the 800,000 barrels of oil a day Saudi Arabia ships to China as evidence of the two countries’ faith and trust in each other. This relationship is an indication that more obstacles could develop that will decelerate the pace and scope of technology transfer related to renewable energy.

In the last few years, the Saudi U.S. relationship has been somewhat strained due to security and stability issues in the region. Post September 11, security issues made it hard for American investors to travel to Saudi Arabia and invest in the fast growing market. Security and stability is one of the factors that affect the transfer of technology in that region, especially for American entrepreneurs (Bureau of Near Eastern Affairs, 2009).

Based on Fact Sheets contained in the International Trade Administration (U.S. Department of Commerce, 2008), the U.S. trade balance with Saudi Arabia has been increasingly negative. Trade balance between the two countries in 2007 was negative at 25.2 billion dollars (Bureau of Near Eastern Affairs, 2009). In a recent study, the Chief Economist of the SABB (Saudi Arabia British Bank), Dr. Sfakianakis (2009) stated, “Back in 2000 U.S. exports to the Kingdom were 19.7% of total imports and by 2007 were down to 13.5%.”

At the same time, China's total market share in 2000 was 4.1%, which had more than doubled to 9.6% by 2007 (Sfakianakis, 2009). Sfakianakis interpreted this fact to be an indication that China is one of the U.S.'s strong competitors in the region. China's impact on Saudi imports is growing on an unprecedented scale. It has expanded to approximately 600% totally, over the last 10 years (Saudi Arabia Monetary Authority, 2009). China is a booming economy with an insatiable appetite for oil. China's willingness to buy huge quantities of oil could discourage Saudi efforts to move to develop technology transfer for renewable resources from the U.S. and other countries. It would be harder for Saudi entrepreneurs to get involved in the transfer of technology from the Far East because of the language barrier, and the high number of foreign workers involved in the industrialization of the Kingdom could increase due to their contacts in the Far East and their control of the country's industry.

Instead of this relationship with the Far East promoting renewable energy technology in any way, as Calabrese (2012) pointed out, "Through a Saudi lens, China could be regarded as a valuable source of support as Riyadh continues on a path of cautious and selective economic liberalization while seeking to deflect U.S. pressure in the area of political reform." Calabrese provided further support for this point by mentioning that Saudi Arabia is looking to get access to China's retail gas market.

As this literature review has shown, Saudi Arabia has to face a number of challenges before it can successfully focus on renewable energy technology transfer and improve its economic security with less dependence on oil. The challenges described in

the literature range from its geography to its education system to its political system and relations with other countries.

The following chapters describe the present study, which was conducted to gather the most current possible information about these barriers and to suggest what Saudi Arabia's priorities should be in confronting obstacles and moving forward.

CHAPTER 3

METHODOLOGY

Introduction to Delphi

As Yousuf (2007) explained, Delphi is a technique that brings a group together to express opinions or make projections about a complex problem. It can be used for various purposes, including setting goals, investigating policies and procedures, or making predictions about future events (Hsu & Sandford, 2007). It is applied by selecting a multidisciplinary panel or committee of experts who are closely involved with the subject or who have studied the subject and asking them anonymously about open-ended questions on the topic of interest. The researcher's goal is to extract honest feedback. After all the answers are gathered, the researcher analyzes and summarizes the answers of the experts based on their similarities while noting disagreements (Linstone & Turoff, 1975). For the most relevant answers, the researcher plans another round to ask the experts to reconsider their answers based on the comments or a composite of comments from the other experts. This method emphasizes that group consensus can be more valuable than the judgment of individuals alone, while avoiding the problem of groupthink, or individuals saying what they believe the other members of the group want them to say (Yousuf, 2007).

Brief History

The Delphi Technique or method is an old and commonly used forecasting technique. The name comes from the ancient Greek oracle at Delphi, which was known for giving prophecies and is associated with wisdom and knowledge (Yousuf, 2007). As

outlined by Rieger (1986), the Delphi method was developed between the 1950's and 1960's by Project RAND, a project originated by the U.S Air Force. At the time, it was developed to improve decision-making to be able to forecast more accurately if there were plans for any attacks on the U.S. Between the years of 1970 and 1984, about 660 scholars used the Delphi technique as a research tool in their dissertations (Rieger, 1986). The method has grown dramatically around the world ever since. It can be found in every field of education and business, urban planning, manufacturing, and especially marketing, where forecasting is required (Yousuf, 2007).

Delphi Definition

Linstone and Turoff (1975) explained the technique as follows: "Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (p. 5). Basically concurring with Linstone and Turoff, Hsu and Sandford (2007) added a slightly more specific current definition of Delphi as a "group communication process which aims to achieve a convergence of opinion on a specific real-world issue" (p. 1). Yousuf (2007) added that Delphi can take different forms, one emphasizing agreement and one, usually used in policy-making, that takes the form of debate to "generate the strongest possible opposing viewpoints on a policy issue" (p. 2).

The Delphi method is defined by Dalkey (1969) as involving three main aspects of decision-making (Figure 1). The first aspect is Knowledge, which consists of the type of information described in this study's review of literature. Second is Speculation, which includes all the assumptions the researcher has in mind about a certain topic. The final

aspect is Opinion, which is the area where the Delphi technique applies (Dalkey, 1969).

Opinion is based on the judgment, wisdom, and insight of the group of experts and is used to forecast more accurate and complete answers for the researched questions.

Dalkey argued that a combination of the three, as Figure 1 shows, is much more valuable than any one alone, including an approach that only recognizes knowledge and doesn't allow any room for speculation.

The Delphi Method has been used by scholars from different backgrounds in most areas of forecasting research. The validity of the Delphi technique depends on the panel's expertise. Spending a considerable amount of time in picking experts who are knowledgeable in the topic of interest is a must (Spencer-Cooke, 1989).

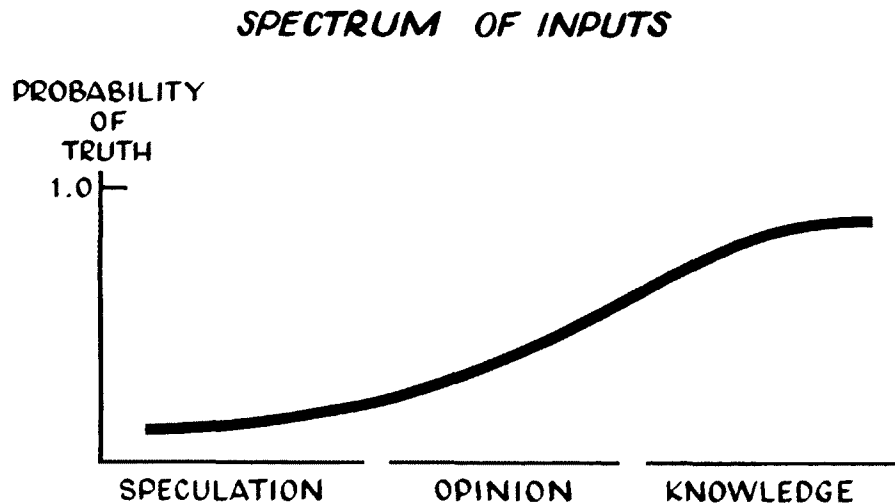


Figure 1. The Three Elements of the Delphi Process. Adapted from "An Experimental Study of Group Opinion," by N. C. Dalkey, 1969, p. 3. Copyright 1969 by the RAND Corporation.

Delphi Procedures

The Delphi procedures consist of two or more rounds of questioning. In this study, experts completed three rounds. In the first round, the facilitator typically addresses the experts with an open-ended questionnaire in order to gather elaboration in the answers and to suggest a range of new ideas. After that, the facilitator starts analyzing the data qualitatively and used this analysis to prepare questions for the second round of feedback. In Round 2, the facilitator distributes another questionnaire and sometimes develops a scale for participants to rank the statements extracted out of the first round (Hsu & Sandford, 2007). The participants have the benefit of anonymity to be able to give their opinion without any pressures due to social, personality, or group-member dominance. They are able to revise, add, or change their opinion. Because each participant must answer individually, the method usually leads to a variety of responses, arguments, and judgments about the selected questions. Skulmoski, Hartman, and Krahn (2007) provided a diagram that puts the whole Delphi process into the context of a research project (Figure 2).

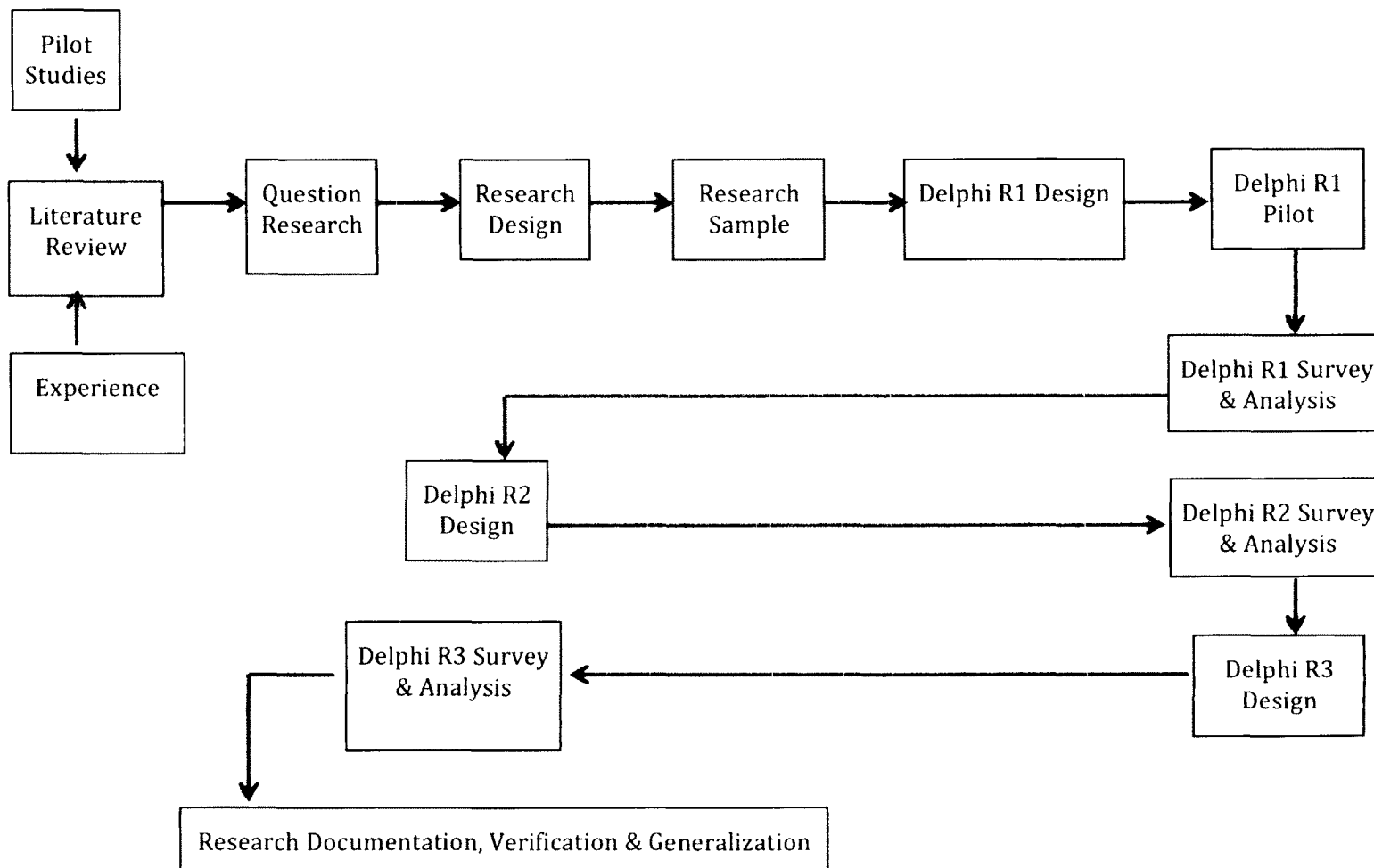


Figure 2. Delphi Procedures. Adapted from “The Delphi Method for Graduate Research,” by G. J. Skulmoski, F. T. Hartman, and J. Krahn, 2007, *Journal of Information Technology Education*, 6, p. 3.

Delphi Key Elements

Since the Delphi Method was developed, four key elements have distinguished it from other forecasting methods. *Anonymity* allows the group member or the expert individual participating in the questioning to have the opportunity to answer the questions anonymously without feeling pressure from other group members. *Iteration* gives the anonymous experts the right to revise the answers given within the allotted number of rounds if necessary with the ability to look at other anonymous group members' opinions (Martino, 1983). *Controlled feedback* statistically presents a summary of the anonymous group members' opinions and judgments on each of the questions in a mean and median format as well as providing a text of all the arguments presented. Statistical analysis of mean and median is sometimes developed in the final round to conclude the research and verify the final judgment of the group of experts (Hsu & Sandford, 2007; Yousuf, 2007). Qualitative rather than statistical analysis will primarily be used in the present study.

The Delphi process was outlined in many publications differently, but the procedures followed in this study are typical of the methods described by Linstone and Turoff (1975), Hsu and Sandford (2007), and Yousuf (2007). In the first round, the researcher sent a list of questions to the experts requesting their opinion, recommendations, and predictions on the researched topic. After gathering all the information from the first round, the researcher developed a collective list of responses, which was sent to the experts individually in the second round. They were asked a more focused question in Round 2, and in Round 3, they were asked to rate the importance of

each item. A difference between the typical Delphi process and the current study is that in the current study, there was no round intended to make sure the experts came to consensus, which would have involved the outcomes of the second round being sent back to the experts with their ratings and the experts not in the consensus group being asked to explain or revise their opinions.

Delphi Efficiency

The efficiency of the Delphi Method depends on many variables in order to get the best outcome. According to Linstone and Turoff (1975), areas where the technique is most efficient to use are (a) when there are no specific systematic procedures that can be used to solve a research problem other than experts' united opinions, (b) if the complex problem addressed has no history of satisfactory documentation or research, (c) if the research requires more individuals than can successfully engage in face-to-face interaction, and (d) if additional group communication will enhance the effectiveness of the face-to-face process.

The Delphi method has been applied throughout the years in many graduate-level dissertations. Appendix A provides Skulmoski et al.'s (2007) list of doctoral dissertations using the Delphi method between 1981 and 2006 and the dissertation topics. The topics range from a study using Delphi to define multicultural children's literature to an analysis of ways counselors believe computer-related technology is used in the profession. The technique itself has been a very successful instrument when applied correctly. The following sections explore Delphi's advantages and disadvantages, with an emphasis on how the method should be used to achieve the greatest advantages.

Delphi Advantages

Many techniques have been used in the field of forecasting and research, and like any other method there are advantages and disadvantages. As for the Delphi technique, the advantages are greater than the disadvantages. First of all, the number of experts participating in the study can be unlimited. The benefit of anonymity and opportunities for the anonymous participants to revise, add, or change their opinion in between rounds (Hsu & Sandford, 2007) and have the ability to share opinion and feedback in between rounds helps the researcher get the best out of the participants in a variety of responses, arguments, and judgments on a selected question (Hsu & Sandford, 2007; Yousuf, 2007). Another advantage of the Delphi Method is the low cost of conducting the procedure (Linstone & Turoff, 1975).

Delphi Disadvantages

Some of the few disadvantages of the Delphi method, which can be overcome, are that the Delphi technique is time consuming, especially when collecting data and sending feedback in between rounds, depending on the number of rounds conducted (Webber, 1995). Another issue is that there is complexity in group member attrition, clarifying their statements, and analyzing the data.

Factors that can Cause Delphi to Fail Linstone and Turoff (1975) have suggested in their book five reasons for the Delphi Method to fail. The majority of them are due to the way the technique is applied and not the technique itself. Yousuf (2007) agreed that poor results can often be attributed to “poor application of the method and not to the weaknesses of the method itself” (p. 6). The Delphi method could fail when (a) the

researcher or the facilitator is trying to control the opinions and perspectives of the expert panel and to serve personal preconceptions. Hsu and Sandford (2007) called this “molding opinion” in their article (p. 5). (b) Having the assumption that the method could substitute for face-to-face communication, which is best in some situations (Linstone & Turoff, 1975). (c) If the researcher has weak writing, mathematical, or summarizing skills which results in the misuse of the technique (Linstone & Turoff, 1975). (d) Not paying attention to disagreements in the consensus in order to keep the process going and get it done (Yousuf, 2007). (e) Underestimating that the Delphi process is challenging and that the experts and their responses should be rewarded for their time, as it is not part of their job (Linstone & Turoff, 1975). Hsu and Sandford (2007) pointed out that users should employ all available electronic technology to facilitate the process.

Pilot Study

Before applying the Delphi technique, the researcher made sure that the subject researched was a good fit for this type of procedure. Based on the recommendations of Adler and Ziglio (1996), three main steps were followed before deciding if the Delphi Technique would be the best forecasting tool: (a) selecting the best communication procedure to be used in solving the problem effectively, (b) deciding who would serve on the panel of experts involved in the study and their location, and (c) determining if there was an alternative approach or technique that could be used that could result in a better outcome.

The Delphi Method is a process that takes two or more rounds of questions sent to a panel of experts to gather comprehensive feedback on the topic being investigated. In

order for the researchers or the facilitators to get honest opinions from the panel of experts, they must make sure that the questions are pretested to improve participants' comprehension. Especially if the researcher is not an expert in the processes of the Delphi Method, the pilot study is a very valuable step to help the researcher make adjustments to the questions before conducting the actual study.

A pilot study was conducted with four U.S.-born college professors and two born in Saudi Arabia but living and working in the U.S. for 20 years. Delphi freeware called the Delphi Decision Aid (Armstrong, 2005) was used. With an administrator login, researchers can send invitation emails to participating experts, see anonymous results and comments as participants complete each round, and send reminders as needed. The pilot study consisted of three rounds of questioning with one exploratory question in each round. The first round asked, "In your opinion what are the factors that may affect technology transfer in Saudi Arabia and why? After the first round, the participants indicated that there were five factors affecting the transfer of technology: (a) dependence on oil (b) political factors (c) education factors relating to technology (d) manpower factors (reliance on foreign workforce) and (e) religious factors. In the second round, they ranked the factors generated in Round 1 in order of importance. In Round 3, they provided reasons for their rankings.

The pilot study was beneficial because the participants suggested ways to clarify the question and definitions they were provided. Several adjustments were made to improve the process before beginning the main study.

1. The researcher sent the experts in the main study an email to let them know they could expect an email from the Delphi Decision Aid site.
2. Experts were notified that they could go back and look at any previous round to see the other experts' answers.
3. A time limit was set for experts to complete each round.
4. The "no opinion" option was excluded from the final study.
5. The researcher provided more background information on technology transfer and the Delphi method for the participating experts.

Possibly the most important result of the pilot study was the decision to re-design Question 3 in the main study. Instead of asking the experts to rank the importance of the factors mentioned in Round 2 from the highest to the lowest, participants were instead asked to rate the importance of each item on a Likert scale from 1 (not important) to 5 (very important). The Likert scale is the most widely-used scale for survey research (Statistics Café, 2011). This decision helped avoid repetition in the answers from one round to the next, which was a problem in the pilot study. It also allowed for a more detailed analysis of each factor, because participants weren't forced to rank them in order. A Likert scale allows participants to "specify their level of agreement to a statement" (Statistics Café). Therefore, if they believed two or more factors to be equally important, the changed format would allow them to say so.

Appendix B shows the Delphi Decision Aid interface and the simplicity of its design, in addition to the format used to present results from the questioning. Two complete responses from the first two rounds of questioning in the pilot study are

included in Appendix B. Appendix C shows the results of the final round of questioning in the main study. This information illustrates how the Delphi Decision Aid represents rating-scale responses graphically as well as giving the user the complete unedited comments from the experts.

The Delphi Experts and Questions

The experts selected for the main study were 10 heterogeneous members of different technological institutions in the Kingdom of Saudi Arabia. They were selected for their expertise in both technology and the transfer of technology. The experts are in the fields of aviation, telecommunication, oil industry, education, health systems, and military and governmental organizations. They hold college degrees of Masters and higher. Six of the experts were Saudis and four of them were expatriates who had been living in the Kingdom for more than seven years. They speak English and Arabic fluently. Two experts out of the first 12 selected decided not to participate for the reason that they didn't want to criticize a country they were still working in, and the number of rounds would be too long for them because they didn't have the time. The 10 experts were interviewed by the researcher and showed the ability to offer honest opinions. The Round 1 question was chosen because it is an open-ended question that would not steer the experts toward any particular answer. This decision was made to give the researcher the best opportunity to potentially gain insights into factors not already mentioned in the literature review, or to verify the literature review without biasing the participants. The Round 2 question followed the same principle, except that it asked specifically about technology transfer related to renewable energy.

Round 1 Question

In your opinion, what are some of the factors affecting the transfer of technology and why?

Round 2 Questions

1. In your opinion, what may be the factors that affect Saudi Arabia's successes in renewable energy technology?
2. By viewing the experts' comments in Round 1, briefly describe any positive or negative comments.

Round 3 Questions

Round 1 and 2 opinions were grouped into categories and summarized for the participants, and they were asked to rate the importance of the topic from 1 (Not important) to 5 (Very important). Topics included the following: (a) Skilled Manpower (b) Education (c) Dependence on Oil (d) Political Factors (e) Geographical Factors (f) Cultural Factors.

Data Analysis

Interpretations of the data gathered in the Delphi study will be interpreted in light of the literature review in the final chapter. Chapter 5 will also consider what the most significant reasons are that technology is not diffused and utilized correctly, and the chapter will include some recommendations for improving this process in order for Saudi Arabia to transfer the right technology to diversify its economy rather than relying too much on oil production and consumption. First, however, the data generated from the experts was reviewed and will be summarized in Chapter 4.

CHAPTER 4

RESULTS

All 10 participants representing different technological institutions in the Kingdom of Saudi Arabia responded to all questions in each round. All participants answered the questions in English, so no translation was necessary. However, some comments have been edited slightly for clarity. The first round of questioning was intended to be as general as possible in order to extract as much information as possible.

Experts' Rating of the Factors' Importance

Factors identified during Round 1 were identified for participants as individual questions in Round 3, and participants were asked to rate the importance of each one on a Likert scale of 1-5, 1 being Not Important and 5 being Very Important. Table 1 illustrates the participants' rating of each factor. Education received the highest mean score, followed closely by Dependence on Oil and Manpower/Political Factors with the same mean scores. A somewhat lower mean was reported for the two remaining important factors, Geography and Cultural Issues. Although a rating scale was not used in the pilot study but was added to improve the Delphi process for the main study, a pilot study results table (Table 2) is included for comparison with the results of the main study. Comparison with the pilot study and a more detailed discussion and summary of the comments participants made in Rounds 1 and 2 to support their ratings in Round 3 follows Table 1.

Table 1

Factors Influencing Successful Transfer of Renewable Energy Technology: Rating of Importance in Round 3

	Q1 Manpower	Q2 Education	Q3 Dependence on Oil	Q4 Political Factors	Q5 Geographical Factors	Q6 Cultural Factors
No. of Answers	10	10	10	10	10	10
Mean Rating of Importance	4.2	4.6	4.3	4.2	3.3	3.4
SD	1.17	.92	0.9	.98	1.27	1.02

Table 2

Pilot Study Factors and Rankings of Importance

Item	Average rank	Best rank	Worst rank	No. times ranked # 1
Political factors	1.6	1	3	3 (43%)
Education factor (weak knowledge of technology)	3	1	4	1 (14%)
Dependence on oil	3	1	5	1 (14%)
Religious factors	4.4	3	5	0 (0%)
No opinion answers	2			
Total answers	7			

Round 1, Question 1 Discussion

One question was asked in Round 1: “In your opinion what are the factors that may affect the transfer of technology in Saudi Arabia?” More factors were identified in this round than in the pilot study with only 6 experts, but both expert panels mentioned political factors, dependence on oil, and education. Education was seen by one pilot study expert as a “crucial element necessary to advance a civilization.” Another pilot study expert mentioned education only indirectly by pointing out that education in new technologies may be deliberately weakened by Saudi Arabia’s ruling class because new technology can be seen as a threat to government power. One expert related manpower to the political system and ranked it last in importance “because foreign workers don’t exert much influence on the political situation.” The 10 participants in Round 1 of the main study discussed education in more depth and related it to Saudi Arabia’s lack of manpower.

Education

Two factors dominated the experts’ comments in the first round: education and manpower as most essential in helping Saudi Arabia succeed in technology transfer. In the first round, comments grouped under the heading Education for later rounds included various synonyms for education, such as “transmission of knowledge” and “training.” Education-related terms were mentioned in connection with problems such as “lack of understanding of new technology” because it is complex, “Lack of sufficient education related to tech,” and “curricula that do not help in compatibility with the learning outcomes of the job market . . . and the absence of a clear plan to do so.” The participants

mentioned several outcomes they believed would come from better education, including “readiness of local manpower” and “ability to operate new technology.”

Two participants broadened the conversation in suggesting that there must also be *interest* in learning the new technology. Another suggested that this learning process would have a cultural dimension: “knowing the benefits of these technologies and the way they will develop the surrounding environment” would lead to “culture change to enable new technologies to be accepted and adapted.”

Round 2, Question 1 Discussion

In Round 2, Question 1 was “In your opinion what may be the factors that affect Saudi Arabia’s successes in renewable energy technology?” In addition, Round 2 offered the experts an opportunity to “briefly describe any positive or negative comments.” Several experts stated that they did not understand the question, so there were no useable responses. Experts in the pilot study were not specifically asked about technology transfer related to renewable energy.

Manpower

When the question was narrowed in Round 2 to ask about renewable energy technology, most of the comments focused on issues other than education, especially human resources (Manpower): “Most of the answers are relating to human factors;” “I think the most important challenges in the field of renewable technology is the human force, as it is a new field. In the kingdom the experience required in the kingdom in such projects is at its minimal level and also hard to find needed resource locally.”

One participant commented that the need for manpower starts at the top because “It is a question of leadership. Some visionary leaders must think of a strategy of planning for the long term stability of the nation.” Then management is involved: “In my opinion the highly skilled Management leadership and the professional trainee will *insa'llah* lead to the Technology transfer.” Another participant mentioned the general need for “professional, knowledgeable people.” Taken collectively, the participants’ comments suggested that manpower is needed at all levels of authority and involvement. In Round 1, participants had suggested the need for manpower at different phases of transfer as well. One pointed out simply that “local manpower” must have the ability to operate the technology, and another that a “human cadre” is necessary to “maintain the transferred technology once it is being applied in the kingdom.” About the potential of technology transfer to affect overall employment in Saudi Arabia as a benefit, and the possibility that manpower would come from local sources, one participant expressed the concern that “technology transfer might create a lot of new jobs for expats but not for locals unless they are formed and ready to take charge.” These details helped expand the research presented in the literature review by providing specific examples of how manpower affects technology transfer. Additional factors of importance were discussed in Round 2. They are considered on the following pages.

Oil

The discussion indicated a general consensus about the need for Saudi Arabia to depend less on oil revenue and consider the benefits of renewable energy as a good plan for the future, not just for short-term gain. One participant expressed a concern similar to

what was summarized in the literature review, that Saudi Arabia's oil supply might not last forever: "Some visionary leaders must think of a strategy of planning for the long term stability of the nation - investing wisely for a time in the future when there is no more oil." Another pointed out that "A long term strategy may be to invest in research and development of energy saving technologies and renewable energy sources."

However, this participant and others seemed to doubt if the shift could realistically happen, as in one comment that "It may make more sense to invest in renewable energy in other countries. Certainly, a complicating factor is that for the time being renewable energy is simply more expensive than fossil energy." Several of the experts' reservations about renewable energy related to political factors within the Kingdom.

Political Factors

One participant stated bluntly that "the government is focused on oil exports" and worried about "a lack of culture change." Another put the problem in terms of "Political wellness," which he indicated was first in his ranking of relevant factors. He went on to mention that "international policies and laws for or against use of Petrol by-products" would also come into play. At least one identified a government role as a requirement for any renewable technology transfer initiative to have a hope of succeeding, "a huge initiative from the government in supporting this technology and supporting business men to adopt the renewable energy technology in their projects." Three of the six experts

in the pilot study ranked political factors first in order of importance of impact on general technology transfer for Saudi Arabia, and most of the comments related directly or indirectly to Saudi Arabia's government.

Geography

Although geographical factors were rated only slightly higher than 3 on the rating scale, participants made some interesting comments about them. Saudi Arabia's geography points to specific types of energy that would be well-suited for the environment. Solar and wind energy were both mentioned: "There is no shortage of sunlight and space, so solar energy would seem to be an obvious choice." Another participant offered his ranking of the best alternative energy sources for Saudi Arabia (two unrelated ideas were labeled 1 and 2): "3-Promoting the solar photovoltaics (PV), wind power and solar thermal power have undoubtedly emerged. 4-Use Of Nuclear Energy to meet the rising domestic need 5- Setting up the regulations and instructions that will lead to use the renewable energy 6-Use of Electric Cars."

On the other hand, a question was raised: "where are the potential customers of solar electricity and how would solar energy be transmitted to market?" Another expert actually saw geography as a reason people might not support renewable energy: "I believe the factors are related to the hard and hot environment we live in, allot of people believe in our hot weather these techs won't work as they should."

Culture

There was not a lot of discussion about cultural factors, but several important ideas were offered. For one, it was suggested that the country should consider "The absolute fit

of the sought technology with the ethical values and culture of the Kingdom.” Most of the comments related more to intangibles such as “awareness” and “belief.” Some examples include the following: “one more important factor is the awareness of benefits of this kind of energy and how does it help in providing a clean environment and also reduce the use of petrol” and “believe in technology.” This was what one expert labeled as his “number 1” answer. It was suggested several times that it was Saudi Arabia’s younger generation who would have to show the belief, awareness, and ability necessary to make renewable energy technology transfer a reality: “It must be remembered that the innovative new solutions are going to come from young people. But, is the younger generation being given opportunities and positions of responsibility and trust?”

The six pilot study experts living in the U.S. and the 10 Saudi experts currently working in Saudi Arabia showed some differences in emphasis in their answers and explanations for their judgments about the various factors influencing Saudi technology transfer. Some of these differences can be explained by the different group sizes; smaller group size limits the Delphi discussion. The larger group generated more topics and more explanation. The experts in both groups were similar in pointing out the areas of greatest concern, including education and dependence on oil. The limitations of the findings and some important implications of the experts’ answers will be described in the concluding chapter.

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

The first round of questioning ended on the first of November, and the second round started at the same time, with a more narrowed question but with the same 10 experts from the first round. A problem was that the second round was done during the time of Hajj, which is a national holiday for almost 10 days in Saudi Arabia. This slowed the experts' response time and may be an explanation for why in general the answers in the second round were more similar to the answers in the first round than expected. Some additional limitations of the study are discussed in the following section.

Limitations

Although the number of participating experts is small and their opinions can't be taken to generalize to other experts throughout the Kingdom of Saudi Arabia, they do represent a variety of perspectives on the issues due to the experts' positions in a range of technical, governmental, and educational organizations. The number of questions asked may have been too small; in Round 1, only one question was asked to try to keep the discussion open-ended and let the experts decide its direction. It might have been helpful to distinguish Round 2 from Round 1 even more by adding more specific questions about renewable energy technology.

Round 2, Question 2 offered an optional opportunity for the experts to comment on other experts' answers positively or negatively: "By viewing the experts' comments in Round 1, briefly describe any positive or negative comments." Few comments were offered, and one participant stated, "question unclear." The question could have been

revised to provide clarity. Another possible reason there were few responses could be that the experts were reluctant to appear to be critical of each other, which would reflect the thinking of the two experts who declined to participate in the study because they did not want to criticize the country in which they work. Possibly the question could have been written to appear less as if it was inviting criticism of others.

It is interesting to note that the six experts who participated in the pilot study were U.S. citizens and Saudi nationals who hadn't been back to the country in 20 years. They were much more direct and specific in criticizing the government of Saudi Arabia and focusing comments on the government's role. One expert wrote the following:

Saudi Arabia receives huge revenues from oil. Therefore, they can pay for the latest technologies without having to develop industries . . . Saudi Arabia does not have a democratic government. The country is ruled by a fabulously wealthy royal family. Therefore, there may not be an open, competitive market system, in which the heads of technology companies may become very wealthy and powerful, and can challenge the wealth and power of the ruling elite. In fact my guess is the heads of companies would be members of the royal family. This will kill competition necessary in the free market.

Significant Findings

The experts' answers were very consistent with factors described in the literature review as impacting renewable technology transfer especially in their focus on Education (Al-Saleh, 2011; Al-Wakeel, 2001; King Abdulaziz City, n.d.) and Manpower (Al-Thawwad, 1999; Ramady, 2005b). The responses were so consistent that it is possible that the participants surfed the Internet for more information in order to accurately express their point of view. This may be due to the experts' background in an education system that is based on memorizing and not on the opinion-giving, or it may

reflect their higher education and desire to be as informed as possible about the topic under discussion.

Figure 3 shows in graphic form how the experts in Round 3 represented Saudi Arabia's situation as it exists currently. One of the main factors impacting renewable technology transfer is lack of education relevant to technology transfer, with the political system being the most important factor in determining whether the education system will change or stay the same. The second main factor is lack of local manpower to lead, manage, operate, and maintain the new technology, a problem that encourages dependence on oil to continue at the present time. The political system is dependent on the oil industry, and oil money gives power to the political system, a relationship that could prevent Saudi Arabia from really committing to renewable energy programs. As pointed out in the literature review, private sector employees consist of 80% foreign manpower and less than 20% Saudis (Ramady, 2005b). Foreign workers are in the country to work in the private sector which is mostly related to the oil industry, and at the same time they work the blue collar jobs for the government and the locals. Meanwhile, the government sector employs 80% Saudis and less than 20% foreign workers. These percentages suggest the amount of money going out of the country that could instead build the Saudi economy as well as giving it a more sustainable energy future.

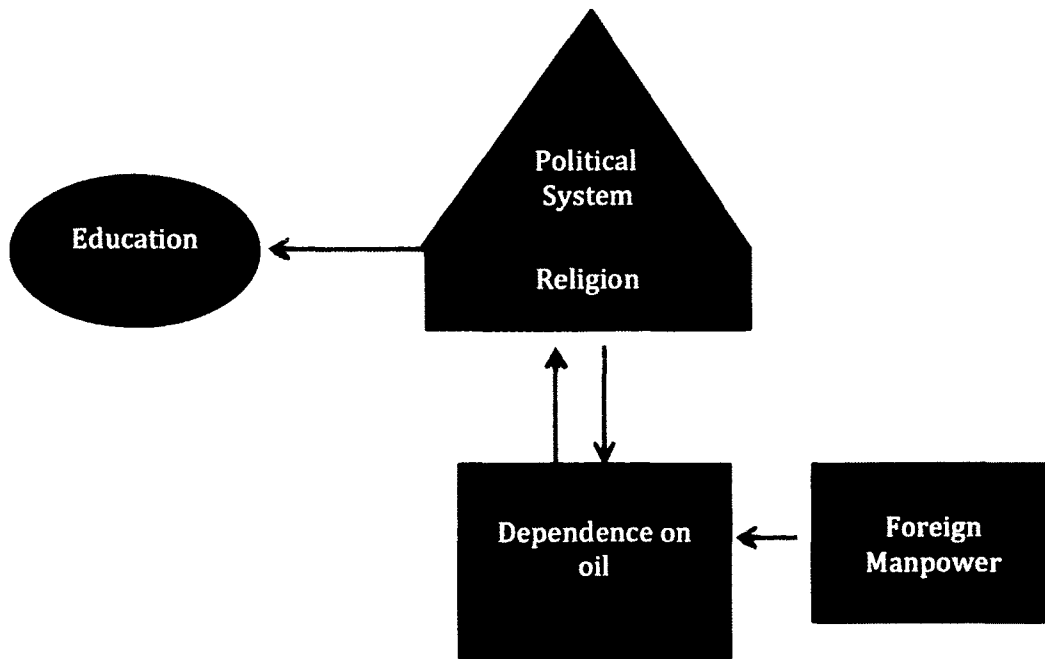


Figure 3. Experts' representation of Saudi Arabia's current system.

The experts who work in government, industry, and education and have first-hand experience verified what the literature review pointed out about the importance of the government's role. In the Delphi study focusing on specific energy scenarios for Saudi Arabia, Al-Saleh et al. (2008) pointed out that political support is a key factor, because in Saudi Arabia "this situation is entirely controllable by the authorities, and thus is a policy choice" (p. 23).

The government funds education, which educates local manpower, who currently don't look for technical jobs in sufficient numbers (Al-Thawwad, 1999; Ali Khan, 2012).

The experts suggested several more specific reasons for the shortage of skilled workers in technical fields, including cultural factors, skepticism about technology, and lack of encouragement from the government. For example, local workers tend to aim for managerial or government positions rather than technical positions in order to be respected by their culture. In turn, education is not emphasizing technical areas and the education system is not giving back to the government. As Figure 3 shows, the arrow goes one way. For this reason there is an absence of R&D, but instead the dependence on foreign-educated workers.

Recommendations for Further Research

This study, although small, added evidence to support the existing published research while suggesting a direction for a larger-scale Delphi project. Such a study could involve greater numbers of Saudi experts with good ideas about what is blocking renewable energy transfer on a significant scale and what to do to improve the situation. This kind of conversation in a small way can contribute to developing the kind of partnerships between experts in education, industry, and government needed to make transfer programs more successful (Al-Saleh, 2011; Gelil, 2009; King Abdulaziz City, n.d.). Al-Saleh et al.'s (2008) Delphi study could be repeated to focus in on technology transfer related to the different energy technologies considered in these authors' original study. They included solar, solar thermal, wind, and a combination of all three. Although the experts in the present study made no significant mention of oil supply but focused on dependence on oil, it is also important that future researchers consider the sources who have warned about the issue of supply (Rubin, 2009; *Scientific American*, 2007). The

experts in Al-Saleh et al. chose the availability of fossil fuels as “one of the most significant and uncertain factors when considering the prospects of renewables in the country” (p. 10).

Considering that the main factor affecting the transfer of renewable energy is the lack of technically-skilled, well-educated manpower, future research should also concentrate on how the government can follow models such as Japan and fund the education system, R&D, and technical institutes to focus more on renewable technology and to improve technical education. Studies like this could demonstrate how the country could benefit from relying more on local manpower and reducing the number of expatriates. Educated foreign manpower should have their input in the education system and not in the private sector. Experts need to help the government capitalize on the efforts it has made so far to show how the education system can be a partner in planning Saudi Arabia’s energy future.

Conclusion

Figure 4 was developed to synthesize the literature review and new Delphi data to represent experts’ view of what the relationships between Government, Education, and Industry should be with renewable energy technology factored in.

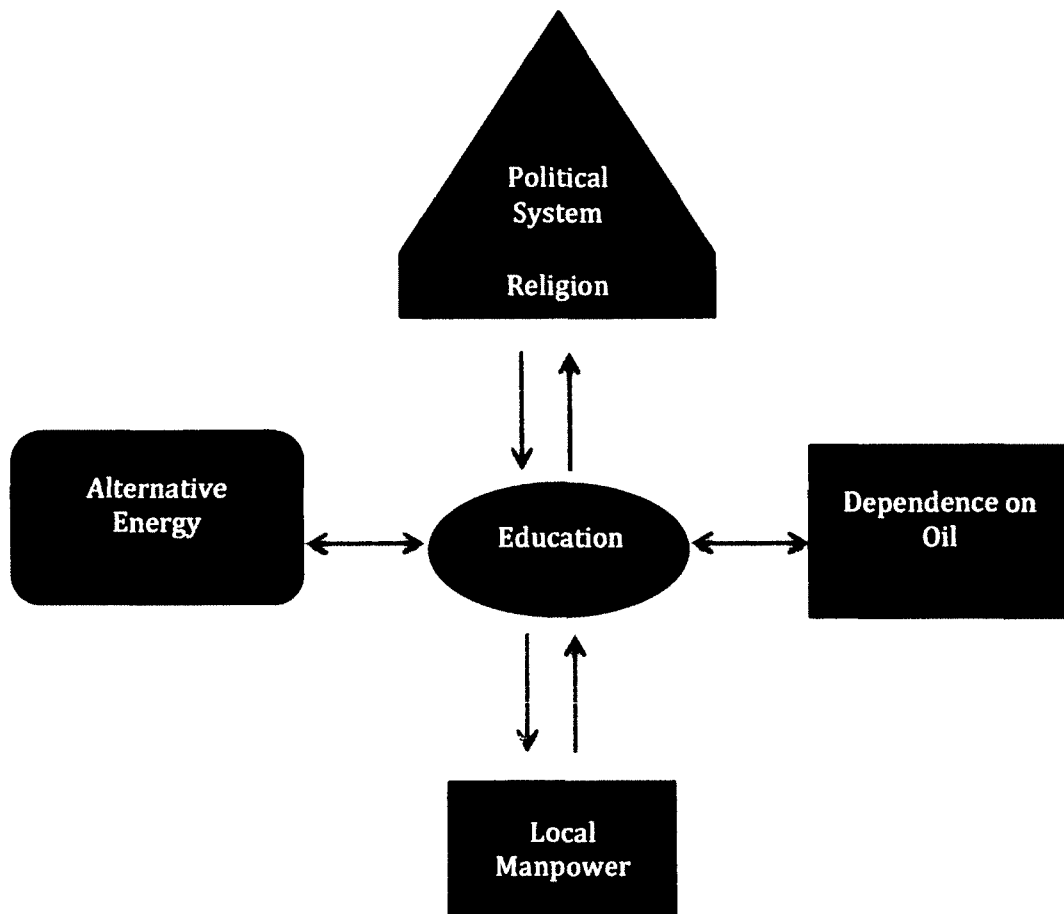


Figure 4. Experts' representation of what Saudi Arabia's system should be.

The government should continue to transition away from its dependence on oil and improve the technology transfer process for renewable energy. Education is at the center of this model because it influences every other factor discussed in this dissertation,

including manpower, dependence on oil, and ultimately, the role of alternative energy. However, education will not be improved as it needs to be without the resources and direction the political system provides.

Because of the deeply-ingrained reliance on oil, the experts in this study have pointed out the challenges in achieving this culture change, which depends mostly on education. Published sources have pointed a way by illustrating that change could be compatible with the Kingdom's political and financial interests. Al-Saleh (2011) interviewed experts in renewable energy who believe that "pursuing renewables could be compatible with the country's strategic interests for a number of reasons" (p. 312). One is that renewable energy for Saudi Arabia would not eliminate the world market for Saudi Oil. "Some . . . indicated that if renewable energy was used to generate domestic power, every saved oil barrel would have much greater value when exported and/or used in the petrochemical industry" (Al-Saleh, p. 312). Part of the challenge is to show that there are serious economic risks to dependence on oil, because it may not always be as profitable and plentiful as it is now. There are also serious environmental risks that have been well documented in many articles (Al-Saleh, 2011; Gelil, 2009; Jaffe, 1996; Rubin, 2009). This dissertation has shown that renewables can help solve the problem of Saudi Arabia's growing population and potential shortage of power for its homes and industries, improve security by diversifying the workforce and economy, and protect itself from environmental disaster. It has pinpointed specific factors that are proving to be barriers to

achieving these goals in the realm of technology transfer and pointed the way to future studies and actions that can remove those barriers and benefit every sector of Saudi culture and economy.

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APPENDIX A

DOCTORAL (PHD) DISSERTATIONS USING THE DELPHI METHOD

Dissertation /Thesis Author	Delphi Focus	Rounds	Sample Size
Stark- weather (1975)	Examine potential directions for industrial arts education looking toward the year 2000	5	10
Silverman (1981)	Develop appropriate content and objectives for a junior high school Death and Dying curriculum.	3	50
Watson (1982)	Provide an operational definition for the concept of therapeutic paradox based on results from a Delphi study using a panel of experts involved in pooling information and opinions about therapeutic paradoxes.	4	26
Wilke (1982)	Forecast the potential future of the General Instruction Physical Education Program in higher education	3	100
Lecklitner (1984)	Identify and evaluate a set of strategies for advancing the rights of the chronically mentally ill in the community.	2	345
Ayers (1985)	Identify the major future changes in leadership roles of public school administrators.	3	82
Mullen (1993) * * Masters Thesis	Examine the future education: attitudes toward and education of students, the structure of the education system in general, governance and finance of education, goals and objectives of Public Education, curriculum and instruction, facilities, and political and economic implications for education.	3	82
Rosenbaum (1985)	Identify what knowledge, skills, and experiences will be needed by college graduates for careers in non-broadcast telecommunications industries during the 1980s, and to construct a descriptive curriculum designed to prepare students adequately for those future careers.	4	144

Brown (1988)	Identify the ethical dilemmas known to be encountered by University or College Counseling Center Directors in the practice of their professional responsibilities in University or College Counseling Centers.	3	28
Ford (1989)	Examine the reactions of health experts toward the use of an innovative telephone-implemented medical self-care model, to find ways the model could be used to redefine how lay people enter the health system, and to determine the appropriate time to develop such a model.	2	26
Cramer (1990)	Investigate the areas of disagreement among experts on important issues in the education of the gifted in the United States.	3	29
Warner (1990)	Identify the needed competencies of a Recreational Foodservice manager.	3	35
Chapman (1992)	Identify the issues that would confront photography education by the year 2000, and determine if there were differences between photography experts in the private sector and photography experts at California state university campuses in their perceptions of the importance of these issues.	3	51
Braguglia (1994)	Achieve an understanding of the knowledge, skills and attitudes needed by merchandising students for entry-level executive positions in the fashion industry.	3	30
Nolan (1994)	Identify the possible, probable, and preferable future of education in three areas: (1) business and school partnerships; (2) the curriculum and design of the learning environment; and (3) technology's role.	3	11
Shook (1994)	Identify the key change agents, and the techniques to effect those change agents related to the transition from an industrial arts program to a technology education.	3	45
Schmidt (1995)	Examine how intuition is characterized and developed.	3	43
Menix (1997)	Compare the change management concepts validated by nurse educators in baccalaureate nursing programs with those concepts validated by baccalaureate prepared nurse managers in mid-level management positions in healthcare delivery environments.	2	16

Good (1998)	Identify recommendations for the future of physical education.	3	30
Krebsbach (1998)	Determine a set of learning outcomes for students in community and technical colleges in order for the learner to function in the major life places of work, community, and family.	3	61
Yang (1998)	Guidelines for integrating the contents from the World Wide Web into the art teacher education curriculum.	3	32
Carman (1999)	Investigate the technology infrastructures that will have an impact on school systems in West Virginia that desire to either retrofit existing high school structures or construct new ones.	3	21
Branch (2000)	Determine and prioritize subject matter content for an environmental education program to be delivered to farmers.	2	41
Costa (2000)	Assess the future directions and strategies of sport management research.	3	17
Prestamo (2000)	Develop a comprehensive inventory of the computer and related technology skills required of reference librarians in academic libraries.	2	14
Richards (2000)	Identify the competencies and the supporting skills and knowledge in public health informatics for public health informaticians and for general public health practitioners.	2	23
Shuman (2000)	Explore the implementation process of a distance learning initiative using televised instruction in an urban university.	3	12
Wei (2000)	Determine if a consensus could be reached between Taiwanese professors and teachers about desired competencies for kindergarten teachers that could be examined during a simulated teaching performance test.	2	28
Whittinghill (2000)	Identify the initial curriculum components necessary for the preparation of graduate-level substance abuse counselors.	3	28
Friend (2001)	Identify essential job tasks and functional categories of ADA Coordinators in public institutions of higher education.	3	8
Cabaniss	Assess how much and in what ways counselor experts believe computer-related technology (CRT) is being	3	21

(2001)	utilized by professional counselors today.		
Skulmoski (2002)	Identify the soft competencies IS team members require to be successful in IS projects.	3	17
Christian (2003)	Essential characteristics of health education accreditation site visit team members.	3	31
Kincaid (2003)	Identify student and faculty perceptions of factors that facilitate or hinder learning in web-based courses.	5	27
Vazquez (2003)	Assess a potential set of items to evaluate participatory ethics in rehabilitation counseling.	3	12
Zanetell (2003)	Develop global and local visions for assessment; stakeholder involvement; and evaluation of water resource management.	3	30
Alexander (2004)	Identify trends or events that are likely to occur between 2004 and 2010 that will influence the future of California charter schools and determine the probability and the potential impact of these trends and events.	4	15
Holmes (2005)	Identify and investigate the nature of emerging practice within the profession of occupational therapy, its rewards and challenges, and the professional competencies for practice.	3	24
Levinson (2005)	Gain consensus on a definition of multicultural children's literature.	3	25
Tsou (2005)	Investigate the consensus of opinion of two groups, Taiwanese university vocational educators and five star hotel managers, regarding the components of an effective hospitality management internship program.	3	20
Topper (2006)	Seek consensus for those best practices and strategies that are seen as paramount for succession planning and business survival by executives from privately controlled organizations	3	37

Note. Adapted from "The Delphi Method for Graduate Research," by G. J. Skulmoski, F. T. Hartman, and J. Krahn, 2007, *Journal of Information Technology Education*, 6, p. 17-20.

APPENDIX B

DELPHI DECISION AID AND PILOT STUDY RESULTS

Decision Aid Welcome and Login Pages



forecastingprinciples.com

Welcome to the Delphi Decision Aid!

Delphi is a data-gathering tool to aid in the anonymous survey of expert judgments, obtained in a series of rounds, ultimately for forecasting purposes. This can have (but is not limited to) the following applications:

- New product forecasts
- Personnel selection
- Estimating the effect of a change in a marketing program
- Predicting outcomes in conflict situations

Delphi is designed only for use with questions that yield either rankings or quantitative estimates.

This site helps you to:

- Select experts
- Develop questions and scales
- Obtain responses from the experts
- Summarize a report after each round

It also allows access to relevant literature including, in some cases, full-text articles.

If you wish to administer a session, please create a new administrator account.

Program development



This Delphi program was developed by J. Scott Armstrong and was funded in part by the International Institute of Forecasters.

Delphi

forecastingprinciples.com

[Administrator log in](#)

[Expert log in](#)

Authorization:

- [Administrator log in](#)
- [Expert log in](#)

Related useful links and texts:

- [Forecasting website](#)
- [>>> What's New <<<](#)

New users

[Create new administrator's account](#) if you don't have one.

Returning users

User name:

Password:

[Forgot password?](#)

with questions and problems

nasir al-otaibi, welcome to Delphi!

[?help](#)

Your sessions

Session name	Current round	Round progress	Session progress	
Pilot Study	3	Results Review	Complete	delete
Technology Transfer In Saudi Arabia	3	Results Review	Complete	delete

New session

Pilot Study: Results Review Screens, Round 1

Session name: [Pilot Study](#)

[?help](#)

Test

Round #: 1





Round state: Results Review

View other rounds:

[\[Round 1\]](#) [\[Round 2\]](#) [\[Round 3\]](#) [\[Overall session results\]](#)



[Question Designing](#) [Expert Selection](#) [Process Monitoring](#) [Results Review](#)

 [Home](#)  [Home](#)  [Back to Session List](#)  [Log Out](#)

Please use the links on the top of this page to view results of other rounds.

Data results: Question #1

Question: In your opinion what are the factors that may affect technology transfer in Saudi Arabia and why?

Responses for this question

Expert's answer:

Weak vocational schools and the unwillingness of Saudi citizens to work in blue-color jobs. The high number of foreign labor working in the kingdom.

Expert's answer:

I think you should provide additional clarification or definition of technology transfer particularly as it might apply to Saudi Arabia. I would also use a definition other than Wikipedia-- There are some typos in what you are sending out so I would clean those up before sending out. ----- Note that I can change what is written here when I return to this round-- just so you know. Does the system note any changes or does the record simply change without notifying you? ----- Your email said this: You have been selected in this research based on your expertise. The participation in this research is conditional and you will be anonymous throw-out the research process and even in the outcome of it. Your honest input will be a great support in this study. Not sure what you mean by "throw-out the research process and even the outcome of it" -- You should probably spell out how you will protect the identity of your respondents. This should be consistent with what you have spelled out in your IRB proposal (Did you do this for your proposal? see <http://www.uni.edu/osp/protection-human-research-participants> .) If not, you will need to get IRB approval for your project before you collect any data from your experts. Check with your advisor, Dr. Fecik on this. ----- Looks like you greatly shortened the information provided to respondents in this version-- not sure whether that is a good idea or not as you

want to give them enough information to get quality information from them. Just some thoughts...

Expert's answer:

1. limiting persons access to SA by restricting entry to the country 2. country, or companies, or organizations resistant to change or innovation 3. educational or knowledge level of Saudi Arabian personnel able to handle such input 4. would facilities, and/or needed utilities be available and accommodating

Expert's answer:

1. Saudi Arabia receives huge revenues from oil. Therefore, they can pay for the latest technologies without having to develop industries to make or develop them. Other times in history governments or countries with large capital assets resulted in a decline in their industrial base. 2. Saudi Arabia does not have a democratic government. The country is ruled by a fabulously wealthy royal family. Therefore, there may not be an open, competitive market system, in which the heads of technology companies may become very wealthy and powerful, and can challenge the wealth and power of the ruling elite. In fact my guess is the heads of companies would be members of the royal family. This will kill competition necessary in the free market. Also the workers in the companies may become a powerful labor force with unions. This may not be a popular development for the ruling class. 3. Many of the new technologies are in the field of communication (cell phones, internet). These technologies have played a large role in mobilizing the public to protest against the government (as has happened in Egypt and Libya). The ruling class would see these technologies as a threat to their power. 4. There may be strong religious forces in Saudi Arabia that would see technology transfer from the West as a threat to their religious beliefs.

Expert's answer:

The lack or absence of necessary infrastructure coupled with shortage of Saudi experts with clear aims for technology transfer.

Expert's answer:

to become more industrialized nation. To create jobs to be independent from oil

Select question to view results:

[1]

Go back to session list if you wish to view or create another session.

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Contact [webmaster](#) with questions and problems

Pilot Study: Results Review Screens, Round 2

Session name: Pilot Study

[?help](#)

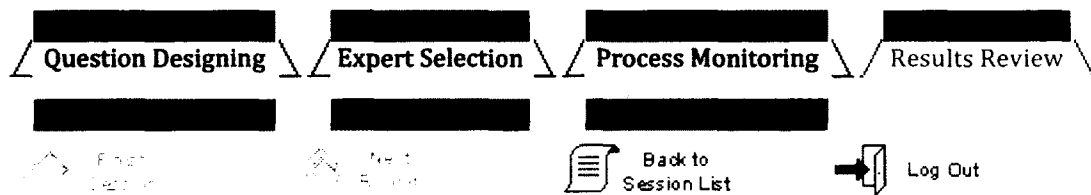
Test

Round #: 2

Round state: Results Review

View other rounds:

[[Round 1](#)] [[Round 2](#)] [[Round 3](#)] [[Overall session results](#)]



Please use the links on the top of this page to view results of other rounds.

Data results: Question #1

Question: Please rank the following factors in order of importance

Items ranked:					
<i>Dependence on oil</i>	Saudi Arabia receives huge revenues from oil. Therefore, they can pay for the latest technologies without having to develop industries to make or develop them other times in history governments or countries with large capital assets resulted in a decline in their industrial base.				
<i>Political factor</i>	Saudi Arabia does not have a democratic government. The country is ruled by a fabulously wealthy royal family. Therefore, there may not be an open, competitive market system, in which the heads of technology companies may become very wealthy and powerful, and can challenge the wealth and power of the ruling elite. In fact my guess is the heads of companies would be members of the royal family. This will kill competition necessary in the free market. Also the workers in the companies may become a powerful labor force with unions. This may not be a popular development for the ruling class. This will result in Limiting persons access to SA by restricting entry to the country forcing the country, or companies, or organizations to become resistant to change or innovation and the unavailability of neither facilities nor utilities to be available and accommodating.				
<i>Education factor which is not technological or science based</i>	Many of the new technologies are in the field of communication (cell phones, internet). These technologies have played a large role in mobilizing the public to protest against the government (as has happened in Egypt and Libya). The ruling class would see these technologies as a threat to their power, which resulted in weak technological and vocational knowledge level of Saudi Arabian personnel able to handle such input.				
<i>Religion factor</i>	There may be strong religious forces in Saudi Arabia that would see technology transfer from the West as a threat to their religious beliefs.				
Item	Average rank	Best rank	Worst rank	No. of times ranked #1	
Dependence on oil	3	1	5	1 (14%)	
	1.6	1	3	3 (43%)	
Education factor which is not technological or since based	3	1	4	1 (14%)	
Manpower factor: Over-reliance on foreign workers	3	2	5	0 (0%)	
Religion factor	4.4	3	5	0 (0%)	
No. of "no opinion" answers:		2			
Total number of answers:		7			
Experts' comments for this question					

Expert ranked #1:

Dependence on oil

Expert's comment:

It is hard to decide which of the factors may be most powerful. In a sense, they are all intertwined. I decided that you couldn't have a rich ruling class without the oil-- and the oil companies love to install and support their own puppets in power. The oil companies have exploited or attempted to exploit every country with oil-- not just Saudi Arabia. The oil companies also have the US politicians in their pocket and that keeps the US supporting the undemocratic system that exists. True democracy is the last form of government that international companies want. Just as they prop up your king, they pour money into the coffers of politicians in our country who give them what they want-- and our environment and economy suffers.

Expert ranked #1:

Political factor

Expert's comment:

I consider the political factor as the major obstacle to technology transfer. This factor affects the educational system which now has more emphasis on religion than math and science. The second major obstacle is the over-reliance on foreign labor. The dependence on oil as the major source of revenue and the incomprehensible reluctance to diversify or invest in oil-related industries to create job and technical know-how is tied to the economic policies of the country. Also, countries that export goods (low and high-tech) would not find a technically savvy Saudi Arabia in their favor.

Select question to view results:

[1]

Pilot Study: Results Review Screens, Round 3, Question 1

Session name: Pilot Study

[?help](#)

Test

Round #: 3





Round state: Results Review

View other rounds:

[\[Round 1\]](#) [\[Round 2\]](#) [\[Round 3\]](#) [\[Overall session results\]](#)



[Question Designing](#) [Expert Selection](#) [Process Monitoring](#) [Results Review](#)

 [Home](#)  [Question](#)  [Back to Session List](#)  [Log Out](#)

Please use the links on the top of this page to view results of other rounds.

Data results: Question #1

Question: Based on your ranking please identify reasons for selecting the highest and the lowest?

Responses for this question

Expert's answer:

My first choice was dependence on oil for the reason that as long as the oil flows, money flows to Saudi Arabia and there is no incentive for doing something different. It seems that humans are not very motivated by remote factors that threaten their well-being. I picked religion as last but I think the religious element is connected with the political factors-- just as in the USA. The moneyed classes buy off the fundamentalists to maintain power and control.

Expert's answer:

Saudi needs help from western countries if they don't invest into research and development. Western countries buy oil and sell military equipment. So, what Saudi will do to be an independent country?

Expert's answer:

#1 - Dependence on oil Dependence on oil as a source of income ever since oil prices increased dramatically is the main factor, which allowed some greedy decisions due to the lack of educated Saudi experts. #5- religion Islam is a religion that support technological invention and innovation looking back at the history we can see that most of the technological inventions where from the Islamic world there are a lot of Islamic countries who are diffusing technology

successfully such as Pakistan, Malaysia and Indonesia.

Expert's answer:

I chose the Political factor as the highest because it influences the other factors. Given that Saudi Arabia has an autocratic form of government where one man commands and the rest obey, whatever the government wishes to do is what gets done. From "5-year development plans" over the last 4 decades, it is clear that Saudi Arabia has not invested in improving its educational system so that it can graduate students with the requisite disposition, skill, and desire to advance technologically. The country has been importing foreign labor from every corner of the globe at the expense of its local labor.

Expert's answer:

despite the fact that all Saudi establishments are controlled by the government which could cause potential discrepancies of data including claims that the government are working hard to launch schemes to support industrial cities and become less oil dependent. I believe that developing manpower is the essential of every country's future however in this case, Saudi Arabia is an oil dependence and everything else can have a slight difference of importance.

Expert's answer:

I selected the political factor the highest because money translates in power. Saudi Arabia has an elite political system in which the royal family controls much of the money and power. I think the political system has to change so that citizens have more rights and and more access to capital for starting their own businesses and competing on the international market. I selected the manpower factor the lowest because foreign workers don't exert much influence on the political situation. Also with the rapidly rising population of Saudi Arabia, there should not be a major problem with not enough workers. But I suspect that not much will change until the political structure changes.

Expert's answer:

Highest Education is an crucial element necessary to advance a civilization Individuals cannot improve themselves unless they receive some educational background Education is also a means to become aware of what other societies have done and provide a historical accounting of their society as well as other societies around them or what their peers have accomplished Education will also provide a basis for common people to provide for themselves Lowest Oil while providing a great deal of economic benefit also does not benefit a wide

segment of the population Even the higher level of the population who receive a large amount of the benefit from oil do not advance their education but use those benefits to keep themselves from advancing their fellow or common folk

Select question to view results:

[1] [2]

Go [back to session list](#) if you wish to view or create another session.

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Pilot Study: Results Review Screens, Round 3, Question 2

Session name: Pilot Study ?help

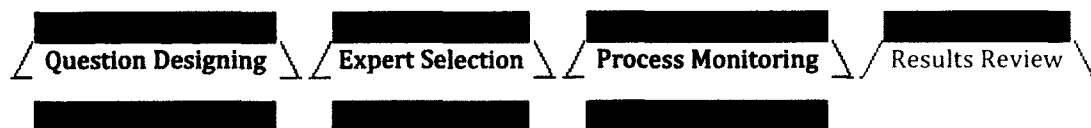
Test

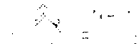
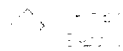
Round #: 3

Round state: Results Review

View other rounds:

[[Round 1](#)] [[Round 2](#)] [[Round 3](#)] [[Overall session results](#)]





Please use the links on the top of this page to view results of other rounds.

Data results: Question #2

Question: By viewing the expert's comments, briefly describe any positive or negative comments?

Responses for this question

Expert's answer:

Not sure what you mean here. Maybe you should direct me to the comments in earlier sessions and ask if I have any reaction to them either positive or negative.

Expert's answer:

All of them are positive factor if Saudi get smater and use them. Religion should be separated from the goverment. Higher education will help to improve the technology. Invest mony on research and development.

Expert's answer:

no comments

Expert's answer:

I agree with the 1st Expert's comment.

Expert's answer:

I don't have any additional comments at this time.

Expert's answer:

The positive aspects are the ability to focus on the items which appeared The results of these rounds will permit Nasir to refine the procedure and provide him with material to allow the context to be fulfilled Negatively, the some aspects of the results will require some additional items to be given further refinement A time limitation will be a necessary aspect to be added to facilitate responses It may be of value to have respondent to note concerns they may have observed during the course of the rounds or responses

Expert's answer:

It is interesting to see the degree of similarity among the respondents' answers.

Select question to view results:

[1] [2]

Pilot Study: Display of Overall Session Results

Overall session results

This page represents summarized statistics for every question used in the session.

- If a question was used in several rounds throughout the session, you will see the summary that takes into account all of the answers received in different rounds.
- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #1

Question: In your opinion what are the factors that may affect technology transfer in Saudi Arabia and why?

Answer		
Total number of answers:	6	
Mean:	N/A	
Standard deviation:	N/A	
Median:		N/A

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Select question to view results:

[1][2][3][4]

[REDACTED]

Data results: Question #2

[REDACTED]

Question: Please rank the following factors in order of importance

Items ranked:






Dependence on oil Saudi Arabia receives huge revenues from oil. Therefore, they can pay for the latest technologies without having to develop industries to make or develop them other times in history governments or countries with large capital assets resulted in a decline in their industrial base.

Political factor Saudi Arabia does not have a democratic government. The country is ruled by a fabulously wealthy royal family. Therefore, there may not be an open, competitive market system, in which the heads of technology companies may become very wealthy and powerful, and can challenge the wealth and power of the ruling elite. In fact my guess is the heads of companies would be members of the royal family. This will kill competition necessary in the free market. Also the workers in the companies may become a powerful labor force with unions. This may not be a popular development for the ruling class. This will result in limiting persons access to SA by restricting entry to the country forcing the country, or companies, or organizations to become resistant to change or innovation and the unavailability of neither facilities nor utilities to be available and accommodating.

Education factor which is not technological or since based Many of the new technologies are in the field of communication (cell phones, internet). These technologies have played a large role in mobilizing the public to protest against the government (as has happened in Egypt and Libya). The ruling class would see these technologies as a threat to their power, which resulted in weak technological and vocational knowledge level of Saudi Arabian personnel able to handle such input.

Manpower factor: Over-reliance on foreign workers The lack or absence of necessary infrastructure coupled with shortage of Saudi experts with clear aims for technology transfer due to the unwillingness of Saudis to work in blue-collar jobs and the high number of foreign labor working in the kingdom (over 80 %) limiting the nation to become more industrialized and dependent from oil.

Religion factor There may be strong religious forces in Saudi Arabia that would see technology transfer from the West as a threat to their religious beliefs.

Item	Average rank	Best rank	Worst rank	No. of times ranked #1	
Dependence on oil	3	1	5	1 (14%)	
Political factor	1.6	1	3	3 (43%)	
Education factor which is not technological or since based	3	1	4	1 (14%)	
Manpower factor: Over-reliance on foreign workers	3	2	5	0 (0%)	
Religion factor	4.4	3	5	0 (0%)	
No. of "no opinion" answers:	2				
Total number of answers:	7				

Select question to view results:

[1][2][3][4]

Overall session results

This page represents summarized statistics for every question used in the session.

- If a question was used in several rounds throughout the session, you will see the summary that takes into account all of the answers received in different rounds.
- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #3

Question: Based on your ranking please identify reasons for selecting the highest and the lowest?	
Answer	
Total number of answers:	7
Mean:	N/A
Standard deviation:	N/A
Median:	N/A

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Select question to view results:

[1] [2] [3] [4]

Overall session results

This page represents summarized statistics for every question used in the session.

- If a question was used in several rounds throughout the session, you will see the summary that takes into account all of the answers received in different rounds.
- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #4

Question: By viewing the expert's comments, briefly describe any positive or negative comments?		
Answer		
Total number of answers:	7	
Mean:	N/A	
Standard deviation:	N/A	
Median:		N/A

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Select question to view results:

[1] [2] [3] [4]

APPENDIX C
FINAL STUDY, ROUND 3 RESULTS

Round 1, Question 1

Data results: Question #1

Question: In your opinion what are the factors that may affect technology transfer in Saudi Arabia and why?

Responses for this question

Expert's answer:

1- there are not enough well trained staff to handle this issue, most of the companies depends on ready qualified staff

Expert's answer:

Depend on the technology type, technology transfer may be vary. In the kingdom, many organizations lately focuses on technology transfer as a cost reduction methodology especially for the high tech and that cost the organizations much money. Usually, TT performed in a vary processed ways and planned very well. On the other hand, there are many other technologies that affect the individuals. And TT depends on their interest in learning the new technology or not. The amount of data in the internet is a key factor in the TT.

Expert's answer:

Identify factors to motivate the higher efficiency and production from the workforce (Inhabitants and Residents). Training and investment on research and development. Transmission of knowledge. Adaptation of technology to the host country Provide the required physical environment (Temperature, etc). Taking into considerations the geographical location factors. Build a high and experienced Management Reuse of the raw materials and concentrate on agriculture lands

Expert's answer:

-One of the main factors in technology transfer is the lack of experienced well skilled human resources, training on new technologies is needed, also the culture factor and culture change to enable new technologies to be accepted and adopted by knowing the benefits of these technologies and the way they will develop the surrounding environment. -The lack of investors in certain fields of technology, critical fields with high risks investors prefer to invest in well known fields like the oil business for example. -Under or over estimating the needs of new technologies and adapting what works for the country or environment and could be cost effective on the long run.

Expert's answer:

A first factor is that the government is focused on oil exports. It's easy and quick revenue. Might also be that the foreign companies don't really want to transfer all of their knowledge to another government, unless they have to. Also technology transfer might create a lot of new jobs for expats but not for locals unless they are formed and ready to take charge.

Expert's answer:

1- Funding - to leverage the cost of transfer 2- IT infrastructure in SA - to support software, hardware and networking requirements of new technologies 3- Readiness of local manpower - ability to operate new technology 4- legal environment - to accommodate the security issues and develop bylaws required

Expert's answer:

Curricula that do not help Incompatibility with the learning outcomes of the job market The absence of a clear plan to do so

Expert's answer:

Technology transfer requires a strong, stable, trusted network of personal relationships. It is important to identify the areas you are interested in and make a long-term commitment to cultivating relationships in these areas.

Expert's answer:

HIGH COST BUILDING THE TRUST

Expert's answer:

1-LACK OF UNDERSTANDING OF NEW TECHNOLOGY. 2-COMPLICATION OF TRANSFERRING OF THE TECHNOLOGY. 3-EDUCATIONAL APPROACH TO TRANSFER TECHNOLOGY(INSUFFICIENT).

Expert's answer:

1- lack of sufficient education related to tech. 2-the government doesn't provide privileges to big companies

Expert's answer:

The factors that will affect technology transfer in Saudi Arabia are: 1- Knowledgeable cadre of the technology being transferred 2- Feasibility study that has shown to the needed technology: without a real needs study, there may be an illusion that a certain technology, which may not be needed in Saudi Arabia, needs to be transferred. 3- The absolute fit of the sought technology with the ethical values and culture of the Kingdom. 4- The human cadre that is able to maintain the transferred technology once it is being applied in the kingdom

Select question to view results:

[1]

[Go back to session list](#) if you wish to view or create another session.

Round 2, Question 1

Please use the links on the top of this page to view results of other rounds.

Data results: Question #1

Question: In your opinion what may be the factors that affect Saudi Arabia's successes in renewable energy technology?

Responses for this question

Expert's answer:

It is a question of leadership. Some visionary leaders must think of a strategy of planning for the long term stability of the nation - investing wisely for a time in the future when there is no more oil. There is no shortage of sunlight and space, so solar energy would seem to be an obvious choice. However, where are the potential customers of solar electricity and how would solar energy be transmitted to market? It may make more sense to invest in renewable energy in other countries. Certainly, a complicating factor is that for the time being renewable energy is simply more expensive than fossil energy. A long term strategy may be to invest in research and development of energy saving technologies and renewable energy sources.

Expert's answer:

it doesnt need in the mean time no govermental support no fund from foreign companies usually

Expert's answer:

1- Political wellness 2- Estimates of Petroleum reserves 3- International policies and laws for or against use of Petrol byproducts

Expert's answer:

I believe the factors are related to the hard and hot environment we live in, a lot of people believe in our hot weather these techs won't work as they should, and another factor is the cost of the renewable energy technologies some think that it's high if compared to petrol solutions, and one more important factor is the awareness of benefits of this kind of energy and how does it help in providing a clean environment and also reduce the use of petrol, we need. To see a huge initiative from the government in supporting this technology and supporting business men to adopt the renewable energy technology in their projects.

Expert's answer:

1- believe in technology. 2-professional @ knowledgeable people . 3-providing sufficient equipment. 4-support from the decision maker. 5-apply it in Saudi, industrial and business sectors.

Expert's answer:

Most of the answers are relating to human factors

Expert's answer:

1- there should be good planning for this issue 2- qualified persons 3- good awareness

Expert's answer:

I think the most important challenges in the field of renewable technology is the human force, as it is a new field in the kingdom the experience required in the kingdom in such projects is at its minimal level and also hard to find needed resource locally. Good long term planning should overcome this issue.

Expert's answer:


the government is focused on oil exports lack of skilled staff lack of culture change

Expert's answer:


1-Enhanced awareness of energy and environmental concerns 2-Setting a range of financial incentives such as net metering, feed-in tariffs that could boost the cost-competitiveness. 3-Promoting the solar photovoltaics (PV), wind power and solar thermal power have undoubtedly emerged. 4-Use Of Nuclear Energy to meet the rising domestic need 5-Setting up the regulations and instructions that will lead to use the renewable energy 6-Use of Electric Cars

Round 2, Question 2

Data results: Question #2



Question: By viewing the expert's comments in round one, briefly describe any positive or negative comments?



Responses for this question



Expert's answer:

It is a good collection of answers. It must be remembered that innovative new solutions are going to come from young people. But, is the younger generation being given opportunities and positions of responsibility and trust??

Expert's answer:

question unclear

Expert's answer:

There is no governmental movement

Expert's answer:

no comments

Expert's answer:

Long term should be considered to transfer the knowledge and build new generation to fulfill the transforming requirements.

Expert's answer:

In my opinion the highly skilled Management leadership and the professional trainee will insa'llah lead to the Technology transfer.

Sect question to view results:

[1] [2]

[Go back](#) to session list if you wish to view or create another session.

Round 3, Question 1

Please use the links on the top of this page to view results of other rounds.

Data results: Question #1

Question: MANPOWER FACTOR It must be remembered that innovative new solutions are going to come from young people. But, is the younger generation being given opportunities and positions of responsibility and trust. There is not enough well trained local staff to handle the transfer of technologies; most of the companies depend on foreign ready qualified staff (80%), which reduced the motivation on production, from the workforce (Inhabitants and Residents). Lack of experienced well skilled human recourse's will affect the transfer of renewable technology unless they are formed and ready to take charge. In order for the country to focuses on the transfer of renewable technology ,the human cadre must be qualified to be able to maintain the transferred technology once it is being applied in the kingdom. The highly skilled Management

leadership and the professional trainee are still required.

Scale: 1 (Not Important) to 5 (Very Important)

Answer

1

[Redacted]

2

[Redacted]

3

[Redacted]

4

[Redacted]

4

[Redacted]

4

[Redacted]

4

[Redacted]

5

[Redacted]

5

[Redacted]

5

[Redacted]

5

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5	
Total number of answers:	10
Mean:	4.2
Standard deviation:	1.17
Median:	4

Experts' comments for this question

Expert's answer:

4

Expert's comment:

usually new ideas need alot of money so the businessman can help to maintain a good structure

Expert's answer:

5

Expert's comment:

I strongly believe that the highly trained staff and skilled management will be the vehicle which will lead the technology transfer in Saudia Arabia. As I have realized and seen that, there are young suadi who have the knowledge and experience and they are enthusiastic to lead the technology transfer. So, let's believe and give them the chance to build the younger generations on the new technologies through highly skilled and targeted training internal and external programs, and let them attain the experience through contact with worldwide universities and industry and conferences and standardization bodies.

Expert's answer:

5

Expert's comment:

The resident workforce must be empowered to act, and take responsibility for the future direction of the nation. It is clear that leadership is the most important issue.

Expert's answer:

1

Expert's comment:

Indeed manpower is crucial to technology transfer

Results display options

You are currently viewing **detailed** results
Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Select question to view results:

[1] [2] [3] [4] [5] [6]

Round 3, Question 2

Please use the links on the top of this page to view results of other rounds.

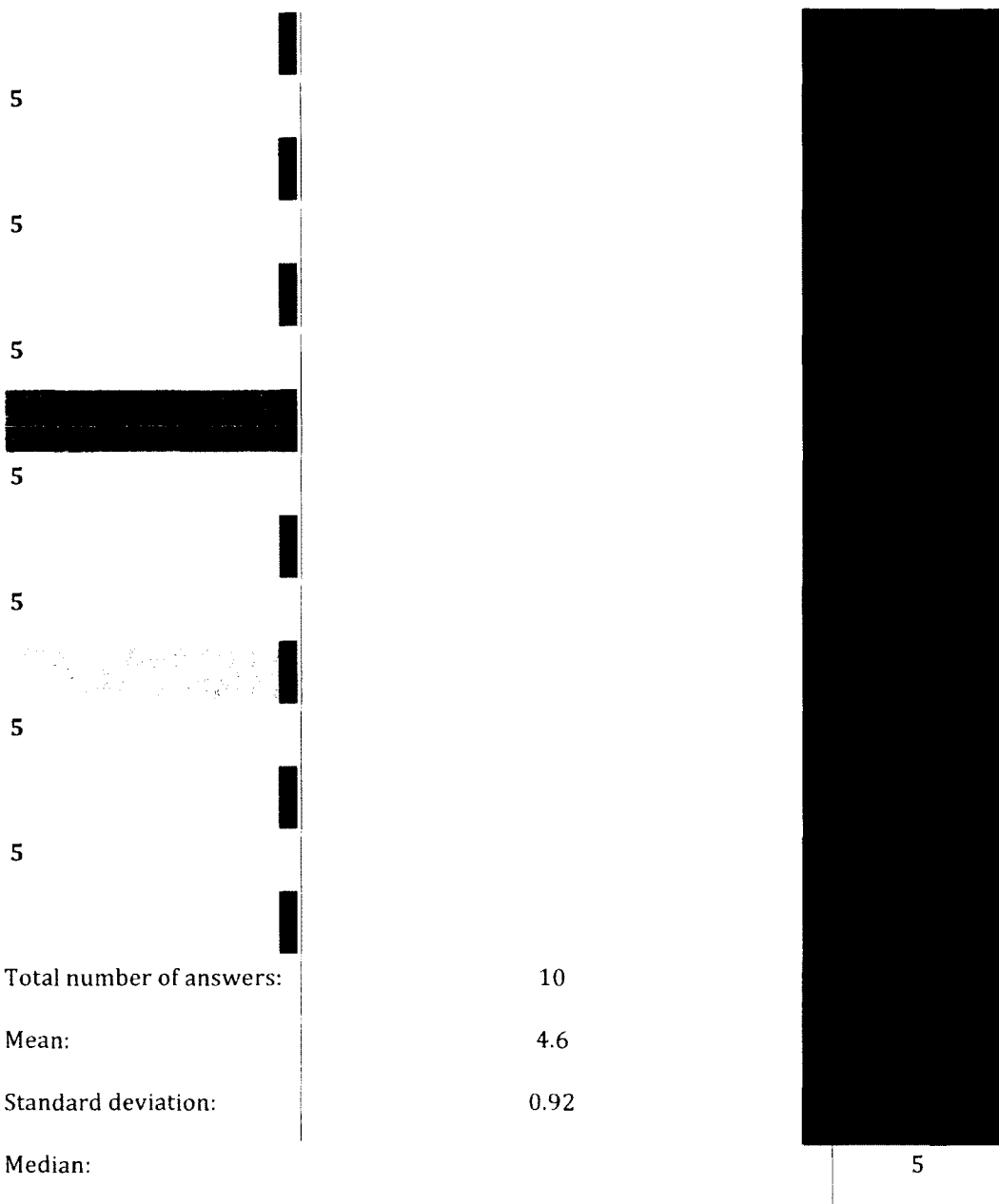
Data results: Question #2

Question: EDUCATION FACTOR The educational system in the kingdom of Saudi Arabia is one of the main factors affecting the transfer of technology (renewable technologies) for many reasons: 1-Curricula that do not help Incompatibility with the learning outcomes of the job market and the absence of a clear plan to do so. 2-Lack of training, and investment in research & development which will result in an improper transmission of knowledge and technology. 3-Under or over estimating the needs of new technologies and adapting what works for the country or environment and could be cost effective on the long run. 4-Educational system that is not since and technology based. 5-Lack of knowledgeable cadre of the technology being transferred. Long term should be considered to transfer the knowledge and build new generation to fulfill the transforming requirements. Investing in research and development of energy saving technologies and renewable energy sources will enhance awareness of energy and environmental concerns.

Scale: 1 (Not Important) to 5 (Very Important)

Answer	
1	[Redacted]
2	[Redacted]
3	[Redacted]
4	[Redacted]
5	[Redacted]





Experts' comments for this question

Expert's answer:

2

Expert's comment:

scholarship?

Expert's answer:

5

Expert's comment:

I strongly agree on that, where the research and development and training are the fundamentals for the technology transfer. Also, we should build short and long term planning strategy to achieve that. Moreover, curriculum at the university level should match the new trend of the technology transfer on the field. University student should be given adequate on job training to improve and build his graduate project on the requirement of the field.

Expert's answer:

4

Expert's comment:

Young people are very good at observing and seeing the meanings of things. If society does not value education then it will not be a priority for students. It is important to have a clear connection between education and careers. I would advise an elite institution with the purpose of educating future technical leaders for the nation.

Expert's answer:

5

Expert's comment:

the number of the graduate from the technical institutes not fill the gap and many of them withdraw as soon as they graduate.

Expert's answer:

5

Expert's comment:

Somehow relates to manpower.

Results display options

You are currently viewing **detailed** results
Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Select question to view results:
[1] [2] [3] [4] [5] [6]

Round 3, Question 3

Please use the links on the top of this page to view results of other rounds.

Data results: Question #3

Question: DEPENDENCE ON OIL FACTOR It is a question of leadership, some visionary leaders must think of a strategy of planning for the long term stability of the nation - investing wisely for a time in the future when there is no more oil. The government dependence on oil will affect the transfer of renewable technology for many reasons: 1-The lack of investors in cretin fields of technology, critical fields with high risks investors prefer to invest in well-known fields like the oil business for example. 2-The government is

focused on oil exports, It's easy and quick revenue. 3-Unclear estimates of Petroleum reserves 4-International policies and laws for or against use of Petrol byproducts.

Scale: 1 (Not Important) to 5 (Very Important)

Answer

1

[Redacted]

2

[Redacted]

3

[Redacted]

3

[Redacted]

3

[Redacted]

4

[Redacted]

5

[Redacted]

5

[Redacted]

5

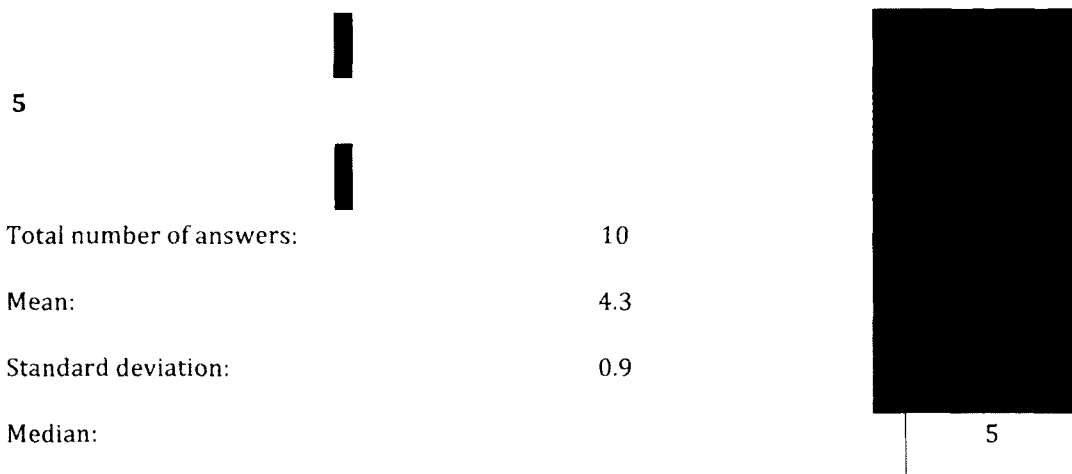
[Redacted]

5

[Redacted]

5

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Experts' comments for this question

Expert's answer:

5

Expert's comment:

we will stay like this until oil price going down unfortunately

Expert's answer:

3

Expert's comment:

In fact that, the leaders should build a strategic plan for about 10 years to come, nevertheless in my opinion oil business should increase and utilized in the areas for the technology transfer and the prosperity of other technology sectors like the telecom field, electric field, industry, etc.

Expert's answer:

5

Expert's comment:

It would be strategic to study very closely how Norway has decided to invest its oil resources in order to maintain a stable technically advanced society with full employment. I believe they have put this opportunity to good use to create long term prosperity. It may be thought that it is 'easy money' but this is a lazy simple answer. In reality it is a very complicated opportunity and if managed correctly it will make opportunities available for long term prosperity. If the opportunity is wasted it would be a tragedy.

Expert's answer:

5

Expert's comment:

although we have alot of natual solar energ we didnt invest in that and the sametime we still have million of forign labour,therefore we didnt invest in solar energy and we didnt invest in our youth.

Expert's answer:

5

Expert's comment:

Completely relevant. Oil future is bright, government not botteront about other possible Sources of income

Results display options

You are currently viewing **detailed** results
Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges

- ⌋ Detailed results - every answer displayed; empty ranges for 0-results to scale
- ⌋ Detailed results - every answer displayed; all 0-results answers

Select question to view results:

[1] [2] [3] [4] [5] [6]

Round 3, Question 4

Please use the links on the top of this page to view results of other rounds.

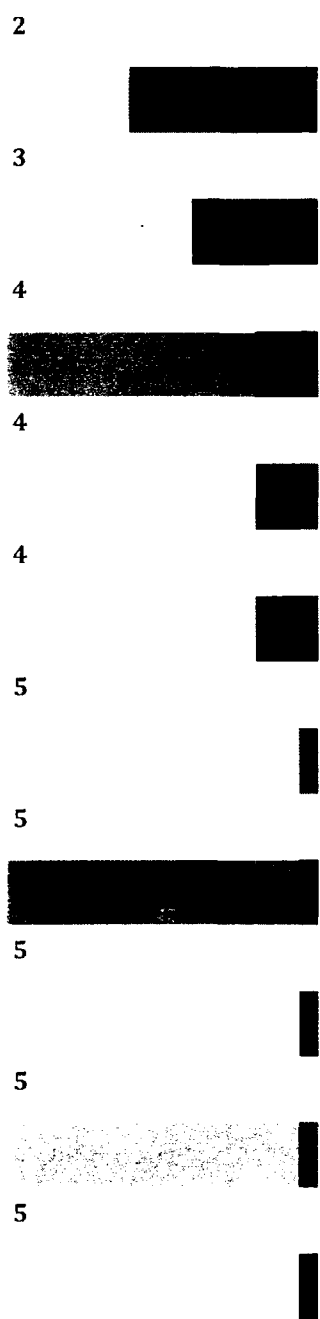
Data results: Question #4

Question: POLITICAL FACTOR Technology transfer requires a strong, stable, trusted network of personal relationships. It is important to identify the areas you are interested in and make a long-term commitment to cultivating relationships in these areas. Initiative from the government in supporting renewable technology and supporting business men to adopt the renewable energy technology in their projects is an important approach. Some political factors that may affect the transfer of renewable technologies in Saudi Arabia are: 1-Foreign companies don't really want to transfer all of their knowledge to another government, unless they have to. 2-Funding - to leverage the cost of transfer 3-Weak IT infrastructure - to support software, hardware and networking requirements of new technologies. 4-Legal environment -- to accommodate the security issues, develop bylaws required and reduce technology transfer complications. 5-Privileges to big companies 6-No funds from foreign companies. 7-Political wellness 8-Support from the decision makers. 9-Setting a range of financial incentives such as net metering, feed-in tariffs that could boost the cost-competitiveness. 10-Setting up the regulations and instructions that will lead to use the renewable energy

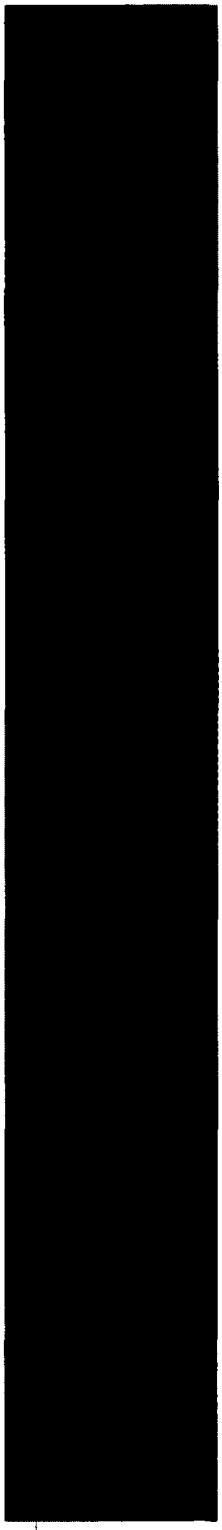
Scale: 1 (Not Important) to 5 (Very Important)

Answer

1



Total number of answers: 10
Mean: 4.2
Standard deviation: 0.98
Median:



4



Experts' comments for this question

Expert's answer:

3

Expert's comment:

all these point above is under control

Expert's answer:

5

Expert's comment:

I recommend to use the Nuclear Energy. Also, to attract the foreign companies to invest in Saudia Arabia through improving the regulations and instructions and also through enahnce the competition which take the saudi inhabitants rights in deployment and incentives into consideration.

Expert's answer:

4

Expert's comment:

I am sure the leaders are watching the 'Arab Spring' political developments very carefully. This is closely tied to the issue of how young people are going to be incorporated into society. Are they being prepared for unemployment and authoritarian political oppression, or is the energy and opportunity of the young people being harnessed for future prosperity? A 'frozen' political structure does not send positive signals to young people that there efforts are appreciated, and then the good ones will leave. It is also clear that intellectual property must be respected. Is the Kingdom part of the Patent Cooperation Treaty?

Expert's answer:

5

Expert's comment:

there are only few tech companies own and led by saudi youth where acually there many smart saudi technologist looking for jobs ,ther be supported by the goverment.

Results display options

Round 3, Question 5

Please use the links on the top of this page to view results of other rounds.

Data results: Question #5

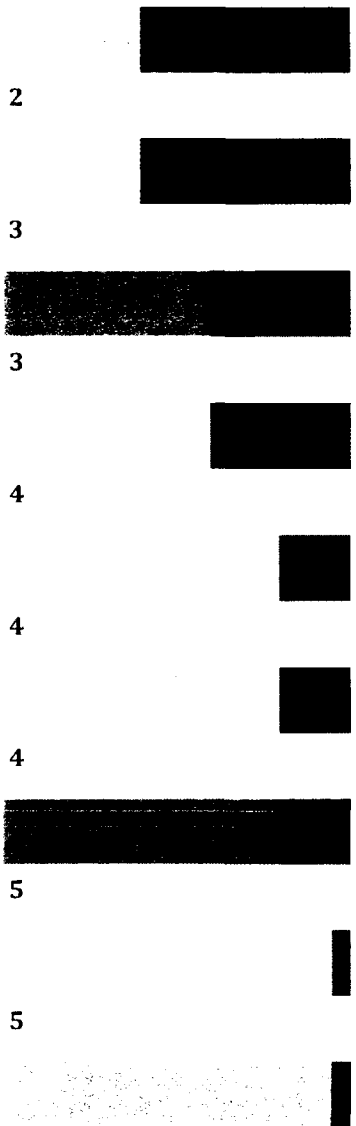
Question: GEOGRAPHICAL LOCATION FACTOR Adaptation of technology to the host country provides the required physical environment. There is no shortage of sunlight and space, so solar energy would seem to be an obvious choice. In contrast, some speculate that it is too hot for solar system to work as it should in hot temperatures and the difficulty of finding needed resources locally.

Scale: 1 (Not Important) to 5 (Very Important)

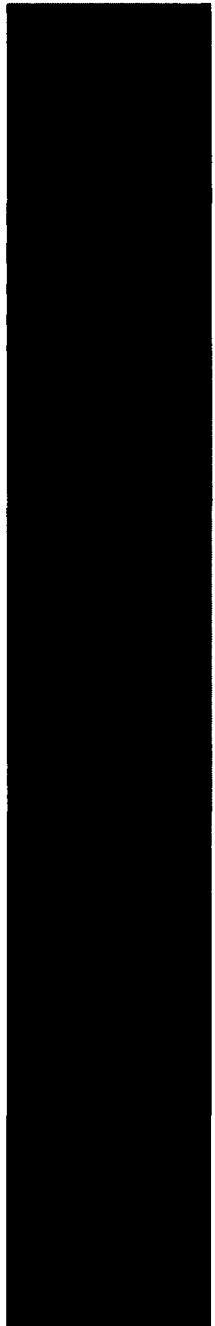
Answer

1

2



Total number of answers: 10
Mean: 3.3
Standard deviation: 1.27
Median:



3

Experts' comments for this question

Expert's answer:

3

Expert's comment:

I agree that the weather are mostly shiny all over the year in Saudia Arabia. So investing in solar Energy will be very good choice for households, and small factories where alot of energy savings will be reached.

Expert's answer:

4

Expert's comment:

CSP - Concentrated Solar Power - systems will not be affected by high temperature. The cost per kilowatt hour of electricity for solar sources is decreasing, to the point that these installations can produce a positive return on investment in 5 to 10 years.

Expert's answer:

5

Expert's comment:

there is no use of solar energy .

Results display options

You are currently viewing **detailed** results
Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale

Detailed results - every answer displayed; all 0-results answers

Round 3, Question 6

Please use the links on the top of this page to view results of other rounds.

Data results: Question #6

Question: CULTURE FACTOR Some of the experts mentioned the culture factor and culture change to enable new technologies to be accepted and adopted by knowing the benefits of these technologies and the way they will develop the surrounding environment. In contrast, some argued that the absolute fit of the sought technology with the ethical values and culture of the Kingdom should be considered.

Scale: 1 (Not Important) to 5 (Very Important)

Answer

1

[Redacted]

2

[Redacted]

2

[Redacted]

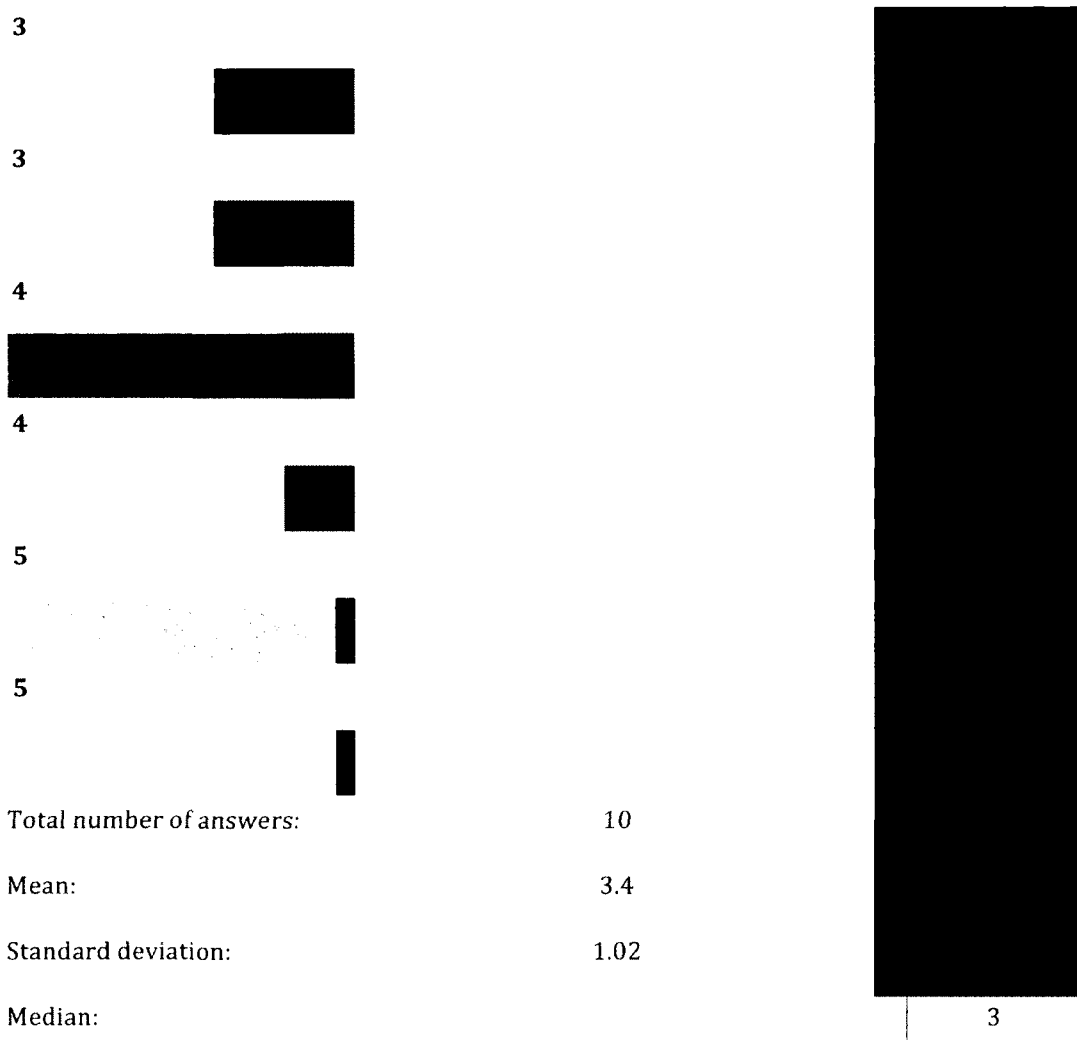
3

[Redacted]

3

[Redacted]

[Redacted]



Experts' comments for this question

Expert's answer:

5

Expert's comment:

Yes, technology transfer should cope with the ethical values of the Saudia Arabia. Taking into consieration that the technolgy transfer should cope with the moral and ethical values.

Expert's answer:

2

Expert's comment:

I think that technology and cultural values are separate issues, at least they should be. Often for example tax incentives are sufficient to encourage people to adapt new technologies.

Expert's answer:

3

Expert's comment:

the social transstion have been changed, to accept tech work.

Results display options

You are currently viewing **detailed** results
Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Final Study: Display of Overall Session Results

Overall session results

This page represents summarized statistics for every question used in the session.

- If a question was used in several rounds throughout the session, you will see the summary that takes into account all of the answers received in different rounds.
- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #1

Question: In your opinion what are the factors that may affect technology transfer in Saudi Arabia and why?		
Answer		
Total number of answers:	12	
Mean:	N/A	
Standard deviation:	N/A	
Median:		N/A

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Overall session results

This page represents summarized statistics for every question used in the session.

- If a question was used in several rounds throughout the session, you will see the summary that takes into account all of the answers received in different rounds.
- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #2

Question: In your opinion what may be the factors that affect Saudi Arabia's successes in renewable energy technology?		
Answer		
Total number of answers:	10	
Mean:	N/A	
Standard deviation:	N/A	
Median:		N/A

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Overall session results

This page represents summarized statistics for every question used in the session.

- If a question was used in several rounds throughout the session, you will see the summary that takes into account all of the answers received in different rounds.
- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #3

Question: By viewing the expert's comments in round one, briefly describe any positive or negative comments?		
Answer		
Total number of answers:	6	
Mean:	N/A	
Standard deviation:	N/A	
Median:		N/A

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Overall session results

This page represents summarized statistics for every question used in the session.

- If a question was used in several rounds throughout the session, you will see the summary that takes into account all of the answers received in different rounds.
- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #4

Question: MANPOWER FACTOR It must be remembered that innovative new solutions are

going to come from young people. But, is the younger generation being given opportunities and positions of responsibility and trust. There is not enough well trained local staff to handle the transfer of technologies; most of the companies depend on foreign ready qualified staff (80%), which reduced the motivation on production, from the workforce (Inhabitants and Residents). Lack of experienced well skilled human recourse's will affect the transfer of renewable technology unless they are formed and ready to take charge. In order for the country to focuses on the transfer of renewable technology ,the human cadre must be qualified to be able to maintain the transferred technology once it is being applied in the kingdom. The highly skilled Management leadership and the professional trainee are still required.

Scale: 1 (Not Important) to 5 (Very Important)

Answer	
1	
2	
3	
4	
4	
4	
4	
5	
5	
5	
5	
5	
Total number of answers:	10
Mean:	4.2
Standard deviation:	1.17
Median:	4

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Overall session results

This page represents summarized statistics for every question used in the session.

- If a question was used in several rounds throughout the session, you will see the summary that takes into account all of the answers received in different rounds.
- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #5

Question: EDUCATION FACTOR The educational system in the kingdom of Saudi Arabia is one of the main factors affecting the transfer of technology (renewable technologies) for many reasons: 1-Curricula that do not help Incompatibility with the learning outcomes of the job market and the absence of a clear plan to do so. 2-Lack of training, and investment in research & development which will result in an improper transmission of knowledge and technology. 3- Under or over estimating the needs of new technologies and adapting what works for the country or environment and could be cost effective on the long run. 4-Educational system that is not since and technology based. 5-Lack of knowledgeable cadre of the technology being transferred. Long term should be considered to transfer the knowledge and build new generation to fulfill the transforming requirements. Investing in research and development of energy saving technologies and renewable energy sources will enhance awareness of energy and environmental concerns.

Scale: 1 (Not Important) to 5 (Very Important)

Answer	
1	
2	
3	
4	
5	
5	
5	
5	
5	
5	
5	
5	
5	
5	
5	
Total number of answers:	10
Mean:	4.6
Standard deviation:	0.92
Median:	5

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges

- Detailed results - every answer displayed: empty ranges for 0-results to scale
- Detailed results - every answer displayed: all 0-results answers

Overall session results

This page represents summarized statistics for every question used in the session.

- If a question was used in several rounds throughout the session, you will see the summary that takes into account all of the answers received in different rounds.
- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #6

Question: DEPENDENCE ON OIL FACTOR It is a question of leadership, some visionary leaders must think of a strategy of planning for the long term stability of the nation - investing wisely for a time in the future when there is no more oil. The government dependence on oil will affect the transfer of renewable technology for many reasons: 1-The lack of investors in cretin fields of technology, critical fields with high risks investors prefer to invest in well-known fields like the oil business for example. 2-The government is focused on oil exports, It's easy and quick revenue. 3-Unclear estimates of Petroleum reserves 4-International policies and laws for or against use of Petrol byproducts.

Scale: 1 (Not Important) to 5 (Very Important)

Answer	
1	
2	
3	
3	
3	
4	
5	
5	
5	
5	
5	
5	
5	
5	
Total number of answers:	10
Mean:	4.3
Standard deviation:	0.9

Median:	5
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Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Overall session results

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Data results: Question #7

Question: POLITICAL FACTOR Technology transfer requires a strong, stable, trusted network of personal relationships. It is important to identify the areas you are interested in and make a long-term commitment to cultivating relationships in these areas. Initiative from the government in supporting renewable technology and supporting business men to adopt the renewable energy technology in their projects is an important approach. Some political factors that may affect the transfer of renewable technologies in Saudi Arabia are: 1-Foreign companies don't really want to transfer all of their knowledge to another government, unless they have to. 2-Funding - to leverage the cost of transfer 3-Weak IT infrastructure - to support software, hardware and networking requirements of new technologies. 4-Legal environment -- to accommodate the security issues, develop bylaws required and reduce technology transfer complications. 5-Privileges to big companies 6-No funds from foreign companies. 7-Political wellness 8-Support from the decision makers. 9-Setting a range of financial incentives such as net metering, feed-in tariffs that could boost the cost-competitiveness. 10-Setting up the regulations and instructions that will lead to use the renewable energy

Scale: 1 (Not Important) to 5 (Very Important)

Answer	
1	
2	
3	
4	
4	
4	

5		
5		
5		
5		
5		
Total number of answers:	10	
Mean:	4.2	
Standard deviation:	0.98	
Median:		4

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

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- Detailed results - every answer displayed; all 0-results answers

Overall session results

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Data results: Question #8

Question: GEOGRAPHICAL LOCATION FACTOR Adaptation of technology to the host country provides the required physical environment. There is no shortage of sunlight and space, so solar energy would seem to be an obvious choice. In contrast, some speculate that it is too hot for solar system to work as it should in hot temperatures and the difficulty of finding needed resources locally.

Scale: 1 (Not Important) to 5 (Very Important)

Answer	
1	
2	
2	
3	

3		
4		
4		
4		
5		
5		
Total number of answers:	10	
Mean:	3.3	
Standard deviation:	1.27	
Median:		3

Results display options

You are currently viewing **detailed** results

Select preferred results display type:

- Brief results - identical answers grouped together; no empty ranges
- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers

Overall session results

This page represents summarized statistics for every question used in the session.

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- If a question was used in a single round, the statistics here will be identical to those for that round.

Data results: Question #9

Question: CULTURE FACTOR Some of the experts mentioned the culture factor and culture change to enable new technologies to be accepted and adopted by knowing the benefits of these technologies and the way they will develop the surrounding environment. In contrast, some argued that the absolute fit of the sought technology with the ethical values and culture of the Kingdom should be considered.

Scale: 1 (Not Important) to 5 (Very Important)

Answer	
1	
2	
2	

3		
3		
3		
3		
4		
4		
5		
5		
Total number of answers:	10	
Mean:	3.4	
Standard deviation:	1.02	
Median:		3

Results display options

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- Detailed results - every answer displayed; empty ranges for 0-results to scale
- Detailed results - every answer displayed; all 0-results answers