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**Assessing the Capability to Acquire and
Absorb Technology within the Public
Sector in Developing Countries: The
Case of Kuwait**

Jassim Mohammad Al-Fahhad

Doctor of Philosophy

Aston University

August 2004

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Thesis Summary

The aim of this research is to assess the acquisition and absorption technological capabilities of the public sector in developing countries, with specific focus on the State of Kuwait. The assessment process of these two capabilities was conducted using a model originally designed for the private sector. In addition, the research aims to propose a framework to enhance the technological capability of developing countries, as well as the performance of the public sector.

To achieve these aims, an investigation of the technology transfer process to three public ministries in Kuwait was conducted. The prime interest of this investigation was to evaluate the role of the transferred technology in enhancing the indigenous technological capability of the public sector. The research is based on a case study approach, comprising a main case study (Ministry of Electricity and Water) and three minor case studies.

Based on the outcomes from an extensive literature review and the preliminary sectoral visits, the research question and four hypotheses were formulated. These hypotheses were then tested using interview-based survey and documentation.

The findings of the research revealed the weakness of the acquisition and absorption technological capabilities of the public sector. Consequently, the public sector relies extensively on foreign contractors and expatriates to compensate for this weakness. Also, it was found that Kuwait Government has not taken the necessary measures to develop its technological capability. This research has proposed a framework which could lead, if properly managed, to the enhancement of indigenous capability. It has also proposed how to improve performance and productivity in the public sector. Finally, the findings suggest that the assessment model, with minor adjustment, is applicable to the public sector.

Keywords: technological capability, technology transfer, assessment, developing countries, public sector.

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Glossary

AGU	Arabian Gulf University
AUS	Assistant Under-Secretaries
BCSR	Bahrain Centre for Studies & Researches
CEGB	Central Electricity Generating Board
FDI	Foreign Direct Investment
FMS	Foreign Military Sales
GCC	Cooperation Council countries
GDP	Gross Domestic Product
IG	Imperial Gallons
ISP	Internet Service Provider
IT	Information Technology
KACST	King Abdulaziz City for Science & Technology
KAF	Kuwait Air Force
KFTZ	Kuwait Free Trade Zone
KIA	Kuwait Investment Authority
KIB	Kuwait Investment Board
KIO	Kuwait Investment Office
KISR	Kuwait Institute for Scientific Research
KNPC	Kuwait National Petroleum Company
KOC	Kuwait Oil Company
KOP	Kuwait Offset Programme
KPC	Kuwait Petroleum Corporation
KSE	Kuwait Stock Exchange
KTI	Kuwait Technology Incubator
MEW	Ministry of Electricity and Water
MoC	Ministry of Communications
MoH	Ministry of Health

MSF	Multi-Stage Flash technique
NICs	Newly Industrialised Countries
OAPEC	Organisation of Arab Petroleum Exporting Countries
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of Petroleum Exporting Countries
PAAET	Public Authority for Applied Education and Training
PIC	Petrochemicals Industries Company
R&D	Research and Development
SARC	Science and Application Research Centre
UAE	United Arab Emirates
UNCTAD	United Nations Conference on Trade and Development
UNCTC	United Nations Centre on Transitional Corporations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organisation
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization

Chapter 1

Introduction

Introduction

In his book *Commodities and Capabilities*, Amartya Sen argues that economic development should be viewed first and foremost as a process of expansion of people's capabilities (Sen, 1985). He also stresses that the common practice of focusing on the growth of national production may only easily lead to a commodity-centred approach in which economic progress is pursued as an end in itself rather than as a means towards the higher objectives of enriching human capabilities and life (Sen, 1990).

The above arguments clearly assert the significance of human capability in economic growth. The concern of this study is with one particular subset of human capabilities which are vitally important for the building up and development of societies' infrastructure: technological capability. The continuous fast pace of technologies development in the current technology-revolution era and the rareness of relevant studies, as shall be seen later, necessitated the focus on this issue.

The selection of this subject stemmed from personal observation within the author's own work environment. The adverse impact of inaccurate and inappropriate technology adoption decisions in this organisation had led to the consideration of this matter. These decisions reflect the fact that senior management did not take advantage of the frequent importation of foreign technologies to build up or enhance local technological capabilities, such as the ability to conduct feasibility studies, technology assessment, the selection of the appropriate technology and the efficient operation and maintenance of the acquired technology. Due to the nature of the organisation, technical decisions

are made frequently. Normally, these decisions are very costly and consume a lot of time and effort. It appears that most of these decisions were poorly judged. As a result, this organisation often ended up by acquiring inappropriate technology or the reliance on costly expatriates was perpetuated.

A preliminary investigation in the form of several interviews with some of the top executive managers revealed that there is insignificant awareness of the potential of indigenous technological capability. Since most of the projects that this organisation is involved with are related to either new technology acquirement (new sophisticated machines, support equipment, tools and software upgrades), or modifying an existing technology, it is imperative to embark on a study to understand the logic and the significance of technology, the appropriate means of transferring it and, potentially, how local technological capabilities can be assessed, enhanced and adapted to accommodate the new transferred technology.

Based on this investigation, the literature review and the pilot survey¹ the formulated research question is: "How can public sector organisations in developing countries assess their capability to acquire and absorb imported technology?" This question was the basis for the design and execution of the research. However, the research could not be conducted in the author's organisation because of security and confidentiality issues. Consequently, it was conducted in other organisations, but within the same sector, i.e. the governmental sector.

1.1 Aim and objectives

This thesis aims to investigate the role of indigenous technological capabilities on the success of imported technology to the public sector in developing countries, on the premise that these capabilities are necessary for the effective transfer of foreign technology. The assessment process was conducted using a model

1. More related information is presented in Chapter 8 and Appendix B.....

developed by Panda and Ramanathan (1996). The model was used to study the technological capability profile of the Kuwaiti Ministry of Electricity and Water (MEW¹). MEW was selected for many reasons. First, it is one of the largest and fastest growing industrial sectors in Kuwait. This implies that the sector is a good candidate for such a study since it is frequently involved in large technical projects. Second, the proposed methodology was originally developed for firms in the electricity field. Third, the researcher has ready access to the required data in Kuwait.

The specific objectives of the research are summarised as follows:

- to assess the acquisition and absorption of technological capabilities within the public sector in developing countries
- to propose a framework to enhance the technological capability of developing countries.
- to propose a framework to enhance the technological capability of the public sector in developing countries
- to evaluate the applicability of the Panda and Ramanathan model (a technological capability assessment model) for technology transfer to the public sector in developing countries

1.2 The research context

Technology and technological know-how are viewed as an important factor and essential element for socio-economic development and the control of nature and resources. Also, it exerts a powerful influence on the standard of living and quality of life. Knowledge, innovations and professional skills are incorporated in the form of nascent technology. Thus, the acquisition of technology is essential for economic and industrial development.

1. By the time this thesis was written MEW had merged with the Ministry of Oil to become the Ministry of Energy.

Recipient and supplier countries alike have critical interests at stake in the generation and acquisition of technology. As a process that enhances the recipient's capacity to produce goods and services, technology transfer is a two-way interaction. However, technology transfers that fail or have unintended consequences may pose economic and political obstacles. From the perspective of the supplier, technology transfers may help win friends, cement political alliances, increase exports, or alternatively lead to resentment and conflicts of interest. The promises of success and problems of failure are particularly apparent when new and complex technologies are introduced into developing countries that have limited scientific and technological infrastructures, and mediocre capabilities (Heeks, 1995).

1.2.1 Technology transfer to developing countries

For developing countries, it is widely recognised that technology transfer has played an important part in the socio-economic development of these countries. It promises economic growth, improved living conditions, manpower development, and even enhanced national prestige and influence. None the less, the technology transfer process to developing countries can be generally characterised as ineffective, if not a failure in some cases (Dahlman, 1987; and Kahen, 1997).

Despite realising the great importance of technology for their development and industrialisation, it seems that most developing countries are not yet able to employ effective strategies and policies for successful transfer of technology (Salami and Reavill, 1997). Furthermore, the majority of decision makers in developing countries perceive the technology transfer process as the mere transportation of physical items from one place to another, while the transfer of the know-how is often disregarded (Levin, 1997).

Many authors (for example Bennett and Vaidya, 2001; Al-Ghailani and Moor, 1995; De, 1999 and Youssef, 1999) have discussed the issue of technology transfer from developed to developing countries. In their view, an effective transfer of technology often requires the following conditions:

- similar levels of technological ability within the same sector
- the existence of compatible interests between the firms
- flexible national policies and regulations which facilitate and control the flow of foreign technology
- the identification of local needs and conditions and the appropriateness of technology
- an awareness of the culture and norms of the host country
- the protection of intellectual properties of the technology suppliers

However, one of the most crucial factors that has great influence on the success of technology transfer in developing countries is the level of the indigenous technological capability (Kondo, 2001; Enos and Park, 1989; Lin, 1997; and Bell and Pavitt, 1992). It is well acknowledged that the technology transfer process yields short- and long-term benefits. Short-term benefits are represented by boosted productivity, quality improvement, new products/processes or lower costs. Over the long term, the benefits depend on how much the recipients have learned from the technological know-how and are able to strengthen their technological capabilities. It is these long-term benefits that most developing countries have neglected. This partly explains the heavy reliance of most of the developing countries on “turnkey projects” when transferring technology. The issue of technological capability and its assessment form the basis for this research.

1.2.2 The issue of technological capability

The notion that had previously prevailed was that developing countries, for their industrial and economical development, could simply acquire foreign technology from other countries which are more technologically advanced. Hence, the

primary technological problem that these countries confronted was the selection of the most appropriate technology from among available alternatives and ensuring that it was transferred under acceptable terms (Romijn, 1998). The recent literature on technology transfer has asserted that such imports are quite insufficient for improving efficiency and inducing a self-sustaining industrialisation process. The main reason is that mere access to foreign technology does not imply an individual's mastery over that technology (Amsden, 1989).

Chapter 3 presents a more specific definition of technological capability. However, it is sufficient here to know that technological capability refers to the local ability of the recipient to acquire, absorb and develop new technology. The existence of local¹ technological capability has many advantages (Kondo, 2001; and Dahlman and Westphal, 1984). First, it enables a firm to identify its needs, to know where to seek possible suppliers of imported technology, to assess and compare each technology option, and select which is most suitable. Second, it assists in selecting the most appropriate mechanism for technology transfer. Third, local technological capability can assist an organisation to understand, assimilate and make effective use of technologies developed in other organisations. Finally, it aids the exploitation of new technologies for socio-economic development.

As indicated above, the significance of domestic technological capability implies that the lack of this capability holds back not just the ability of the organisation to acquire the most appropriate technology and absorb it efficiently, but also its ability to diversify, diffuse technology and reap the externalities that arise from technological activity. Also, it is very important to stress that the imported technology and its supplemental elements (e.g. maintenance and operation contracts) cannot be a permanent substitute for the lack of domestic capability. Desai (1989) stresses that the imports of foreign technology may serve as a

1. Note that the terms "local", "domestic" and "indigenous" technological capability are used interchangeably throughout the thesis.

“vehicle to the building blocks” for the development of local technological capability, but not as a substitute for it. Moreover, the lack of technological capability may contribute to the perpetuation of technological underdevelopment and dependency. For example, technology transfer, specifically turnkey contracts, often exclude local execution of technological tasks and thus limit local learning of the relevant skills while the various restrictive contractual terms also greatly prevent local innovative efforts. This technological underdevelopment is not only a serious long-term problem, but also has many implications on the short term cost such as those associated with payments for and appropriateness of technology and foreign control over future decisions on technology imports (Chantramonklasri, 1990).

Katz (1984) points out that in order to benefit from technical knowledge and to reduce technological dependency, firms or countries need to develop their own technological capabilities. These capabilities can be acquired or developed through different means. The acquisition of foreign technology plays an important role in local technological development in the sense that it might stimulate and enhance the acquisition of local technological capability. Several studies have shown that the massive inflow of foreign knowledge has to a great extent been neglected by the policy makers in developing countries as a possible tool for the development of local technological capabilities (Dahlman and Westphal, 1981; and Kahen, 1997). Such neglect had various negative consequences on the economic and industrial sectors. Thus, immediate attention must be paid to raising and developing domestic technological effort. Without this, developing countries run a greater risk of being restricted by a weak technological infrastructure.

Before developing technological capability, an organisation needs first to assess its current capability. The assessment is a vital process since it will provide useful information to management regarding the current state of the capability, its rate of accumulation and the desired level that needs to be attained. This will allow

the organisation to recognise its strengths and weaknesses with respect to technology absorption.

Having assessed the local capabilities, the next step is to embark on enhancement procedures for them. Technological capability development is a process of accumulating knowledge and requires concentrated efforts. The normal strategy would be to adopt a step-by-step approach starting with basic tasks and progressing towards more complex ones, while accumulating knowledge at each step (UNCTAD, 1996). However, the progress of learning must be fast enough to keep up with the rapid change in technology.

1.2.3 The case of Kuwait

The discovery of oil in 1938 brought with it a new era for Kuwait that involved different aspects of society: educational, cultural, economic and structural. The public sector in Kuwait plays a dominant role in planning and implementing the country's economic and development strategies. It has been the main supplier of most of the public utilities and services.

Kuwait, as is the case with most developing countries, does not have the necessary production facilities and skilled labour force for making a significant impact on its many social, industrial and agricultural requirements. Therefore, for their innovative activities and the technology to improve productivity and quality of life, its indigenous firms are crucially dependent on transfer of technology from abroad.

The dominant form of technology transfer to Kuwait is the turnkey operation, particularly when highly sophisticated technologies are involved (Al-Sultan et al., 1999). In most cases foreign contractors are entirely responsible for the execution of the projects, from the early phases to completion. Local firms are almost entirely excluded from participation, except for administrative and

legislative tasks. Very often a turnkey operation is accompanied by a management contract to carry out the operational and technical services for a limited duration, during which time the capabilities of local labour are developed. The transfer of technology to Kuwait has contributed greatly to its enormous development in terms of industrial infrastructure and the standard of living. This was attributed mainly to the abundance of funds resulting from Kuwait's vast oil resources. However, in the process of transferring technology many obstacles have been encountered. Among these obstacles is the lack of explicit governmental policy. Although the policy of the Kuwait government since the 1950s has been to promote the engagement of scientific and technological know-how through the establishment and support of various related institutions and laboratories, there has been no explicit national technology policy to guide, supervise, assess and develop the activities of these institutions and laboratories (Al-Sultan et al., 1999; Al-Sultan, 1995; and Al-Ali, 1991).

Another obstacle is the shortage of local skilled personnel who have the ability to absorb and adapt the acquired technology. This could be attributed to the fact that the technology transfer process was not perceived as a potential tool to develop indigenous technological capability. As a consequence, industry and other production and services sectors in the economy have been obliged to seek foreign consultants and expatriates for issues concerning technology acquisition, operation and maintenance, which in turn have increased the country's dependence on foreign contractors (Al-Sultan et al., 1999).

Another factor that has always played a major role in inhibiting effective technology transfer is the lack of adequate qualified expertise to support the decision-making process (Al-Ali, 1997). Normally, the majority of Kuwait's firms (both from industry and government) who search for technical advice and services related to the required technology make contact either directly with particular organisations (nominated ones) or indirectly through agencies (embassies, professional institutions, friends, etc.). In either case, the quality of

the services provided depends entirely upon the expertise of the selected firm(s) without offering clients the opportunity to seek independent advice or to examine the available alternatives. In the light of current economic changes and privatisation in Kuwait, these phenomena are expected to increase.

It should be mentioned that Kuwait was subjected to a massive shock when the country was invaded by Iraq in 1990, which left significant scars on the whole of the Kuwaiti economy. The infrastructure of the country, in particular the oil industries was ravaged when Iraqi troops destroyed more than 800 oil wells. Because of the lack of local skilled personnel, the government has subsequently sought foreign assistance to repair and reconstruct the entire industry infrastructure, a task that has proved to be extremely costly.

1.3 The research approach

An in-depth literature review was conducted to refine the research topic by focusing on areas that would encompass most aspects of the intended research topic (Fink, 1998). These areas are as follows:

- the significance of technology to the developing countries
- the theoretical and practical view of the technology adoption process
- the technology transfer to developing countries (including objectives, mechanisms, obstructions and factors that influence its successful application)
- the technology transfer to Kuwait
- the determination of technological capabilities of an organisation

Figure 1.1 illustrates the steps that were followed to refine the research problem.

As it is depicted in the figure, the initial step of the literature review process was to review issues that are related to technology management. The next step was

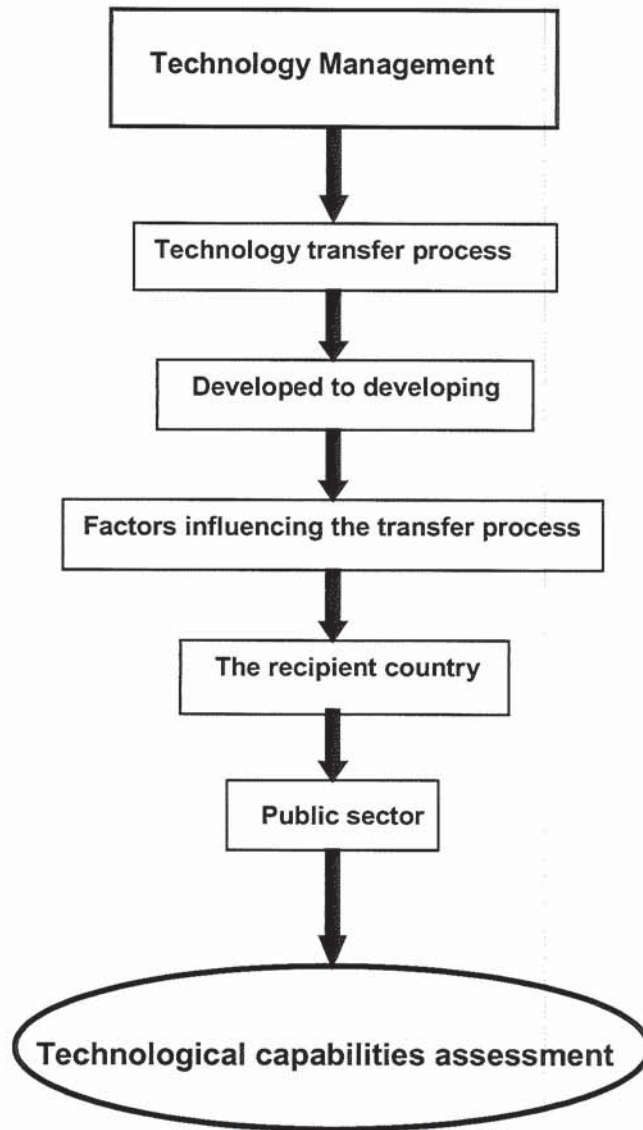


Figure 1.1 Research problem refining steps

to explore the technology transfer literature, particularly between developed and developing countries. The exploration process reveals the significance of the

factors that influence the success of the transferred technology. Some of these factors are associated with the supplier of the technology. Others are linked to the host country or firm. Since the ultimate objective was to investigate the different aspects of the technology transfer process to the public sector from the perspective of the recipient, the plan was to focus on those related factors.

A careful study of those factors yields that the presence of a certain level of technological capability within the public sector is a crucial factor in the success of the transferred technology. Consequently, it was decided then to concentrate on the assessment of technological capability of a public sector firm. The rationale for concentrating on the public sector is based on two factors. First, various studies have indicated that the technological capability in developing countries is insufficient to absorb modern technology from foreign suppliers (Kondo, 2001; Kim, 1998; and Ernst et al., 1998). Since the public sector in most developing countries dominates the economic activities (Looney, 1994; Casley and Lury, 1981), this implies that the public sector is responsible for this deficiency. Despite this, few empirical studies have actually addressed this critical issue. Most of the available literature focuses on organisations in the private sector. It is well appreciated that there are various factors governing the performance of private sector organisations towards the achievement of the specified objectives (Doyle and Klenier, 1994). Percentage of market share, competitors and stockholders are a few examples to mention. Most of these factors do not exist in the public sector. Therefore, this research is an attempt to explore how a public sector organisation could strengthen its capability and, consequently, improve its performance, with the absence of the above factors.

The second factor is that it appears that even the few studies that have investigated the technological capability issue in the public sector have actually treated the term “technological capability” as synonymous with the ability to modify or produce new technology, the breakthroughs that play so visible a role in the industrialised countries. It must be clearly understood that technological capability is the ability to learn and master progressively the many elements

involved in producing industrial services and goods (Goldman et al., 1998). Also, most developing countries lack the appropriate skills to acquire and absorb the foreign technologies (Lall, 1992; and Dahlman and Westphal, 1984). Both of these capabilities, i.e. acquisition and absorption, need first to be strengthened before moving to the next phase, i.e. innovation. Hence, this research has mainly focused on acquisition and absorption technological capability in the public sector.

As noted earlier, discussions on local technological capability in the past have mainly focused on the developing of the innovation capability only. Furthermore, the emphasis of these studies was on the private sector. This thesis aims to contribute to the knowledge by filling this gap in the literature. This was achieved by the assessment of the capability to acquire and absorb technology in the public sector. It also aims to provide policy recommendations for the improvement of these capabilities. Another “minor” contribution was the modification of the Panda and Ramanathan model¹ to make it suitable for public sector organisations.

The nature of this research can be described as exploratory. Exploratory research is “usually undertaken when there is not enough information available about the research subject” (Sarantakos, 1997: 7). In certain cases exploratory research is undertaken in order to provide a basis for further research, while in other cases it is undertaken to gain information on the issue itself.

For this research, there were very few references in the literature that have discussed the significance of acquisition and absorption capabilities in the public sector in developing countries. Moreover, very few studies have actually emphasised the assessment of these capabilities in order to understand their effect on the acquired technology in Kuwait (see for example Al-Sultan et al.,

1. This model was originally developed for private firms.

1999). Since the researcher's knowledge of the problem is insufficient, this research is exploratory-based.

This research has adopted the case study approach. This approach is useful for exploratory research (Yin, 1994). It is a strategy where, most of the time, the research questions are "how" and "why". The case study method allows the researcher to focus on a contemporary phenomenon, taking into account the context in which it is located, without having much control over the setting. In this kind of strategy the boundary between phenomena and context is blurred and several techniques of data collection can be used (Eisenhart, 1989).

There are several sources of data in case study research. A combination of interviews and documentation collection techniques was used in this research. This combination had the advantage that the methods complemented each other and established the authenticity of the research findings by triangulation (Ghauri, et al., 1995). Also, it allows the addressing of a broader range of historical, attitudinal and behavioural issues.

The empirical work of this research was divided into two phases. Phase one investigated the technology transfer process to the public sector in Kuwait and the degree of awareness of the indigenous technology concept. The investigation was based on the literature review, pilot survey and three minor case studies. The outcome from phase one was used to formulate four research hypotheses.

The purpose of phase two was to test these hypotheses through an in-depth investigation of the technology transfer process to MEW (the main case study), and through the assessment of the indigenous technological capability of MEW, using the Panda and Ramanathan model.

1.4 Structure of the thesis

Figure 1.2 outlines the structure of the thesis. Chapter 1 provides an introduction to the research topic. Chapter 2 discusses the issue of technology transfer to developing countries. It also discusses various typologies of the term “developing countries”. Chapter 3 reviews the issue of technological capability in developing countries, with particular focus on the acquisition and absorption capabilities. The technology transfer process to the public sector organisations in the Gulf Cooperation Council countries (GCC) is presented in Chapter 4. A general description of the Kuwait political and economic situation (including an evaluation of the technology transfer process) is provided in Chapter 5. Chapter 6 discusses the profile of three ministries which represent the minor case studies. These are the Ministry of Health (MoH), the Ministry of Communication (MoC) and the Ministry of Electricity and Water (MEW). The research methodology is presented in Chapter 7. Chapter 8 describes the preliminary phase conducted to explore the perception of the “technology transfer” concept at the executive level in the public sector in Kuwait, and to evaluate the degree of awareness of the “indigenous technology capability” concept at the same level. An analysis of the

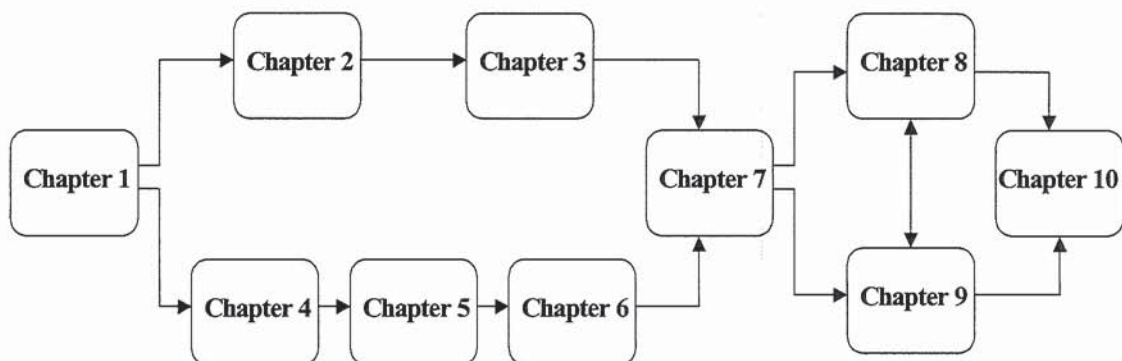


Figure 1.2 Structure of the thesis

interviews conducted in this phase and the formulated hypotheses are also presented in this chapter.

Chapter 9 provides details of the main case study. It evaluates the MEW authorities' awareness of technological capability. It also investigates the technology transfer process in MEW to determine the degree of dependency on foreign contractors and to identify any difficulties incurred through the process. In addition, it assesses the technological capability of MEW through the application of the Panda and Ramanathan model. Finally, it tests the applicability of this model to the public sector in Kuwait.

Chapter 10 contains a summary of the findings, the implications of the research, a suggested framework for employee motivation in the public sector, the limitations and contributions of the research and a proposal for further research.

Chapter 2

Technology Transfer to Developing Countries

Introduction

Technology plays a significant and invaluable role in the different aspects of human societies. It is a key resource of profound importance for a nation's security and economic development. In addition, it is viewed as an important strategic factor and fundamental element for economic growth and as an instrumental means of controlling nature and resources. It also exerts a powerful influence on standards of living and quality of life. New knowledge, innovations and professional skills are an intrinsic part of new technology. Thus, the acquisition of technology is essential for the development process of economies. Moreover, since technology is continuously changing, with new products and processes frequently being developed, the need to acquire technology has to be considered as a continuous process, and one that grows with the expansion of economic activity (Stewart, 1985).

According to Basant (1993), there are three means of technology acquisition. First, knowledge generated by the firm through its own R&D efforts, and translated into innovation. Second, knowledge purchased by the firm in the form of licences, patents, etc. Finally, technology spillovers established by knowledge generated from other firms or organisations.

Technology can provide more efficient ways of working and open new paths for human activity. It also offers possibilities for reducing lead-time for marketing a

product, improving quality and productivity, reducing expenses and satisfying different aspects of human needs (Preece, 1989). Among the four inputs to production: capital equipment, labour, raw materials and technology, technology is the only element that is not physically limited, and the only source of output that can increase without increasing capital or labour as inputs (Wei, 1995).

2.1 Defining technology

Because it is a special category of resource and is so varied in its content and in the meaning attached to it, there is no distinct definition of the term “technology” in the academic literature. The term has been applied widely to almost everything from manufacturing hardware and software to search procedures and methodologies. Some authors have broad definitions while others have confined it to equipment and apparatus. Braun (1998) perceives technology as skill possessed by people, while Steele (1989) defines technology as “the system by which a society satisfies its needs and desires”. Dosi (1984) defines it as a set of pieces of knowledge, both practical and theoretical, know-how methods, procedures and physical devices which incorporate such knowledge. Lowe (1995) argued that Dosi’s definition is insufficient and prompts the question of quantum: how big a set of pieces makes a technology. Woodward (1965, cited in Lowe, 1995) considers it to be the collection of plant, machines, tools and methodology available at a given time for the execution of the production task.

The more generally preferred definition is Schon’s, as it appears to encompass most of the elements that are included in other definitions, yet at the same time it distinguishes those features which are specific to a particular environment, interface, type or embodied form of knowledge. He defines technology as “any tool or technique, any product or process, any physical equipment or method of doing or making, by which human capability is extended” (Schon, 1967).

In general terms, technology involves four major components: know-how or technical information, human skills, its organisational structure and the physical part of that technology. According to Sharif and Ramanathan (1987) the four components of technology are technoware, infoware, humanware and orgaware, as presented in Figure 2.1.



Figure 2.1 Four components of technology
Source: Sharif and Ramanathan, 1987.

Williams and Gibson (1990) perceive the role of technology as follows:

- technology is a constantly replenishable national resource
- technology generates wealth, which in turn is the key to economic, social and political power
- technology is a prime factor for domestic productivity and international competitiveness.

Steele (1989) concurs with the above statement by stating that success in technological endeavours is a key to economic power and competitive position.

Technology is embodied in tangible items such as tools, equipment, documents, machinery and industrial complexes. It is also expressed in intangible forms such as patents, licences, know-how contracts and skills. According to Barbosa and Vaidya (1997) technology could be:

- a production process or part of a process that may lead to the enhancement of production efficiency, minimise cost and improve quality control
- a product which has better quality, better appearance or greater functionality
- a combination of product and process, as product improvement generally requires changes in process.

Technology is neither a free nor a public good. It is not a form of accumulated general knowledge for economic activity which can be readily copied, reproduced and re-used by any firm that wishes to have access to it. Because technology is continuously changing, with new processes and products being developed or improved regularly, the need to acquire technology is also continuous, and one that grows with the expansion of economic activities (Erdilek, 1984).

Management of technology is a difficult and complex process (Hawthorne, 1978). It involves the handling of technical and social issues in a broad spectrum of functional areas including manufacturing, design, development, information, processing, construction, pollution, violence, and so forth. Enos and Park (1989) perceive management of technology as concerned with developing and enhancing the capabilities of individuals and the characteristics of institutions to match the potential benefits, and to contain the hazards resulting from technological change. Pinheiro stresses that the term “technological management” includes an idea that should be emphasised, because it denotes that besides the fact that the general principles of administration are observed, the specifications of technology require its management, i.e. the activities of planning, organisation, direction, monitor and control, to occur in parallel to the utilisation of specific techniques (Pinheiro, 1999).

El-Kholy (1999) states that the role of technology management is to ensure the proper execution of the following functions:

- selection of technology, or rather technological products
- effective negotiation and contracting for their acquisition
- installation, operation and maintenance of the imported technology/products
- adaptation to local conditions (environmental, human, etc.).

There are various issues that fall under the umbrella of technology management. Among these issues is the managing of the transfer of technology, which forms the core of this research.

2.2 The concept of technology transfer

The term “technology transfer” was initially introduced in the 1940s by the US Federal Government who were responsible for the direction of a steadily increasing share of national research and development resources, primarily for achieving military, space and atomic energy objectives (De, P.K, 1999).

As in the case with the term “technology”, there is no universally accepted definition of technology transfer. Some authors appear to restrict it to mean the transfer of technology between developed and developing nations. Others tend to broaden the concept to cover all aspects of transfer, such as transfer of technological knowledge throughout society.

Lowe (1995) defines it as any transfer process that leads to knowledge being exploited away from its sources. Waddington and Steward (1987) views it as “the acquisition by the people in one country of economically useful knowledge from people in another country”. Abdulhaq (1985) argues that it is a process whereby technology developed in one place is being diffused to another location and can be affected in various ways. On the other hand, De Mattos (1979) perceives the

term as a misnomer. His argument is that technology is not transferred; it is a purchase process.

UNCTAD's International Code of Conduct on the Transfer of Technology uses the following definition: "Transfer of technology under this Code is the transfer of systematic knowledge for the manufacture of a product, for the application of a process or for the rendering of a service and does not extend to the transactions involving the mere sale or mere lease of goods" (UNCTAD, 1985, Chapter 1, paragraph 1.2, cited in Lowe, 1995)).

For the purpose of this research the researcher has adopted the definition of Sarfaraz and Emmamizadeh (1993) which defines technology transfer as the process of transferring from one nation to another nation the know-how required to successfully utilise a particular technology. From this definition it can be concluded that technology transfer has two aspects. The first is product transfer, such as machines, equipment, tools, etc., whereas the other part is the know-how transfer, such as human experience, technical information, training programmes, etc. Transfer of technology, therefore, can be in any of the above forms or their combinations. It is worth noting that some authors have criticised the above definitions. For example, Autio and Laamanen (1995) argue that most definitions of technology transfer fail to take the time dimension into account. These definitions assume that technology does not change during the transfer process. "If the time dimension is not taken into account, many important technology transfer mechanisms are excluded from the range of possible technology transfer mechanisms" (Autio and Laamanen, 1995: 647).

According to Bennett and Vaidya (2001), technology can be transferred either vertically or horizontally (see Figure 2.2). The transfer of technology between two parties in the same country or between departments within the same firm represents vertical transfer. Vertical transfer "follows the progressive stages of invention, innovation and development, with the technology becoming more

commercialised as it proceeds through each stage" (Bennett & Vaidya, 2001: 13). In contrast, the transfer of technology between different operational environments, i.e. from one country to another country, is referred to as horizontal transfer. Horizontal transfer has two forms. One form is between two countries with almost similar levels of social, economic, developmental, cultural and scientific bases, e.g. North-North (between developed countries) or South-South (between developing countries). The other shape is between countries where there are very few or no similarities in the infrastructure, i.e. North-South.



Figure 2.2 Vertical and horizontal technology transfer

Source: Bennett and Vaidya, 2001

This form of transfer, which is the focus of this research, is the dominant one amongst developed and developing countries.

Sarfaraz and Emmamizadeh (1993) have further subdivided the horizontal transfer into three categories: material transfer, design transfer and capacity transfer. According to their classification, material transfer is characterised by the importation of new materials or products without any adaptation to the local

environment. Design transfer involves the transfer of the capability to manufacture a specific product in another country. Capacity transfer is when scientific knowledge and capability to develop new technology is transferred from foreign firms.

The nature and magnitude of transfer is greatly affected by the social, economic and political conditions in both countries, the receiver and the sender (Chatterji, 1990). The technology transfer process involves complex and diverse activities. The degree of complexity and diversity depends upon many factors, such as the nature of the required technology, the accumulated experience of the acquirer and the means of transfer process.

The UNCTAD report stresses that technology transfer should be perceived as a “dynamic and evolving process that requires constant adaptation by all actors”. As a process, transfer of technology should be understood to mean both the successful learning of information by one party from another party, and effective application of that information in generating marketable products and services. Such transfers are costly and require investment by both parties in a process with uncertain outcomes (UNCTAD, 2001).

2.3 Modes of technology transfer

There are various classifications for different forms of technology transfer. For example, Erdilek and Rapoport (1985) mention the formal and informal channels, Al-Ghailani and Moor (1995) distinguish between direct and indirect, the United Nations Centre on Transitional Corporations (UNCTC) identifies commercial and non-commercial (OECD, 1981), Buckley (1985) refers to the internal and external mechanism, Olukoshi (1990) uses embodied and disembodied, Kim (1991) classifies market and non-market mediated and Lall (1992) distinguishes between two broad categories: internalised and externalised. A selection of some of these classifications is further illustrated in the following paragraphs.

The contact between the two parties, i.e. the supplier of the technology and the importer, occurs either directly or indirectly (Al-Ghailani and Moor, 1995). Direct contact is where the technology transfer process occurs without the interaction of a third party. Such transfer, which is termed as unpackaged technology, normally involves simple technologies: a machine, equipment, a patent or technological service in engineering (ibid). Indirect contact is when the transfer process takes place through a third party. This kind of transfer is called packaged technology because it involves process or product packaged technologies.

According to the OCED (1981), technology transfer often takes two forms of transaction: commercial and non-commercial. Commercial transactions may involve the following distinct operations:

- assigning or granting of industrial rights
- handing over technical or non-technical know-how in the form of documents, plans and diagrams
- the communication of technical or other know-how in the form of supply of services
- providing a combination of services with a view to commissioning an industrial complex
- providing technical services related to the selling or leasing of machinery.

Non-commercial transactions include multilateral or bilateral co-operation agreements with developing countries. These transactions generally relate to infrastructure projects of all kinds, such as government services, urban management, educational, scientific and research services. They may also cover other activities such as agriculture.

Bell (1980) has divided the overall flow of technology from exporting firms to importing firms into three categories (see Figure 2.3). The first category is Flow A. Capital goods (machinery, equipment, tools, etc.) and technological services

(feasibility studies, designing, construction, installation, plant commissioning, training programmes, etc.) constitute part of the total flow of foreign technology. When capital goods and technology are incorporated in the new production facilities set up they increase the industrial production capacity of the technology-importing economy.



Figure 2.3 The categories of technology transfer
Source: Bell ,1980.

The second category is Flow B. Investment in new production systems involves a flow of knowledge and skill needed for the operation and maintenance of the new system. The know-how and expertise that are necessary to run the new system are normally relocated and incorporated in the new unit of production capacity in the form of "human capital". Flow B consists of two main components: the first component is information which consists of operating procedures and routines, the input of materials, the specifications for the output products, the maintenance

procedures, quality control, marketing and purchasing input and so on. Much of this is usually codified in the tangible forms of manuals, schedules, charts, diagrams, etc. The second component is the training programmes and instructions that are required to carry out the operation and maintenance tasks. It is worth noting that information and training do not on their own permit efficient utilisation of the new production system. Experience in carrying out the required tasks according to the specified procedures and routines is important. However, the adequate flow of information, sufficient training schemes and necessary experience permit the accumulation of base expertise and know-how which allow the operating of the new facility at the design levels of efficiency.

The last flow is Flow C. It concerns technical knowledge and expertise that provide a basis for implementing technical change, such as the improvements to the production system through the alteration of products, processes, materials, procedures and organisation during the post-investment phase of the project. There are two components to this flow. The technical knowledge about the facility itself is the first one. This knowledge is “deeper” than that involved in the information about routine operating procedures. It consists of the knowledge and understanding that enables one to manipulate or replicate the technical system, not just to use it. In other words, it is the “know-why” in contrast to the “know-how”. The second component is the various kinds of expertise required to utilise that knowledge and transform it into concrete realities of new or changed production systems. It could include, for example, the expertise required to carry out various types of engineering planning and design, to carry out technical and techno-economic evaluations of alternative plans and designs and to transform designs into the hardware incorporated in the new or changed system. An important factor to be considered here is that the techno-managerial capacity has to be solid enough to coordinate those various tasks.

Some may argue that an overlap exists between Flow B and Flow C. However, the main distinction between the two flows is that the knowledge and expertise

required to produce technical change is significantly different from the knowledge and skills required to operate and maintain the given facility.

It is worth mentioning that oil-producing developing countries do not have or face any difficulties regarding Flow A and B, albeit that some of these countries (such as the Gulf Cooperation Council (GCC) countries) rely heavily on expatriates for Flow B. However, the majority of developing countries (Kuwait as well) face difficulties in Flow C, since their socio-economic structure and educational and vocational training programmes do not support this trend (Hegasy, 1999).

2.4 Channels of technology transfer

The transfer of technology among nations or firms occurs through different channels or mechanisms, where each channel has its own characteristics, its merits and shortcomings and may in some cases exist independently of other channels. These channels include foreign direct investment, joint ventures, contracting, franchising, licensing, management contracts, turnkey operations and exporting (Youssef, 1999). These various channels will be briefly described, especially emphasising the issues of technology transfer.

In foreign direct investment (FDI), the multinational corporations (MNCs) are the sole or major owner of the foreign subsidiary. This gives the parent company a great deal of control over the affairs of the local unit. It also means the determination of the type of technologies being transferred.

Joint ventures can be defined as an association between two or more firms sharing equity capital, investment risks, control and decision-making authority, profits and other benefits from operations.

In contracting, the local producer functions as a production platform for foreign retailers according to certain detailed specifications provided by the latter. The

foreign retailers are usually highly concerned with design, quality and delivery dates.

Licensing is an arrangement whereby a foreign manufacturer allows a local producer to utilise certain know-how, protected by legal rights (usually a patent), to produce a product locally for a specified duration and in exchange for a fixed fee (royalties) and, in some cases, a percentage of sales value. The licensor agrees to provide the required technology through complete capital investment by the licensee.

In franchising, the technology transferred is mostly of the soft and human type. The potential benefit of this type of transfer is the development and upgrading of the service-providing process as well as the supporting management system. The parent company of the chain applies a worldwide system with minimum adaptation.

Management contracts are also used to transfer the soft and human types of technology. Often, this type of channel, like the other forms, is combined with limited equity participation in the local firm (Youssef, 1999).

Turnkey contracts or projects are normally applied when the transferred technology is highly complex and a high degree of integration between the hard, soft and human parts of the technology is required from the initial stage of the project, due to mediocre managerial, engineering, scientific and technological infrastructure in the recipient country. Very often, turnkey contracts are accompanied by a management contract for a limited duration, during which local capabilities are developed. Because of the weakness in their technology infrastructure, this form of technology transfer is dominant in the developing countries, as described in more detail in Chapters 4 and 5.

Salami and Reavill (1997) and UNIDO (1999) point out that the effectiveness and the appropriateness of each of these channels depends on several economic, strategic and policy factors. It depends on the nature of the acquired technology, the transfer cost and risks, the level of technological and managerial capabilities of the recipient, the objectives and goals of both the supplier and the recipient, the policies and strategies of the recipient government and the ability and capacity of the recipient to learn and absorb technological know-how.

Because foreign direct investment (FDI) provides probably the most important and cheapest channel of direct technology transfer to developing countries among all the other channels, and can also be a medium for acquiring skills, technology, organisational and managerial practices and access to markets (Damijan et al., 2003), the following paragraphs emphasise it in more detail, with particular focus on GCC countries.

A policy implication for developing economies that has been drawn from growth theory is that foreign direct investment increases growth through access to better technologies. The results obtained by Barrell and Pain (1997) and Borensztein et al. (1998) also suggest that the transfer of technology is an important channel through which this happens. Besides contributing to more investment, FDI also has the added advantage of generating technological spillovers.

Several studies offer empirical evidence of the importance of FDI flows for economic growth in developing countries (see Aitken and Harrison, 1997; and Blomstrom and Sjöholm, 1999). Foreign direct investment by MNCs is considered to be a major channel for access to advanced technologies by developing countries. MNCs are among the most technologically advanced firms, accounting for a substantial part of the world's research and development (R&D) investment. Some recent work on economic growth has highlighted the role of foreign direct investment in the technological progress of developing countries

(Borensztein et al., 1998).

The two distinct features of total FDI inflows to developing countries are that it has been fluctuating in recent years, and the existence of a considerable gap between it and the inflow to developed countries (see Table 2.1). Also, the bulk of the inflow has been directed to only a limited number of countries, with China being the largest developing country recipient of FDI. Moreover, within the group of developing countries, the distribution of FDI flows varies widely both across regional groupings and individual countries (Damijan et al., 2003).



Table 2.1 Distribution of world FDI inflows by region in millions of US\$ (1990-2001)
Source: World Development Report, 2002.

As indicated in Table 2.1, the FDI inflows for GCC countries, which are mostly in the oil and petrochemicals sector, have stayed outside the surge of capital flows going to developing countries. They averaged 0.96% of total developing countries' flows. The low level of FDI inflows to the GCC countries can be attributed to two factors (Sadik and Bolbol, 2001). First, the GCC market is neither deep nor big enough to attract market-seeking FDI, and it does not yet constitute a fully-fledged free-trade area. Second, the GCC market is out of line with the production chain of major direct investors. This is because GCC labour is neither cheap nor highly skilled. Al-Sultan (1995) adds another factor: that

GCC countries depend crucially on turnkey projects in transferring the required technologies (see Chapters 4 and 5).

2.5 Cost of transferring technology

As stated previously, technology is not randomly and freely distributed throughout the world. Rather, it must be acquired at an expense. One of the reasons firms choose to transfer technology rather than buying the knowledge is that transfer is usually considered less costly. However, the costs of transfer can be substantial, especially since many of the costs are hidden. The transfer cost can amount to between 20% and 60% of the total project cost (Teece, 1998,). The cost of transfer is especially high when "the technology is complex and the recipient firm does not have the capabilities to absorb the technology" (ibid). The recipient of the technology is obliged to allocate substantial resources that may be utilised not only to transfer the technology physically, but also to ensure its successful absorption.

There also appears to be a strong relationship between the codification of knowledge and the costs of its transfer (Joyner and Onken, 2002). The more the knowledge has been codified, the more economically it can be transferred. Tacit knowledge is difficult to codify, mainly because, by its very definition, it has a more meaningful and complete dimension that is difficult to articulate. However, it still remains apparent that the more knowledge can be codified or digitised, the less costly its transfer, so any attempt to codify and break down tacit knowledge has a definite advantage for the firm. Indeed, if knowledge is perceived to be highly tacit, this could indicate that the underlying system is not well understood (Teece, 1998). This limits learning because scientific principles cannot be systematically applied.

Costs are associated with several stages of technology transfer: pre-engineering costs, engineering costs, research and development costs and pre-start-up training costs (Teece, 1977).

One common activity among all the stages of technology transfer is that of coordination between the two participating units, the sending unit and the receiving unit. As Teece states, costs go up as the complexity of the technology transfer increases. One of the factors contributing to higher costs is that of the longer time and increasing coordination needed to successfully transfer more complex technologies.

Normally, there are two types of incurred costs when transferring technology. The first type involves physical items or hardware of technology, such as machinery, tools, equipment and spare parts. It also involves the underlying infrastructure of the acquired technology, such as buildings, instrumentation, stores, electrical and mechanical installations, painting and so forth. Costs of this type are relatively straightforward. It involves nothing more than the summing up of the related items (Sarfaraz and Emmamizadeh, 1993).

The second type of costs involves factors that must be acquired if the first type is to be utilised effectively. It includes technical information (know-how and know-why) related to methods of operation, maintenance, quality control and consultation. In most cases, the calculation of the costs of the second type is much more complex (ibid). Different models have been designed to assist in the estimation of the associated costs of transferring technology (see for example Sarfaraz and Emmamizadeh, 1993).

2.6 Technology transfer to developing countries

2.6.1 Definition of developing countries

Before discussing technology transfer to developing countries, it is essential first to elaborate the term “developing country”. Terms used to describe countries that are less economically developed than those of the industrialised nations are several. “Developing country”, “third world”, “undeveloped” and “underdeveloped” have all appeared and been used extensively by bodies such as the United Nations. This research will focus only on the term “developing country”.

Various typologies have been attempted to describe developing countries. Some are based on per capita GDP, some on population density, abundance of natural resources, stage of development, status of educational system, scientific technological capacity or system of governance, to name but a few. Developing countries are defined as all countries in Africa, Asia and Latin America with the exception of Australia, Japan, New Zealand, Russia and South Africa (Bulmer, 1993). These countries share certain basic characteristics. The majority of them suffer from poverty, sometimes extreme poverty, and lack of development. In addition, most of them have been subjected until recently to colonial exploitation.

Another distinctive characteristic of developing countries is that they tend to have economies in which agriculture is the dominant activity and to have low per capita income, nutritional standards, literacy, productivity and low annual consumption of electricity per capita. Compared with the industrial countries of the developed world, water, health and social service provisions and transport and communication facilities are poorer.

Developing countries also tend to have rather high birth and death rates, short life expectancy and a marked incidence of ill health, malnutrition and disease (ibid.). Table 2.2 lists selected development indicators for developing countries.

There are very wide variations among developing countries, where some are much more industrialised and developed than others. Brazil, for example, is classified as a developing country, yet, at the same time some Brazilians enjoy enormous wealth and the country is on the verge of a major industrial breakthrough.



Table 2.2 Selected development indicators for developed and developing countries
Source: UNCTAD Handbook of Statistics, 2001.

Another example is Singapore, very different from neighbouring Indonesia, which is generally much poorer.

Moreover, the Gulf Cooperation Council countries (GCC, discussed in more detail in Chapter 4) which are members of the developing countries group, have the wealth required to promote their social and economic development. Also, their infrastructures (with the exception of the industrial sector) resemble that of some of the developed countries¹. Yet, they are still categorised as "developing countries". Therefore, the researcher recommends that these countries, and

1. According to the World Bank classification, Bahrain, Kuwait, Qatar and UAE are grouped under the "high-income economies", along with other developed countries, such as Japan, UK, Italy, France, etc. (World Bank Group - data and statistics, 2004).

possibly similar ones, be reclassified under the term “industrialising” rather than “developing”.

According to Simpson (1987), there are immensely wealthy cliques at the top end of the scale and great poverty elsewhere. Some developing countries without the benefits of major mineral resources, such as Lesotho, Ethiopia and Malawi face almost insuperable problems of poverty so that in most cases their survival is crucially dependent upon international aid.

As a result of these variations, a number of economic classifications have been developed in order to reflect more accurately the differences among developing countries (UNCTAD, 2001). These classifications distinguish, in the first instance, between the major oil-exporting nations and other developing countries. The latter are in turn subdivided into two categories: major exporters of manufacturers and a residual category, remaining countries, distributed according to major geographical regions.

The group “major petroleum exporters” consists of eleven OPEC (Organisation of Petroleum Exporting Countries) member countries. In addition, nine non-OPEC countries are included on the basis of the following criteria: the share of petroleum and petroleum products was not less than 40% of their total exports, and their exports of those products amounted to at least one billion US dollars on average in the period 1997-98.

The group “major exporters of manufacturers” includes twelve countries on the basis of the following criteria: the share of manufactured products was not less than 50% of their total exports, and their exports of those products amounted to at least 20 billion US dollars on average in the period 1997-98 (UNCTAD, 2001).

The residual category has been further subdivided into a “least developing countries” group (LDCs) and “heavily indebted poor countries” group (HIPC).

In addition, all developing countries have been classified according to their per capita GDP in 1995, into three groups: high-income, middle-income and low-income countries.

In economic terms, at least in terms of development, the developing countries consist of “have-nots”, even though many of these countries are wealthy and rich in resources (Simpson, 1987).

2.6.2 Model for technology transfer

For developing countries, successful technology transfer promises to lead to economic growth, improved standards of living conditions, human resources development and even enhanced national prestige and influence.

The flow of technology transfer is a complex process and it often needs a model to render it understandable (Leonard and Kraus, 1985). Throughout the literature, various models have been specifically developed for developing nations to serve as a guideline in the technology transfer process (for example UNIDO: Manual on Technology Transfer Negotiation (1996), Al-Ghailani and Moor (1995), Salami and Reavill (1997), Hemais (1997) and Kahen (1997)). These models provide assistance in the choice of appropriate technology strategies and in the identification, selection and evaluation of technologies. They also address issues of technology negotiation, including negotiated opportunities for technology absorption, learning and innovation. Moreover, they provide practical approaches and methodological tools for the analysis of legal, cultural, political, technical and economic aspects of technology transfer and acquisition at the country, industrial and enterprise level.

In spite of their usefulness, these models have two major drawbacks. The first problem is that they tend to focus on specific aspects of the technology transfer process. For example, Kahen’s model (1997) was basically developed by looking

at the major issues involved within the technological policy planning systems. The model of Hemais (1997) is more tailored to the technology supplier. The other drawback is that some of these models (for example UNIDO (1996) and Al-Ghailani and Moor (1995)) lack the empirical case studies to demonstrate the practical aspect of the models.

It appears that among these models, that of Salami and Reavill (1997) is the most comprehensive. This systematic model was selected to illustrate the necessary steps in the technology transfer process, as depicted in Figure 2.4. They have supported the theoretical framework of their model with practical case studies. Also, the model was proven to be a useful guide in technology transfer in developing countries (Hipkin, 2004). Salami and Reavill believe that this framework of technology transfer can assist policy makers and planners in developing nations to acquire foreign technology successfully.

As shown in the figure the process comprises five interrelated stages. In stage one, the decision for technology selection is based on the identification of the needs and objectives that they intend to achieve through technology transfer, the country's weakness and capabilities and the human factors in the use of imported technology.

In the next stage several technology alternatives are examined in order to select the appropriate one. The selection process is based on the country's standards and constraints and may be undertaken by ranking priorities for different technologies based on the judgement of policy makers. The final decision for the most appropriate technology selection takes place in the third stage. The appropriate technology supplier is also determined in this stage, considering different criteria such as the cost and quality of the technology and trade



Illustration removed for copyright restrictions

Figure 2.4 Model for technology transfer process
Source: Salami and Reavill, 1997.

relationship. Also at this stage the financial support required for importing technology is evaluated through final cost and benefit analysis.

The fourth stage identifies some important criteria needed for better adaptation and assimilation of the imported technology, through the common acts of the supplier and recipient. These criteria vary for each developing country and normally depend on the cultural and socio-economic factors of the recipient country.

The evaluation and modification stage comprises the assessment and evaluation of some of the most crucial elements of success and failure affecting the whole process of technology transfer. The previous intended objectives and goals are re-evaluated to ensure that all of them have been achieved accordingly.

2.6.3 Status of technology transfer in developing countries

A basic fact underlying the process of international technology transfer is that the origin of the vast majority of technological developments is concentrated in a few developed countries. Because of the historical domination of research and development by developed countries, a very large part of the technology used is transferred from developed countries (Stewart, 1985). Although some developing countries have begun to promote local technological development, they remain dependent on the developed countries for most of their technology. During the past decades, developing countries have rapidly expanded their imports of equipment and technologies. The major suppliers have been the United States, Japan and European countries (ibid).

The transfer raises four major issues, namely the costs of the transfer, the appropriateness of products and techniques which are transferred, the effects of the transfer on learning and technological development in developing countries

and the socio-economic and development impacts of the technological dependence paradigm (Heeks, 1995).

The developing countries have been faced with a dilemma and a challenging situation. Due to the high costs and risks, uncertain development times, previous requirements relating to infrastructure, the shortage of financial aid and proper human skills and other reasons, the majority of the developing countries cannot afford to develop their own technologies, particularly advanced ones. They have to acquire many sophisticated technologies from developed countries and absorb them at a rapid pace to compete with the new technologies emerging in the world market. Transferring technology from the developed countries to developing countries is an inevitable objective to promote economic development and international peace. However, it can also be a mechanism for potentially perpetuating and deepening the dependent relationship between developing and developed countries, particularly if the acquired technology is advanced (Sharif, 2000).

In addition, the terms and conditions of the transferred technology tend to be unbalanced in favour of the technology supplier (Madu, 1989).

The technological gap between developed and most developing countries is wide (see Table 2.3). Flows of advanced technological knowledge today tend to be more closely associated with foreign direct investment and licensing in technologically sophisticated industries. These activities have largely been concentrated in a few regions or countries (UNCTAD, 2001). While the share of high technology products in world exports of manufactures has gone up, rising from around 14% in 1980 to about 23% in 1996, only a small number of developing countries, mainly in East Asia and Latin America, export high and medium technology products – the most dynamic segment of world trade (ibid). A key component of any transfer process is the effective transfer of the skills and

intangible know-how that ensure production capability. These can be of greater developmental value than the transfer of tangible goods and inputs.



Table 2.3 Selected science and technology indicators for developed and developing countries, 2002.
Source: UNESCO, 2003

The technology transfer process to developing countries can be generally characterised as ineffective, if not a failure in some cases (Dahlman, 1987; Kahen, 1997). Despite realising the great importance of technology for their development and industrialisation, it seems that most developing countries are not yet able to employ effective strategies and policies for successful transfer of technology (Salami and Reavill, 1997). It is widely recognised that any technology involves four major components: know-how, the human side of a system, its organisational structure and the physical part of that technology (Kahen, 1997). It seems that little attention has been devoted by developing countries to the first three components while the main focus has been on the last one. Levin (1997) pinpoints that the vast majority of managers in the developing countries view the technology transfer process as moving machines, tools and equipment. "Managers for years thought and acted as if technology transfer were

that simple... Shipment of human skills, knowledge and culture is on the contrary quite different from moving physical things” (Levin, 1997: 300).

Another main factor that is responsible for the failure or ineffectiveness of transferred technology is that the organisational structure within which technology transfer planning operates is deeply affected by political issues, hence, the selection of candidate technologies cannot often be passed through a reliable, factual and effective evaluation process (Kahen, 1997).

In addition, many developing countries do not appear to have established the necessary procedures for selecting the most appropriate technology needed for economic growth and industrialisation. Indeed technology transfer is a difficult task. The effects arising from transfer of technology are complicated because of the variety of actions and reactions involved. It is evident that technology conceived in one environment may be difficult to transfer (or transplant) to another different environment.

The successful and effective transfer (or transplant) from a developed country to a developing one often requires the following activities (Bennett and Vaidya, 2001; Erdilek, 1984; Casanueva, 2001; Al-Ghailani and Moor, 1995; Youssef, 1999; and UNIDO, 1978):

- similar levels of technological maturity within the same sector
- the capacity and skills of human resources to assimilate new technologies
- the existence of compatible objectives between the firms
- flexible national policies and regulations which facilitate the flow of foreign technology
- the establishment and maintenance of an appropriate partnership between the firms
- the identification of local needs and conditions and the appropriateness of technology

- an awareness of the culture and norms of the host country
- the protection of intellectual properties of the technology supplier.

However, one of the most crucial factors affecting the success of technology transfer is the presence of a certain level of indigenous technological capability in the host firm. The importance of this factor was the core discussion of various authors (for example, Kondo, 2001; Enos and Park, 1989; Abdulhaq, 1985; Lin, 1997; Bell and Pavitt, 1992; Katrak, 1997; Dahlman and Westphal, 1984; Casanueva, 2001; Odagiri and Goto, 1996; and Kumar and Kirshnan, 2000). This factor, which forms the basis of this research, is discussed in more detail in Chapter 3.

2.7 Conclusion

The role that technology plays in promoting and sustaining economic development is invaluable. The developing countries have realised the potential of technology for boosting their economic growth. However, the weak technological infrastructure of the developing countries has forced them to rely extensively on developed countries in transferring the required technology. Technology transfer has been viewed as a way of transferring technical knowledge from one place to another. The technical knowledge consists of the technology needed to produce products or provide services, as well as the processes required for these products and services. Different forms of channels were used to transfer technology, with FDI and turnkey as the most common types used in developing countries. The cost of transferring technology is highly dependent on the degree of the complexity of the technology. The cost can take two forms: physical items such as equipment and tooling, and the information that must be acquired to use the hardware properly.

Various factors have been identified that govern the effectiveness of the technology transfer process from developed to developing countries, among

which is the presence of a satisfactory level of technological capability within the technology acquirer.

Developing countries experience many difficulties in transferring the appropriate technology. Although these difficulties vary from one country to another, most of them are related to the level of the indigenous technological capabilities in these countries.

Although many authors have emphasised the role of local technological capability in the success of the transferred technology in developing countries, little attention has been paid to the assessment process of technological capability. The next chapter discusses the concept, the importance and the assessment of technological capability, within the context of the developing countries.

Chapter 3

Technological Capability in Developing Countries

Introduction

In developing countries there was little recognition by governments of the importance of improving indigenous technological capability until the late 1970s. Research focused mainly on the choice and transfer of technologies. The dominant view was that technological pitfalls could be overcome through the adoption of advanced technologies from developed countries (UNIDO, 1978). However, the interest has shifted to emphasise the potential of local technological capabilities in industrial growth and, hence, in supporting and boosting economic development. Additionally, the literature provides evidence of the role of indigenous technological capability in reducing dependence on foreign technologies (Al-Ali, 1995).

As noted in the previous chapter, developing countries rely extensively on foreign technology for their economic and industrial growth. It was also noted that an adequate level of local technological capability is a prerequisite for the success of the transferred technology. However, there is evidence that the existing technological capability of developing countries is inadequate to support the incorporation of new technologies into their economies. Relying on foreign technology does not necessarily mean that there is no need to develop indigenous technological capability. Moreover, there is no automatic link between technology imports and the development of indigenous technological capability. Appropriate technology transfer often leads to the learning and development of

capability. Therefore, it is essential for developing countries to acquire or develop their technological capability through conscious and sustained efforts by both firms and governments. However, unless there is a methodology to assess the technological capability, it will be difficult for a firm to measure the capabilities it possesses and plan for their enhancement. Although the issue is crucial, the assessment of technological capability has not received the attention it requires (Panda and Ramanathan, 1997).

This chapter focuses on technological capability issues in developing countries, with particular concern on acquisition and absorption capabilities, and the assessment of a firm's technological capability using Panda and Ramanathan methodology.

3.1 Defining technological capability

Throughout the literature there is no agreed definition of technological capability. Terms such as "local technological capability", "technological capacity", "indigenous technological capability" and "technological mastery" are often used to refer to the same concept. In addition, some authors refer to technological change as synonymous with technological capability. Various definitions exist in the literature, ranging from simple straightforward to more complex and diverse, as listed in Table 3.1.

For the purpose of this study technological capability can be defined as the "variety of knowledge and skills, managerial and technical, that organisations need to acquire, assimilate, use, adapt, improve and generate new technology" (Ernst et al., 1998). All these processes require continuing technological effort, in other words the ability to use technological knowledge effectively. It seems that this definition is the most appropriate one among those that are listed in Table 3.1 since it lies more or less at the centre-point between the extremes. The

extremes refer to definitions that are not too short and general (such as Caillodas, 1987) or too specific (such as UNIDO, cited in Okejiri, 2000).

Author	Definitions of technological capability
Caillodas (1987)	The local capacity to create, adapt, diffuse and use technology.
Abdulhaq (1985)	The capability of the recipient to adopt, adapt and absorb the technology.
Kahen (1997)	The acquisition, absorption, and eventually the development of that technology.
Hinojosa (1995)	The capacity to select, assimilate, adapt and improve existing or imported technology and create new technology.
Panda and Ramanathan (1995)	A set of functional abilities, reflected in the firm's performance through various technological activities and whose ultimate purpose is the firm-level value management by developing difficult-to-copy organisational abilities.
UNIDO (Okejiri, 2000)	The abilities needed to carry out production related activities, ranging from planning the purchasing of equipment, plant start-up and operation, the adaptation of inputs, improvements to production processes, changes to product specifications, product-process interface engineering, incremental improvements to processes and products, new product design, applied R&D and basic research.

Table 3.1 Types of technological capability definition

Several authors have suggested that technological capability encompasses the following activities (based on Dahlman, 1987; and Bessant et al., 2000):

- awareness of technology issues and the need to acquire technology
- the development of a technology strategy, including a framework with priorities and an action plan

- the ability to search , screen and select the appropriate technology
- the ability to operate and absorb the technology effectively
- the adaptation of the new technology to suit the local environment (minor change)
- the modification of the new technology in response to a changing economic environment (major change)
- the ability to learn and accumulate experience in order to continuously improve capabilities
- the ability to form and exploit linkages with networks of technology suppliers and others involved in technology.



**Figure 3.1 Technological capability components
(Based on Enos, 1991).**

According to Enos (1991), technological capability has three main components (Figure 3.1). First, it exploits a complex mix of human skills that embody technical knowledge. The second component is the "institution" through which all the technical knowledge incorporated in individuals is assembled and applied. At the macro level the institution that facilitates such collaboration is the government, whereas at the micro level this role is played by the enterprise. The last component is a common purpose which is necessary to ensure that the result of

this assembling of skills is productive. This implies that a firm whose managers are interested in any objective other than that of mastering and improving their production methods is unlikely to become technologically capable. A common purpose is needed to encourage excellence in the application of the technology.

3.2 Importance of technological capability and its assessment

As stated previously, the effective use of foreign technology depends to a large extent on the presence of a certain level of indigenous technological capability in the recipient. Prior knowledge of the relative technological capability possessed by an organisation gives many advantages. Kondo (2001) stresses that it enables a firm to identify its needs, to know where to seek technology candidates to be imported, to assess each technology, to compare those candidates and to select the most appropriate one. Abdulhaq (1985) argues that it assists in selecting the appropriate mechanism of technology transfer. Furthermore, it supports a firm's operation by lowering the cost of productivity and improving reliability, maintenance procedures and service quality (Dahlman and Westphal, 1984). Also, technological capability stimulates the process of benefiting from technical knowledge. Katz (1984) points out that in order to benefit from technical knowledge, firms or countries need to develop their own technological capabilities.

Cohen and Levinthal (1989) state that in-house effort and capabilities help a firm to understand and assimilate technological development in other firms. This implies that the firm's in-house efforts and capabilities may help it to assimilate and make effective use of its imported technologies. Moreover, increased technological capability in firms pushes their production activities closer to their efficiency boundaries.

Another major feature of technological capability is that it aids the exploitation of new technologies for socio-economic development:

“Countries that wish to exploit new technology for socio-economic development must build a critical minimum competence. The concept of technological capability captures the idea of such competence” (UNCTAD, 1996: 5).

As indicated above, the significance of domestic technological capability implies that the lack of this capability, at the firm level, holds back not just the ability of firms to acquire the most appropriate technology and absorb it efficiently, but also their ability to diversify, diffuse technology and reap the externalities that arise from technological activity.

3.3 Classification of technological capability

Firms might acquire various types of capabilities. Drawing upon Lall (1987; 1992), Dahlman and Westphal (1984) and Ernst et al. (1998), technological capability at enterprise level can be classified into two broad types: investment capability and production capability. Each of these capabilities can be broken down into three levels: basic, intermediate and advanced, as illustrated in Table 3.2. Learning and understanding investment and production activities during the “basic” phase are essential preparations for acquiring the next level of capabilities, i.e. “intermediate” and “advanced” levels respectively.

Investment capability refers to the skills and knowledge required to identify, select, obtain and install new technology for the expansion of existing production capacity or the establishment of new capacity. It includes capabilities required before the investment is undertaken and those needed for carrying out the investment itself. These capabilities cover a variety of activities, including preparation of feasibility studies, site selection, search for sources of technology, bargaining with suppliers, civil engineering and associated services, the selection and procurement of equipment and training and recruitment of workforce.

Type	Investment			Production			Linkage
	Pre-investment	Project execution	Product	Process	Management & control		
BASIC	Pre-feasibility studies and feasibility studies, site selection, scheduling of investment	Civil construction, ancillary services, equipment erection, commissioning	Assimilation of product design, minor adaptation to market need	Debugging, balancing, quality control, preventive maintenance, assimilation of process technology	Work-flow scheduling, time-motion studies, inventory control	Technology suppliers provide supervision and training, local procurement of goods and services	
INTERMEDIATE	Search for technology source, negotiation of contracts, bargaining suitable terms, information systems	Equipment procurement, detailed engineering training and recruitment of skilled personnel	Product quality improvement, licensing and assimilating new imported product technology	Equipment stretching, process adaptation, licensing new technology	Monitoring productivity, improved coordination	Partnership relationship with technology suppliers, increased local procurement, technology transfer to local suppliers	
ADVANCED		Basic process design, equipment design and supply	In-house product innovation, basic research	In-house process innovation, basic research	Coordinating R&D and commercial strategies	Turnkey capability, licensing own technology to others	

Table 3.2 Levels of technological capabilities

Production capability is the skills and knowledge needed to operate a technology. It includes activities ranging from basic skills such as the organisation and control of the production process, the controlling of raw material and quality control to more advanced ones such as improvements in adaptation. Production capability can be achieved through local participation and considerable indigenous effort to master the acquired technology.

The skills needed to transmit and receive information from suppliers, subcontractors, consultants, service firms and technology institutions is referred to as linkage capability. From Table 3.2 it can be noted that the “advanced” level represents a mature stage where innovation takes place.

3.4 The acquisition of technological capability

According to Bennett (2002), the benefits from technology transfer are in the form of cost reduction or product enhancement in the short term. The long-term benefit is the development of technological capability. Nevertheless, the importation of technology does not imply automatic acquisition of technological capability. Within the same context, the successful mastery of operational technology (the know-how) may not automatically lead to the development of deeper technological capabilities (the know-why). Technological capability has to be consciously acquired or developed because technology has many tacit elements and involves search, experimentation and training. Enos (1991) applies a useful analogy for the development of technological capability:

“Technological capability does not descend from the heavens, ... it must be manufactured, like capital goods. The analogy of technological capability with capital goods is deliberate and fruitful: both require the sorts of resources that are most scarce in developing countries; both yield a product that is useful not in itself but in the other products that its application permits; both take considerable time in their production and yield their flow of services

over a long period; and both can become obsolete with further advances in the state of the art.” (Enos, 1991: 15)

Dahlman (1987) emphasises that it must be thoroughly understood that there is a major distinction between acquiring technology and acquiring technological capability. While the former can be possibly by different means, such as foreign direct investment, licence, technical service agreements, etc., the latter can only be acquired through human capital formation, which involves formal education, on-the-job-training, experience, etc. Barbosa and Vaidya (1997) and Bennett (2002) stress that the development of technological capability is not just a one-shot effort. It is a long-term complex process with various levels of technological competence. It involves the development of various technological abilities, such as the usage, adaptation, development, designing and marketing of the technology. Desai (1989) emphasis that the imports of foreign technology may serve as a “vehicle to the building blocks” for the development of local technological capability.

Lall (1987) has proposed three factors that contribute to the development of technological capability: internal, external and international. Internal factors are essentially to do with technological assimilation and implementation, the firm’s size, the technological strategy, the nature of ownership (private or public), etc. External factors are represented by government policy, macro-economic variables such as exchange and interest rates, local scientific and technological infrastructure, the educational system and so forth. International factors consist of the pace of technological change, access to foreign technology, impact of foreign competition and feedback from export activities.

In addition to these factors, the mode of technology transfer may affect the extent and nature of local capability development (World Bank, 1995). For example, a heavy reliance on foreign direct investment can be an extremely effective method of transferring operational know-how of new technologies, and can have

numerous beneficial externalities. However, it may not be the best way to promote technological intensification since it involves the risk of investment termination at any point in time.

Katz (1995) and Okejiri (2000) emphasise that the kind of technological capabilities that emerge and develop in any given social setting depend on the type of economic agents in such a setting, the resources they control and the public policies which they are affected by over time. They both agree that the size of the firm, its field of activity, type of production organisation, degree of production and type of ownership are all important determining factors in the development of indigenous technological capability.

Chantrmonklasri (1990) points out that “learning by doing technical change” is a critical factor for acquiring and accumulating technological and managerial capabilities. Such methods of learning require opening the “black box” of the technology involved or at least part of it and manipulating its content. With little or no explicit investment in this learning mechanism, firms are unlikely to progress.

The challenge of capability development demands that attention be paid to a variety of technological functions. The technological functions of firms determine their level and rate of learning. These functions may include the operation and maintenance of production facilities, process adaptation, quality improvement and so forth. Bee and Batra (1998) suggest that the most effective way to acquire technological capability is to make continuous, incremental modifications that adapt new technologies to suit the specific local environment. This implies that a firm can develop technological capability and thus enhance technical efficiency without conducting basic research in new technologies or generating completely indigenous technology.

3.5 Technological capability in developing countries

A number of empirical studies have emerged associated with the development of indigenous technological capability in developing countries at the firm level (see for example Panda and Ramanathan, 1995; Hinojosa, 1995; Ernst et al., 1998; Kim 1988; Romijn, 1998 and Okejiri, 2000). However, the vast majority of these studies tend to give great attention to the status of technological capability in private sector firms. It is well appreciated that competition, national or domestic, forces firms in the private sector to continuously examine and evaluate the strengths and weaknesses of their production and process capabilities and, consequently, to make the necessary efforts to overcome any existing problems. In other words, the two major factors that are considered to be the driving force in acquiring or developing the needed technological capability – incentive and motive – are present in the private sector.

It is the opinion of the author that the literature is dominated with studies pertaining to the private sector. Despite this it is evident that the technological capability in the public sector in developing countries is insufficient to absorb modern technology from foreign suppliers (Kondo, 2001; and Ernst et al., 1998), and the studies that have treated this critical issue are rare. Additionally, it appears that those few studies that have discussed the public sector are treating the term “technological capability” as synonymous with the ability to modify or produce new technology, the breakthroughs that play so visible a role in industrialised countries. It must be clearly understood that technological capability is the ability to learn and master progressively the many elements involved in producing industrial services and goods (Goldman et al., 1998).

It is widely recognised that developing countries rarely have the experience, financial resources and human capacities needed to develop their own technologies. In fact, most of these countries lack the appropriate skills to acquire and absorb the foreign technologies (Lall, 1992; and Dahlman and Westphal,

1984). These two fundamental capabilities, i.e. acquisition and absorption, are discussed further below.

3.5.1 Acquisition capability

Acquisition capability is the first element in technological capability. It is an essential requirement for the success of the technology transfer process:

“Technology acquisition is the other side of the coin of technology transfer: without the local capability to acquire technology, technology transfer cannot occur”. (WSSD, 2002: 6)

According to Fransman and King (1987), acquisition is the ability to search, assess alternative technologies and select the most appropriate ones. It is also known as investment capability (Lall, 1987). Dore (1984) attributes the search and select ability of technology to the technological data base, which allows the survey of the availability of technology worldwide, detection of any new development and judgement as to what is worth purchasing. Technological knowledge is not necessarily available to the public. Thus, the ability to identify technology sources, the existing range of choices and the associated cost in obtaining knowledge is part of acquisition capability.

Another essential component of acquisition capability is the possession of negotiation skills which allow the acquirer to procure the technology that suits their own requirement, to get proper contract terms and to be able to select the contractor who offers the best terms. In fact, there is a direct relationship between negotiation skills and the level of technological capability possessed by the acquirer (Hinojosa, 1995). The higher the technological capability the higher the negotiation skill since it can accurately assess the real value of the different components of the technology being acquired.

It is worth noting that other important activities also constitute acquisition capability, for example the ability to conduct feasibility studies, lay down detailed specifications, site selection, input requirement, scale of production, etc. These activities are summarised in Table 3.3.



Table 3.3 List of examples of technological capability activities

Source: Lall, 1987; and Hinojosa, 1995.

The acquisition of appropriate technology has been the major dilemma in developing countries for many reasons (UNIDO, 1978). First of all, developing countries lack the necessary skill to accurately identify their needs. Second, most

developing countries do not possess the necessary infrastructure for studying and evaluating the various available technologies. Third, it is well understood that technologies are mainly developed to suit the internal conditions of the developed country, which in most cases vary significantly from the internal conditions of the developing countries. This fact is mostly neglected by developing countries.

In addition to the above points, Hinojosa (1995) stresses that the availability of technological information and the ability to employ this information effectively in making evaluative judgements are essential elements of the selection process of technology. Although what is called the “information revolution” has facilitated the availability of information (for example, the Internet, intranet, teleconferencing, etc.), most developing countries still have little or no information on what is available in the world or even in their own country. Consequently, the weakness or the absence of a technological database is the major factor in obtaining inappropriate technologies.

Another important aspect in the selection process is the realisation of the dynamism of technology. Technologies are being developed or modified on a continuous basis. It is essential for developing countries to be able to follow the changes to the set of technological alternatives. This may involve the capacity to anticipate future technological development. This requires not only access to information network systems, but also a capacity to analyse such information and forecast technological change.

3.5.2 Absorption capability

As noted previously, successful transfer of technology depends crucially on the capability of each developing country to acquire and absorb foreign technology. Absorption capability, also referred to as mastery or operational capability, can be defined as the process by which imported technical knowledge is learned and

embedded into local systems in a sense that allows its application as it is designed for (Enos and Park, 1989). It implies operation and maintenance of a production system or plant. It includes the enhancement of human resource skills to meet standard specifications and training to upgrade technical competence.

The absorption capability can be described as the necessary capacity to better understand the principles of technology that firms are using, to master its application and achieve the same level of productivity as in the country of origin (Hinojosa, 1995). It allows the firm to improve over time its understanding of the technological factors or parameters which affect productivity.

There are various activities associated with absorption capability (refer to Table 3.3). Among these activities are the learning of basic operating skills and routines, troubleshooting, achieving rate capacities, setting up suppliers, quality control, balancing different stages of the process, and so forth.

The ability for absorption of foreign technology involves a better identification of various components of technological knowledge and the degree of its complexity, allowing the firm to master the acquired technology. It is worth bringing to the attention of readers not to confuse the term 'absorption capability' with the common term 'absorptive capacity' as the former implies the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends, which is critical to the firm's innovative capabilities (Cohen and Levinthal, 1990).

Developing countries have been continuously facing challenging situations in absorbing foreign technologies. This is mainly due to the shortage of skilled and experienced personnel and the absence of well-structured training schemes (Al-Ali, 1995).

There is a notion that the accumulation of acquisition and absorption capabilities may provide the basis for in-house innovation by enabling organisations to reshape their skills and structures. Dahlman and Westphal (1984) and Zwizwai (1996) argue that both these capabilities are important aspects of the capabilities to invest and to innovate. Thus the accumulation of acquisition and absorption experience can provide the understanding necessary to carry out some of the tasks involved in the modification or creation of new technology. In general, the increased capability contributes to an economy's capacity to undertake independent technological efforts, including replication or adaptation of foreign technologies as well as innovation.

Based on the above fact, and in order to reap the most benefit from the foreign technologies, developing countries should reshape their technological strategies and adjust their priorities towards focusing on augmenting two main elements of technological capability: (i) the acquisition and (ii) the absorption of imported technology. It is very important for developing countries to achieve this before attempting to acquire innovative capability.

3.6 The experience of NICs

Developing countries can learn many valuable lessons from the successful experiences of technological and industrial development of Asian Newly Industrialised Countries (NICs). In the past decades these countries have achieved a remarkable performance and successful development. NICs have used the acquisition of foreign technology as a means of forming a basis for augmenting their technological capabilities (Salami and Reavill, 1997). Drawing upon the work of UNCTAD (1996), Kim (1998) and Salami and Reavill (1997), the following sections briefly discuss the experiences of three NICs: South Korea, Indonesia and Malaysia (see Table 3.4).

Table 3.4 Selected economic indicators for NICs
Source: World Development Report, 2003.

3.6.1 South Korea

The vast growth rate and industrialisation of South Korea has been one of the exceptional successes of international development. This success can be mainly attributed to the set of appropriate industrial and technological policies which were designed to promote the importation of foreign technologies to strengthen its local technological capability. To achieve this national goal, the Government of South Korea planned an intensive educational and training programme for personnel to enhance their capabilities of absorbing and assimilating the imported technology. Furthermore, the government has supported the R&D institutions through promulgated policies and regulations.

The massive introduction of foreign technologies in the past decades enabled South Korea to develop its technological and industrial infrastructure. Although the majority of the transferred technologies were in the form of capital goods, some other transfer methods have also been employed in the early stages of South Korea's industrialisation, for instance reverse engineering and turnkey agreements.

It is worth mentioning that there are other additional factors which supported such success, namely the well-developed infrastructure, high rate of education and well-established administrative structure.

3.6.2 Malaysia

The significant economic and industrial growth of Malaysia during the last three decades can be attributed mainly to the implementation of successful industrial policies and plans, namely the New Economic Policy (NEP¹) promulgated in 1971 (replaced in 1991 by the National Development Policy – NDP), the Industrial Co-ordination Act (ICA) in 1975 and the Industrial Master Plan (IMP) in 1985. The ultimate objective of these policies and plans was to accelerate the rate of growth of technological and industrial development through the assimilation and absorption of foreign technologies and the promotion of the local technological capability.

Malaysia has acquired most of its technologies through the importation of capital machinery and equipment and turnkey contracts. Also, Malaysia has obtained the needed technologies through other forms of transfer, such as licensing and joint venture.

The Malaysian Government has adopted a new long-term objective under the IMP. The focus of the plan is to increase indigenous technological capability through the further utilisation of the country's comparative advantage, and development of its resource-based industries.

3.6.3 Indonesia

Indonesia is a resource-rich country which is classified as a second-tier NIC. During the period 1965-85, the Indonesian Government introduced and pursued an Import Substitution Industrialisation (ISI) policy, which was managed through

1. The NEP was initially introduced to restore the distribution of wealth among local communities.

protection of domestic industries. ISI was largely financed by oil income and foreign aid and loans. The goal of ISI was to encourage the flow of foreign investment into the country in order to import substantial quantities of foreign technologies and managerial expertise. This policy has led to more investment in improving the infrastructure and general education required for better acquisition of foreign technology.

The Indonesian Government has also introduced other measures to attract more foreign investment, such as tax exemptions and establishing export-processing zones.

In addition to the attraction of foreign investment, the Indonesian Government has used other technology acquisition channels, such as importing capital and intermediate goods, joint venture and licensing agreements.

3.7 Technological capability in a utility sector

Since the interest of this study was to assess the technological capability of a developing country through the utilisation of a utility firm as a case study (more details of this firm are available in Chapter 6), it is worth mentioning what is available in the literature regarding this issue. Very few references were located that focus on technological capability in a utility sector (for example, Cook and Surrey, 1989; Panda and Ramanathan, 1995; and Paukatong et al., 2003). The following discussion is mainly based on the work done by Cook and Surrey (1989).

According to Cook and Surrey, technological capability in a utility sector falls under four broad categories: user capability, strategic planning capability, project design capability and plant and equipment capability. The development of all of these capabilities involves training, experience, research and development.

User capability is the ability to operate and maintain plants and equipment effectively. It is fundamental and the reinforcement of the other capabilities is crucially dependent on it. The basic requirement for user capability is the higher level of management and engineering skills necessary to recognise problems, to know when to seek advice and how best to implement it. If user capability is low, the performance is likely to be poor which causes power shortage and, consequently, reduces output in the industrial sector. Investment decisions should recognise this and avoid high levels of sophistication and capital intensity. Build-operate-transfer (BOT) agreements for new plant are an important way of developing user capability, provided that the training and technology transfer elements are taken seriously. Under a BOT agreement the private firm builds the plant and operates it commercially for a specified period, then it transfers its ownership to the government.

Since most of the utility sectors in the developing countries are government-owned or subject to strong government control, strategic planning normally takes place at government level. Hence, strategic planning capability can be defined as the ability required by the governments to assess advice and take complex planning decisions with major implications for the future. The capacity to make strategic decisions consists of sufficient knowledge of the advice on alternatives and the political judgement to assess their acceptability in terms of regional impact and costs and benefits to the country as whole, both in the short and long term.

Project design and management capability is the ability to plan, design and manage the construction of a capital project, to select, coordinate and supervise the many subcontractors and to commission the plant. It requires high-level expertise over the whole area as well as wide commercial knowledge of the reliability and efficiency of suppliers and a flexible organisation capable of taking on heavy but temporary workload. Two aspects of the project design and management function must be emphasised. First, it is complex and requires high

quality management skills. Second, subcontracting arrangements allow varying degrees of domestic participation in the work.

Plant and equipment capability can be defined as the capacity to produce plant, equipment and technical services for electricity generation. It also includes the ability to adapt imported technology to suit the local environment.

3.8 Models for technological capability assessment

As Abdulhaq (1985) indicates earlier in the previous chapter, developing countries often seek the required technology without considering whether the level of their own capability is sufficient to absorb it. Kondo (2001) concurs with Abdulhaq by articulating that these kinds of capabilities (i.e. acquisition, absorption and innovation capabilities) are often lacking in firms in developing countries. Thus, the assessment of technological capability of firms in these countries is a vital process.

Following an extensive literature search, very few models linked to the assessment of technological capabilities were identified. Abdulhaq (1985) has proposed a method of measuring technological capability of a country by taking the case of agricultural mechanisation technology. He applied a factor analysis technique for finding the weights for each individual related variable.

Through the use of panel discussions and analytical hierarchy process technique, Lin (1997, cited in Ernst, et. al, 1998) has developed a measurement questionnaire to evaluate a firm's technology capability, which can be used in industries to help local firms self-assess their technology capability before they become involved in technology transfer projects.

The Technology Needs Assessment (TNA) report, which was prepared for the World Summit on Sustainable Development (WSSD, 2002), developed frameworks and tools designed to identify and determine the capabilities needed

to implement the technology priorities of developing countries. The tools assess the key local capabilities needed for successful technology transfer, including policy objectives formulation, technology transfer mechanisms and the performance of existing policy machinery. TNAs allow developing countries to self-assess their overall national technological capabilities.

It is worth mentioning that there is no complete set of indicators that can effectively measure the degree of technological capability in existing literature. This is mainly due to the fact that technology has many different dimensions which are difficult to measure (Lin, 1997).

This research has adopted a methodology developed by Panda and Ramanathan (1996)¹. The prime reason for this adoption is that the focus of the other models is mostly at the country level instead of the firm level. Also, it appears that this model had identified various strategies that management must pursue for attaining a desired level of capability. In addition, the proposed methodology has been specifically designed for the assessment of a utility firm in a developing country, which matches the interest of this research.

The Panda and Ramanathan propose a methodology to assess the elements of strategic, tactical and supplementary capabilities. According to them, these elements constitute the technological capability of a firm. The methodology also includes the assessment of the steering capability of the firm in its analytical framework. The proposed methodology comprises five steps as illustrated in Figure 3.2.

Based on value-adding stages, Panda and Ramanathan have classified technological capabilities into three major categories; strategic technological capabilities, tactical technological capabilities and supplementary technological capabilities.

1. Most of the content of this section was adopted from the work of Bennett, Al-Fahhad and Al-Sultan (2002).

The first category comprises generating, design and engineering and construction capabilities. This comprises activities such as idea generation, improvement in system design, evaluation of new projects, process design, site engineering, civil construction and erection and commissioning.

Tactical technological capabilities include production, marketing and selling and servicing capabilities. It covers activities such as quality assurance and inspection, operation and maintenance of plant equipment, distribution of electricity, installation, diagnosis of problems and setting service-level standards.



Figure 3.2 A model for assessing technological capability

Source: Panda and Ramanathan, 1996.

The last category consists of acquiring a supportive capability which includes activities such as skill development, strategic planning and technology evaluation.

Another non-technical capability, called steering capability, is required for effective deployment and upgrading of technological capabilities. Steering capability involves functions such as shared vision and value, managing change, directing resource allocation and integrating organisation both internally and externally.

Panda and Ramanathan identified ten types of electricity utility companies on the basis of their likely mix of value-adding activities (Appendix D). They emphasise that it was shown that while it is a prerequisite for all involved companies to obtain the required tactical and/or strategic technological capability, it is essential that all of them have the obligation of acquiring an adequate level of supplementary technological and steering capability.

Nine different sub-capabilities were proposed that could be used to measure each type of capability (see Appendix G). Under each sub-capability were identified a set of several elements for more comprehensive measurement. In their turn, these elements are subdivided into several indicators. For example, the sub-capability for the assessment of servicing capability has four elements: the capability for diagnosing problems and undertaking corrective action (SEC1); the capability to provide technical advice to customers (SEC2); the capability to conduct research to determine and monitor customer needs and satisfaction (SEC3); and the capability to plan, monitor and coordinate service activities, service capacity and to schedule service personnel and equipment (SEC4). Furthermore, the criteria for assessing SEC1 sub-capability is by measuring system average restoration index (See Appendix I and J).

At the benchmarking stage (Step 4) it is recommended to use the previously stated indicators to assess the technological capability of a firm against a state-of-the-art firm. It is also suggested that any successful technologically advanced firm could be used for the benchmarking process and it is not necessary to select a world-leading firm.

The final step comprises the determination of the gap between the advanced firm and the firm under assessment. This could lead to the identification of the strengths and the weaknesses of the firm, which enables possible corrective actions.

Panda and Ramanathan have illustrated their model through case studies of two firms in the electricity utility sectors. The two case studies, based on the proposed methodology, showed how the technological capability profile of both firms can be developed and draw attention not only to areas of strength but also to those that are weak and need improvement.

3.9 Technological capability development

The assessment process of technological capabilities is not an end by itself. Rather, it is a vehicle for embarking an enhancement procedures for technological capabilities.

Technological capability development is a process of accumulating knowledge and requires concentrated effort. The normal strategy would be to adopt a step-by-step approach starting with basic tasks and progressing towards more complex ones, while accumulating knowledge at each step (UNCTAD, 1996). However, the progress of learning must be fast enough to keep up with the rapid change of technology.

Lall (1987) lists a number of internal and external factors which affect the technological capability building process. Internal factors refer to factors which

reside within the organisation. They include type and complexity of available technology, organisation's size, culture, structure, management style, technological strategy and the learning process. External factors are mainly associated with government technology policy, local science and technology infrastructure, educational system, the pace of technological change and access to foreign technology.

The development of technological capability is a complex issue. Since it is impractical to cover all of its aspects, the emphasis will be on the most influencing factors that affect capability development in the developing countries (Badran, 2002; Al-Sultan, 1998 and Shaheed, 1989). These factors (the learning process, local science and technology infrastructure and educational system) are described below.

3.9.1 The learning process

The process of acquiring and accumulating capability is referred to as "learning" (Chantramonklasi, 1990). Technology transfer should be viewed not only as the purchase of an essential input to production but also as a learning process. Simultaneously with the development of capabilities for controlling and efficiently using foreign technology, high priority in the decision making process should be devoted to maximise the learning effect of transfer of technology.

The World Investment Report (1999) suggests several features of technological learning:

- technological learning is a real and significant process. It is conscious and purposive rather than automatic or passive
- the learning process itself often has to be learned
- the learning process is highly technology-specific, since some technologies are more embodied in machines while others have greater tacit elements
- the learning process is path-dependent and cumulative

As illustrated earlier, technology is a combination of equipment and knowledge. Since knowledge is embodied in human beings, development of technological capability entails, among other things, expanding the number of people with technological knowledge and improving the level of knowledge of these skilled personnel. This can be achieved through various means, among which is training. Training, which is part of the learning process, is critically important in building up acquisition and absorption capability. Human skills can be developed through conventional training, while technological knowledge has to be learned by doing (Levin, 1997). Also, training programmes continuously upgrade the quality of job performance, stimulating the employees with new challenges which overcome and reduce their workload. Furthermore, they facilitate and improve organisational performance.

3.9.2 Local science and technology infrastructure

It is widely recognised that industrial development and capability building is highly dependent on the level of local science and technology infrastructure. The central element of local science and technology infrastructure is the research and development (R&D). R&D is an ingredient of many higher level technological capabilities, but their role is often misunderstood by the decision makers in developing countries (Cook and Surrey, 1989). Firstly, they are not a separate activity and they alone will not build up the capabilities. They are part of the adaptation and modernisation of designs and production methods, part of the information gathering and feedback, part of the operating practice, part of maintenance and part of problem solving. Secondly, spending more on research does not lead automatically, via development and innovation, to improved capabilities. The learning process necessitates the establishment of R&D capability.

3.9.3 Education system

Education has been recognised as one of the essential underpinnings of human development and social progress. It is also a vital aspect for economic growth. Through it, human skills can be developed leading to qualifications at different levels. Education at all levels is needed if economies are to climb from subsistence farming, through an economy based on manufacturing, to participation in the global knowledge economy (World Bank, 2000).

Knowledge and skills are increasingly critical in developed world. For example, human capital in the United States is estimated to be at least three times more important than physical capital (Barro and Lee, 2000). In developing countries, high-quality human capital is developed in high-quality education systems, with tertiary education providing the advanced skills that command a premium in today's workplace. Most of these countries have seen a substantial rise in the proportion of their personnel receiving higher education.

Recent studies (see, for example, Mingat and Tan, 1998 and 1996; UNDP, 1998) have confirmed the significant link between education and productivity and economic growth. These studies have also revealed that the higher level of human resources education facilitates the discovery, adaptation and use of more efficient production processes.

In a world where every aspect of life is increasingly dependent upon scientific and technological progress, the promotion of capacity-building and education in science and technology is indispensable for all developing countries not only to achieve sustainable development but also to establish a scientifically and technologically literate personnel in the interest of national objectives. The above studies have found that education contributes to better natural resource management and more rapid technological adaptation and innovation. It also illustrated that education is linked with greater diffusion of information, which is crucial for boosting productivity.

3.10 Conclusion

Technology transfer involves the transfer of physical items and the transfer of tacit knowledge. The latter is becoming more important and involves acquiring new skills and technical and organisational capabilities.

Technological capability is referred to as the ability of the recipient to effectively acquire and absorb the foreign technology. The presence of indigenous technological capability is considered as a key element in the success of the technology transferred. A successful transfer of technology involves technological efforts on the part of the recipient to learn to operate and assimilate the imported technology as well as the ability to adapt it to the changing circumstances. The assessment of indigenous technological capability provides critical information to help a firm make strategic decisions. It can provide an indication of what a firm needs to do to improve its technological capability to become more efficient and productive. Therefore, it is an essential task. Different forms of technological capabilities have been identified. These forms can be grouped into three major capabilities: acquisition, absorption and innovation. The mere transfer of technology does not lead to the acquisition of technological capability. It has to be developed through various means. The development of technological capability is a cumulative process and takes substantial time and efforts.

Developing countries face major challenges in acquiring and utilising foreign technologies due to the lack of the appropriate technological capabilities. The crucial capabilities for developing countries (at firm level) are the managerial and technological capabilities needed to assess, select, acquire, absorb and implement specific technologies. With this capability in place, it is more likely that specific technologies can be acquired and absorbed efficiently. By contrast, if the techno-managerial capabilities are mediocre or not available, then it is unlikely

that a firm in the developing countries will absorb and exploit the specific technologies in a way which fosters the technological and industrial development. As a result, developing countries are in urgently need to take the necessary measures to develop or enhance their technological capability.

Developing countries can learn from the experience of NICs in using their efforts to utilise the foreign technologies as bases for the development of their technological capability.

The Panda and Ramanathan (1996) model can be used as a guideline for assessing the technological capability of firms.

Because developing countries are a heterogeneous group, the analysis of technology transfer processes (specifically the role of the indigenous technological capability in its success) is not feasible. Consequently, this research focuses on the GCC countries. The next chapter presents the major characteristics of the GCC countries, with particular focus on the technology transfer issue.

Chapter 4

Technology Transfer to the Public Sector Organisations in the GCC

Introduction

As was emphasised in Chapter 2, developing countries diverge significantly in terms of their social, economic, industrial, demographic, political stability and country's infrastructure. Based on this diversification, it would be illogical to draw a valid conclusion that could be applicable to the whole range of developing countries. As a result, and in order to draw a sensible generalisation of this research, it was decided to focus on the public sector in the Gulf Cooperation Council countries (GCC). The prime reason for this is that there are no associated studies that focus on the assessment of the technological capability in these countries. Moreover, all of the GCC countries share similar economic, technological and industrial aspects. These aspects can be summarised as follows (Al-Sultan, 1998; Al-Zayyani, 2001; Gurumurthi, 2000; Ramanov, 1999 and Looney, 1994):

- GCC countries have high per capita incomes and a high demand for imports
- oil represents the major national resource
- GCC states are at comparable stages of industrial development
- GCC states share similar industrialisation strategies, resources and infrastructure
- there is no explicit national policy for science and technology (with the exception of Saudi Arabia)

- the low population density has led all GCC countries to embrace an open-door policy with regard to expatriate labour
- the industrial and technological levels are low
- GCC countries face severe shortages of entrepreneurship in technological activities

Moreover, the GCC indigenous societies are bonded by other factors, such as religion, traditions, culture and language. These factors are apparent in the GCC Charter:

“ Article 4 of the Charter also emphasized the deepening and strengthening of relations, links and areas of cooperation among their citizens¹. The underpinnings which are clearly provided for in the preamble of the GCC Charter, confirm the special relations, common qualities and similar systems founded on the creed of Islam, faith in a common destiny and sharing one goal, and that the cooperation among these states would serve the sublime objectives of the Arab nation.

The decision was not a product of the moment but an institutional embodiment of a historical, social and cultural reality. Deep religious and cultural ties link the six states, and strong kin relations prevail among their citizens. All these factors, enhanced by one geographical entity extending from sea to desert, have facilitated contacts and interaction among them, and created homogeneous values and characteristics (Corporation Council of Arab States, 2002).

1. Citizens are referred here to indicate the indigenous population. The other non-indigenous population is normally referred to as "non-citizens" or "residents".

This chapter begins with a brief description and major characteristics of the public sector in general. Then it focuses on the public sector in the GCC, in particular on the process of technology transfer to these countries, with the purpose of providing an explanation for the choice of topic in this research. It is important to state here that this chapter has few literature references because of the scarcity of studies that focus on the economic and technological aspects of the GCC countries.

4.1 The concept of “public sector”

The basic responsibilities and functions of the public sector have traditionally been associated with facilitating public goods (infrastructure, national security, fire fighting, preservation of internal order, control over immigration, legal and judicial systems, health services, environmental protection, etc.). Furthermore, it promotes efficient resources allocation (for example, intervention in markets to correct market failure). It also provides macroeconomic growth and stability. Finally, it ensures some norms of distributional equity (Askari and Tyler, 1997).

As in the case of most terminologies of social and management sciences, there is no standard definition of the term “public sector”. There is a great deal of “grey area” where organisation may not obviously belong to one sector or another. For instance, is an industry in the public sector if the government owns 51% of the share and in the private sector if the government owns 49% of the share? What degree of independence from the government must an organisation achieve in order to be classified in the private sector? Such enquiries and others have made it difficult to agree upon a unified definition.

As well as this, the existence of various definitions of the public sector, and of each of the concepts involved, has led to the problem that different countries may apply the definition in different ways. Another major problem is that some

concepts appear to have different meanings in different countries, and it is not always made clear exactly what is covered by the figures provided.

Another common problem is that social services such as health and education are not always included under the same heading. They may fall under central administration, regional government or local government, or all three, or they may even appear as an independent item. The actual structure will probably depend on the degree of centralisation in a particular country (Lawton and Rose, 1994).

Having mentioned this, various definitions of the public sector exist throughout the literature, among which is the Wikipedia Encyclopaedia definition which states the following:

“The public sector is any part of a country's economy which is controlled or operated by the state, either by national or local government. It is the opposite of the private sector which includes the part of an economy which is controlled by private individuals or companies . The public sector often includes public services such as education or healthcare, and often nationalised (government owned) companies and industries” (Wikipedia Free Encyclopaedia, 2004).

The concept of the public sector according to Marinakis consists of many different levels which have to be properly identified in order to obtain an accurate picture. The basic classification can be summarised in the following scheme (Marinakis, 1994):

central administration +
regional and local governments =
general government +

parastatal organisations or public enterprises =
total public sector.

The United Nations System of National Accounts (cited in Marinakis, 1994) provides clear definitions of “general government” and “total public sector”. According to the United Nations, “general government” comprises:

1. Producers of government services; all bodies, departments and establishments of any level of government (central, state or provincial, local) which engage in administration, defence, maintenance of public order, health, education and cultural, recreational and other social services, furnished but usually not sold to the public.
2. Non-profit-making institutions which are wholly or mainly financed and controlled by government.
3. Social security arrangements imposed, controlled or financed by the government.
4. Government enterprises that are highly integrated with the public authorities; these consist of ancillary departments and establishments mainly engaged in supplying goods and services to other units of government, but also include agencies that sell goods mainly to the public but operate on a small scale.
5. Public saving and lending bodies which are financially integrated with the government or which lack the authority to acquire financial assets or incur liabilities in the capital market.

“Total public sector” comprises general government plus public enterprises (also called state-owned enterprises or “parastatals”), which are bodies that produce

goods or services and sell them to the public, whose ownership or control rests with public authorities.

Al-Oraibi (1990) defines the public sector as the governmental economic activities that are devoted to managing projects or corporations which could be managed by the private sector.

The definition that is adopted for this research is that of Al-Nasrawi (1990). According to him the public sector can be generally defined as the total policies and economic activities that are set and controlled by the government authorities through its ministries and governmental agencies. This definition was adopted by the Symposium of Public and Private Sector in the Arab Region held in Cairo (1990) to describe the public sector in the Arab region. It seems that this definition is most appropriate since the GCC is part of the Arab region.

The public sector is normally characterised by a multiplicity of different stakeholders, all of whom may have a legitimate interest in its performance (Flynn, 1997).

Lawton and Rose (1994) have listed a range of arguments that have been advanced to indicate the uniqueness of the public sector. These arguments can be summarised as follows:

- the public sector is exempt from the competitive world of the market and hence has no incentives to minimise costs or operate efficiently¹
- most of the objectives are ill-defined and expressed in vague terms, such as serving the public, maintaining law and order, reducing inequality and poverty, improving health, etc.
- strategic planning is more difficult because of the short-term considerations of politics

1. The researcher disagrees with this statement as incentives to minimise cost in the public sector normally exist in the form of, for instance, quality control departments, tender issues regulations, etc.

- the public sector is exposed to great depth of accountability from politicians, pressure groups and voters who have an interest in the performance of the public sector
- the functions of the public sector are limited by statute

Another major aspect of the public sector is that, unlike the private sector where there is a direct relationship between commercial success – as measured by profitability and market share – and the standard of the services provided to customers, the public sector position is more complicated and in many instances distinctly different¹. In general terms, markets have no influence on the reasons for providing services, the nature of these services and the manner in which they are delivered. In these circumstances the balance between public expectations and satisfactions and the level of service to be provided is determined on political judgements about economic and social priorities (ibid).

In addition, the procurements policy of the public sector is inefficient. There is no incentive to purchase the highest quality or the most cost-effective goods, as in the private sector. Rather, the main concern is usually to stay within a “maze” of rules governing the process (Doyle and Klenier 1994).

Also, corruption constitutes a major characteristic of the public sector. In most developing countries, corruption is widespread and part of everyday life (Hors, 2000). Buscaglia (1999) defines corruption within the public sector as systematic use of public office for private benefit that results in a reduction in the quality or availability of public goods and services, and enormous economic costs.

The public sector in developing countries is often bureaucratic and inefficient. And a large number of complex, restrictive regulations coupled with inadequate controls are characteristics of developing countries that corruption helps to get around (Gray and Kaufmann, 1998).

1. This cannot be true in all cases since there are profitable publicly owned enterprises, such as airlines.

Corruption can affect various aspects of the public sector, among which are government contracts. Corruption can influence the choice of private parties to supply public goods and services and the exact terms of those supply contracts. It can also affect the terms of recontracting during project implementation (ibid).

In addition to the above, the lack of motivation and the existence of low morale is another distinctive characteristic of the public sector (Flynn, 1997). From the organisational perspective, motivation is strongly linked to performance. It is well acknowledged that highly motivated personnel will perform better than those with a low level of motivation.

Dixit (2000) believes that the main characteristics are the lack of competition, motivation and the weakness of incentives. Another reason is “the absence of a profit motive as the sole reason for existing in government operations (Doyle and Klenier 1994: 25)”. It is well acknowledged that the effectiveness of human capability development process is highly dependent on motivation factor. Highly motivated personnel will perform better than one with a low level of motivation.

The idea of motivating employees is extremely important for organisations. Employee motivation could be degraded as a result of several management practices. For example, public sector employees are not typically rewarded for being efficient but for complying with a multitude of regulations and constraints (Doyle and Klenier 1994). Managerial incentives focus on compliance with regulations and staying out of trouble. There is certainly no incentive to take risks by innovating. Another example is that employees who perform their jobs well do not receive more incentives than those who perform poorly. Variable pay systems which provide a link between pay and job performance are typically do not exist (Perry and Kleiner, 2002).

Employee motivation is a dynamic process, not a task. This implies constant monitoring and maintaining of the motivation level. However, employee

motivation, especially in the public sector, is usually a difficult and complex task, since it is linked to human behaviour and psychology. Outstanding job performance is difficult to reward and performance below the minimum acceptable level is often difficult to correct. Authorities in the public sector need to set up a proper motivation process, taking into account different aspects of human needs.

The most effective action to motivation improve is incentives (Jones, 1997). According to Doyle and Klenier (1994), incentives can be defined as variable rewards directly related to the outcome of a particular situation. Incentives can have a strong impact on performance because of the direct relationship between performance and the reward.

Based on the work of Doyle and Klenier (1994), Perry and Kleiner (2002) and Jones (1997), the following incentives were identified.

- *Pay*

Financial incentives are important. Experts recommend that to ensure the incentive structure promotes the desired behaviour, the base level of payment must be fairly determined so that the incentive is not perceived as a reliable addition to an artificially low salary. However, financial incentives should not be the central issue for motivating employees, mainly because employees are different and intrinsic motivation sometimes is more valuable.

- *Promotion*

Promotion is a key factor in motivating employees. Organisations often use it as an incentive to motivate workers for better performance and to retain valuable employees while, at the same time, filling higher level positions. In addition to giving employees financial rewards, promotion affords them the incentive and opportunity to acquire new skills or additional training that may ultimately result in capability enhancement.

- *Flow-down of goals*

The flow-down should begin with the strategic plan, the annual organisational goals, director's or manager's individual performance goals, on down to all employees in the organisation. Each member of the organisation should be able to tie their individual performance goals to the organisation goals. Organisations should rely less on the traditional hierarchical management structure that focuses on rules, and focus more on goals ' results.

- *Formal feedback system*

This system permits individual performance results to flow back to management and influence the organisation's strategic plan. It should also reward consistent performance, support employee initiative, maintain the self confidence of others and reinforce desired results.

- *Conducting effective performance evaluations*

Performance evaluation should complement the organisation's performance management system by providing performance feedback to individuals. A feedback to individuals should be provided at the end of the evaluation process. The feedback should highlight the individual strengths and accomplishments as well as areas which need improvement. Criticism should be constructive, positive and caring.

- *Positive and empathetic leadership*

Often one single change which can have the largest impact upon an organisation is positive attitude and behaviour by an organisation's leadership.

- *Reduce interpersonal conflicts*

Interpersonal problems and personality conflicts exist in all organisations and they shift the employee's attention from the goals of organisations.

- *Empowerment*

Empowering employees with the autonomy to assume more responsibilities proved to be powerful motivator. However, increased autonomy at lower levels of

the organisation requires more discretionary decisions and increased cooperation throughout the organisation.

- *Training, development and career advancement*

Often employees need to be multi-skilled. Training is needed to keep the employees' skills current. Filling vacancies with internal candidates encourages employees to participate in training and professional development.

4.2 Public sector in the GCC

4.2.1 Foundation and objectives of the GCC

The Gulf Cooperation Council (GCC) was formed in 1981 by six Arab Gulf states, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE). According to the GCC Charter, the underlying objectives of the GCC are to “effect coordination, integration and inter-connection between member states in all fields, strengthening ties between their populace, formulating similar regulations in various major fields such as economy, finance, trade, customs, tourism, legislation, administration, as well as fostering scientific and technical progress in industry, mining, agriculture, water and animal resources, establishing scientific research centres, setting up joint ventures, and encouraging cooperation of the private sector, in addition to the promoting of security and stability in the region, particularly through the integration of foreign security treaties”.

The main motivation behind the establishment of the GCC was the threat posed by the Iran-Iraq war in 1980. Since the end of the conflict in 1988, the GCC has lost most of its sense of direction (Economist Intelligence Unit, 2003). Heads of the states hold an annual summit. Summits are mostly concerned with exhibiting unity to the outside world and reaching a “compromise” over the problems that divide the organisation.

While economics were secondary in the formation of the GCC, the GCC Economic Agreement, passed in 1981, did set out certain economic objectives for the fledgling organisation (Dar et al., 2001):

- implementing a free trade area with no barriers on regional products and common tariffs on foreign imports
- consolidating bargaining power in negotiations with external trading partners
- establishing a common market that grants citizens the right to travel, work, own, and inherit in all member states
- harmonising development plans to promote integration.
- adopting a common oil policy
- coordinating industrial policy, particularly with respect to petroleum based products
- promoting joint projects to coordinate chains of production
- adopting a common legal framework for regional trade and investment
- linking transportation networks

In economic affairs, integration has, until recently, been limited. Moves towards tariff unification were agreed in principle in 1993. However, as with many other agreements, follow-up moves were slow and marred by disputes over compensation arrangements.

GCC states have sought a free trade agreement with the European Union (EU) since the establishment of the Council. To the GCC, such a zone means an investment influx, technology transfer and greater access to EU markets. Custom unification had been the EU's prerequisite for any free trade deal with the GCC nations on the grounds it wants to deal with a single economic entity with unified tariffs rather than scattered blocs (Gulf News Online, 2004). In late 1999, the six members finally accepted a draft set of customs laws and set the deadline for their implementation in 2003 (the laws were launched in January 2003). The GCC has also set years 2005 and 2010 as the target dates for the establishment of a monetary union and a common currency, respectively. The extent to which

the GCC will maintain this objective against significant economic and political obstacles is in some doubt, however (Economist Intelligence Unit, 2003).

4.2.2 Economic profile of GCC

Table 4.1 lists the GDP in various sectors for the GCC states¹. A number of structural conditions can be identified that emerged as a result of the sudden leap in oil prices in the early 1970s (Looney, 1994).



Table 4.1 Gross domestic product (millions of US dollars) by economic activity at current prices (2002).

Source: GCC Information Centre, 2003.

1. Some of these figures pertain to firms in the private sectors as well.

1. The role of oil and natural gas

The majority of the GCC countries are endowed with great amounts of crude oil and natural gas. They account for 44% and 15% of the world's proven reserves, respectively. Crude oil production and exports represent about one fifth of the world's total output and one fourth of exports. Besides being key players in the global international financial system, with large private and official assets invested in major financial markets, these countries are also major donors of development assistance¹ – bilateral and multilateral.

The GCC countries have judiciously invested their major gains from the high prices of oil in the 1970s and 1980s in modern physical infrastructures and improvement of the living standards of their people.

2. Export manufacturing

There is no “really autonomous, integrated, multi-sector industrial basis being established. What actually exist are scattered industries, with each factory related to a parent foreign company” (Looney, 1994). This is particularly true for iron, steel, aluminium and petrochemicals, geared as they are in response to foreign demand.

3. Consumer goods production

There are many factors that seem to account for the inability of GCC countries to produce consumer goods (Looney, 1994). They include:

- the general inability of local industry to compete with those of the industrial nations in cost and quality

1. For example, Kuwait has established the Kuwait Fund for Arab Economic Development to provide aid to development projects in the Arab Region.

- the lack of resources and raw materials, especially food and agricultural products
- the lack of trained human resources and efficient management

To conclude, many of the problems facing the industrial sectors in the GCC states can be attributed to the lack of an overall industrialisation strategy, the absence of technological and scientific policies (discussed further in the next section), bureaucracy and administrative routine and the instability of the industrial labour force.

4.2.3 The role of the public sector in the GCC

The public sector in the GCC states plays a pivotal role in planning and implementing the industrial and development strategies of these states.

The governments of the GCC countries have been the main supplier of most of the public utilities and services. The following is a list of broad groups of services provided by the public sector in these countries: education; health services; housing (eligible citizens only); water (fresh and brackish) and electricity; telecommunication services; fuel (particularly gas for domestic usage); public transport (e.g. bus services); physical infrastructure (e.g. road networks); sanitation services; and other miscellaneous social services. Under existing policy, education, health (for GCC citizens) and sanitation services are provided free of charge. Most of the other services, such as electricity, water, gas and oil products are supplied at highly subsidised prices to both GCC citizens and expatriates (Eltony, 2001).

A major principle of the underlying economic and governing philosophy of all GCC governments has been to provide a strong focus on the income distributional role of the public sector. Oil revenues have accrued to the state as the “custodian” of the country’s oil wealth, and government has sought

mechanisms through which these proceeds can be distributed to the population as a whole.

All of the GCC governments have chosen to use the state apparatus as a means of channelling these resources to the population. "The accrual of oil revenue to the government and the decision not to make direct payment to residents have implied a much larger public sector and government role in the economy than would otherwise have been the case, bringing with it both extensive public employment and pervasive government involvement in the economy" (Askari and Tyler, 1997: 49).

The distribution of benefits derived from oil wealth and its proceeds to the local residents has taken several forms (ibid.):

- public employment with relatively generous salary, retirement and benefit packages
- low and very limited taxation
- the development of a comprehensive state welfare system, providing a wide range of public services with minimal recovery cost
- the provision of generous, direct and indirect, consumer and producer subsidies

The provision of these benefits with all attendant distortion effects has become a well-established part of the social contract.

Many authors share the idea that the public sector in the GCC endures several problems. Al-Nasrawi (1990) states that the public sector in the Arabian Gulf states is full of complicated drawbacks. These drawbacks, which adversely affect work productivity and efficiency, have made public sector activity disappointing. Al-Hamad (1990) comments that the performance level of the public sector was

less than what was originally planned. It failed to achieve a lot of planned production and services projects.

The negative performance of the public sector in the GCC can be attributed to the following factors (Al-Oraibi, 1990; Al-Homoud, 1990). Firstly, poor management style: management is characterised by bureaucracy, favouritism, lack of consultation and poor capacity to organise or direct work. Normally, management practice focuses on knowledge of systems, structures, procedures, rules and legal precedent and pays much less attention to the importance of performance-oriented management styles that encourage participation, flexibility, team work, problem solving and equity. Secondly, the increasing cost of the public services. Thirdly, the absence of effective criteria in the selection of appropriate personnel for the leading positions. The current criteria are mainly centred on nepotism and notorious and wealthy family-linked personnel. Fourthly, the low capability of the government to design and implement effective general policies. Finally, the attempts of the government to raise the standard of living for residents without paying attention to the high incurred cost.

In addition to the above, the public sector in the GCC countries is experiencing a chronic and serious problem: the weakness of the technological and scientific base and the incorrect practice of the process of transferring foreign technology (Al-Zayyani, 2001; Al-Otaibi and Al-Sultan, 2003). This issue is elaborated further in the next section.

4.2.4 The situation of technology in the GCC

The role played by national technology capabilities in meeting the challenges and making optimal use of opportunities posed by regional and global conditions is highly recognised. Most of the industrialised nations have taken concrete steps towards building essential components of their national technology policies. With the exception of Saudi Arabia, which initiated its long-term science and technology strategy 2001-2020 (still under development), none of the GCC states

have in fact formulated explicit technology policies. It is worth mentioning that the Kuwait Institute for Scientific Research is proposing a national scientific and technological policy for Kuwait (described in more detail in Chapter 10).

As indicated in the introduction, the GCC states are characterised by high income, low population density and intensive reliance on oil and oil-related exports for economic and industrial development. The nature of the development projects can be described as “explosive” due to the abundance of oil resources and the surge in oil prices in the 1970s. As a result, the GCC countries have adopted a heavy import-oriented strategy for the development of their infrastructure projects without any remarkable effort to establish and augment a technological and scientific base (Al-Zayyani, 2001).

There is no doubt that institutions that plan and carry out development strategies are critical for the development and augmentation of a technological base, and hence the technology transfer process, because they incorporate the technical commercial, managerial, financial, and research expertise required to diagnose problems effectively and to select and fully absorb technologies. Although the GCC recognises the crucial contribution that technology makes to economic development, the interest from the GCC states in building and developing a technological base has started late, with limited efforts and modest pace (Al-Otaibi and Al-Sultan, 2003).

These efforts have so far focused on setting up a few technological and research institutions, as illustrated in Table 4.2. A brief description of these institutes is provided below.

Bahrain Centre for Studies and Researches (BCSR)

The BCSR was established in 1981 to serve the Bahraini community by conducting applied research, particularly of a contractual type, and to offer

Country	Formal national tech. policy	The institutes	Evidence of technological initiatives
Bahrain	None	Bahrain Centre for Studies & Recherche	Arabian Gulf University
Kuwait	None	Kuwait Institute for Scientific Research	- Kuwait Technology Park - The Kuwait Technology Incubator
Oman	None	None	Arabian Gulf University and Sultan Qaboos University
Qatar	None	Science & Application Research Centre	Arabian Gulf University
Saudi Arabia	Exists	King Abdulaziz City for Science & Technology	
UAE	None	None	- Science & Technology Parks - Abu Dhabi's Business Centre - Dubai Internet City

Table 4.2 Science, technology and R&D institutions in the GCC states.

consultancies to leaders and decision makers in both the public and the private sectors. The main objectives of BCSR are (BCSR, 2004):

- to establish the importance of applied scientific research as a means of supporting decision making in the various spheres
- to establish a cadre of Bahraini researchers in the areas of national priority
- to measure and analyse economic and social developments and public opinion pertinent to national issues
- to adopt a proactive stance with regards to the major issues facing the Bahraini community and put these issues forward for discussion, analysis and the proposal of appropriate solutions

Kuwait Institute for Scientific Research (KISR)

The KISR was established in 1967 by the Arabian Oil Company Limited (Japan) in fulfilment of its obligations under the oil concession agreement with the

Government of the State of Kuwait. The institute was established to carry out applied scientific research in three fields: petroleum, desert agriculture and marine biology (KISR a, 2004).

The main objectives of the institute are:

- to conduct scientific research and studies concerned with the progress of national industry and which facilitate the preservation of the environment
- to encourage Kuwait to practice scientific research and nourish the spirit of research in the younger generation
- to explore and study natural resources and means for exploiting them, energy and water resources, and methods to improve agriculture and develop aquatic resources
- to render scientific, technological and research consultation services to the government and to the national establishment
- to follow up the development of scientific and technological progress, and adapt it in ways that conform with the local environment
- to establish and foster relations, and carry out mutual research with higher education institutes, and the technological and scientific sectors in Kuwait and various parts of the world, and
- to participate in the study of ways to verify the resources of the national economy by investing the results of scientific and technological research in industry and directing it in the services of the state's economic and social development goals

Science and Application Research Centre (SARC)

The centre aims to support scientific research with applied features in the scientific domains, transfer technology, and mainly to link the researchers in the

University of Qatar with accessible research domains in the Qatari environment. This covers the industrial, agricultural, and medical sectors, where the researchers realise the importance of interaction with their counterparts in other similar research foundations and institutions in Arab and foreign countries, an aspect the centre was keen on strengthening. The emblem of the centre represents the research activities in the domains of “environment and serving the community”. This emblem shows the pillars of research that the centre endeavours to concentrate on, and in which it aims to strengthen its research activities.

To achieve these objectives, the centre established a station for remote sensing, and laboratories for chemical, physical, and biological analysis, as well as for engineering studies (SARC, 2004).

King Abdulaziz City for Science and Technology (KACST)

The KACST is an independent scientific organisation of the Saudi Arabia Government, established in 1977. From its inception in 1977, KACST has been carrying out its mission in the promotion of science and technology in the Saudi kingdom by coordinating and cooperating with various universities, agencies and institutions concerned with research and technology, and encouraging Saudi experts to undertake research that will help promote the development and evolution of the society (KACST, 2004).

KACST has established several national research institutes. Among these are the Institute for Petroleum and Petrochemical Research, the Institute of Energy Research, the Institute of Natural Resources and Environmental Research and the Institute of Atomic Energy Research.

In addition to these institutions, the GCC has established the Arabian Gulf University (AGU), located in Bahrain and serving the six Gulf states, offering special programmes geared to help these states meet their development goals.

Furthermore, other measures have been taken by the GCC states in an attempt to pursue technological development. For example, and as indicated earlier, the development of a national science and technology strategy by Saudi Arabia aims to support and sustain social and economic development programmes in the kingdom. This strategy includes long-term goals and objectives for the period 2001-2020 as well as four executive five-year plans defining priorities and describing detailed programmes and projects. Each of the coming four successive five-year plans (the seventh, eighth, ninth and tenth) will be associated with a counterpart of the national long-term, comprehensive science and technology plan for the period 2001-2020. The plan accommodates the diversity of scientific and technological fields and recognises the complex relationships between those fields and their influence on economic sectors. It attempts to strike a balance between indigenous R&D and imported technologies, taking into account local capabilities for technology transfer and adaptation (ESCAW, 2003).

Another example is Oman. As a result of recent restructuring, the Sultan Qaboos University has a Vice-Chancellor who was directly engaged in technological capacity-building efforts in Ireland during the 1980s and 1990s. A special post of Director of Innovation Services has also been established to deal with industry, including in particular the development of science and technology parks. University staff members appear to be engaged in current efforts aimed at national capacity-building in R&D and technology development (ESCAW, 2003).

For the UAE, four technology initiatives were achieved. First, the establishment of two science and technology parks which provide access to world-class experts in technology through more than twenty multinational partners, including Lucent, Honeywell, Northrop Grumman, Daimler-Chrysler and Thomson CSF. These parks were established to foster the use of the latest technologies in the UAE while building the technological infrastructure required for further sustained development. Second, Abu Dhabi's Business Incubator Initiative is expected to

foster entrepreneurship and facilitate the process of turning innovative ideas, funding, business and professional development into new business opportunities for national entrepreneurs. Third, the Abu Dhabi Innovation Centre with the objectives of (i) developing a sustainable indigenous technology base, and (ii) applying existing technologies in innovative ways to further the region's economic development.

Finally, Dubai Internet City (DIC): the initiative was launched by the Government of Dubai in 1999. It aims to create the infrastructure, environment and attitude that modern businesses need in order to operate globally and efficiently in a knowledge-based economy. It capitalises on Dubai's established position as the Gulf's major trading centre by inviting international IT firms to set up shop at a free-trade zone complex being erected on Dubai's outskirts. The ultimate objective is to establish Dubai as a major regional hub for e-commerce. By promoting information technology (IT) and web-based businesses, DIC has established a cluster characterised by interaction among IT developers, service providers, logistics firms, educators, incubators and venture capitalists at a single location (ESCAW, 2003).

The contribution of the above institutions and centres to the technological and industrial development of the GCC countries has been limited. The absence of an explicit national technology policy, the weak coordination between these institutes and governmental and industrial sectors and the lack of governmental seriousness and commitment in implementing the recommendations of these institutes are the major factors of this limitation (Tahir, 2003; Al-Halwaji, 2002). In addition, these institutions tend to be bureaucratic and unresponsive to industry's needs.

It is well recognised that one of the major indicators of the development of nations is the percentage of the GDP that is dedicated to the science and technology base. The funding of science and technology in the GCC countries

varies from 0.03% in UAE to 0.24% in Kuwait with an average of 0.18% for all the GCC¹ (Alnaser et al., 2003; Bahran, 2003) compared with 2%-3% in the industrialised countries. This figure (0.18%) is far less than the minimum percentage (1%) for an effective science and technology base which is specified by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) (Al-Otaibi, 1998).

Because of the weakness of the technological and scientific bases, GCC countries depend crucially on foreign technology. USA, Japan and western European firms and organisations have been the major suppliers of engineering products (machinery, equipment and instruments) and technological and managerial services. The acquired technologies were concentrated in six major fields: communications, medical services and equipment, petrochemical and chemical industries, military equipment, civil aviation industry and water and power stations. Turnkey is the dominant type of technology transfer. Needless to say this mechanism of technology transfer has a marginal effect on the learning process of the recipient.

The absence of technological capacity accounts for the GCC states' inability to establish a real partnership with foreign contractors who execute more than 95% of the advanced technical projects in these countries (i.e. power plants, communication networks and centres, civil aviation industry, industrial factories, etc.). Normally, the foreign contractor avoids any authentic technology transfer, and concentrates on a technology-free transfer process – that is, transfer of capital goods unaccompanied by the transfer of scientific equipment and technical expertise and skills related to the imported machines and instruments (Looney, 1994).

1. These figures, however, are somehow misleading because in a number of cases they include expenditure on higher education.

While it is true that some training programmes are executed for the recipient countries' workforce in the plants, there is no real technological partnership in the field of planning and the initial establishment of the industrial projects. Thus, this situation not only increases the dependency of Gulf states on the technical know-how of the advanced industrial countries, but they cannot guarantee the viability of their instruments without the participation of the foreign contractor (Nayfa, 2002).

Although the GCC technology trade has increased during the past four decades technology transfer to the GCC states has remained very limited. Technology trade, which includes international sales of industrial rights, equipment, technical services and training, and plans and documents, is only one part of technology transfer. Technology utilisation or absorption by the recipient is a critical part of technology transfer. The extent of absorption depends on the type of capability developed by indigenous personnel in a particular firm or industrial sector to operate and maintain equipment or, at higher levels, to modify the technology or design and produce new products. It is well appreciated that technology is much more easily traded internationally than absorbed by recipients in developing countries.

In the GCC a number of factors constrained the successful transfer of technology. They all relate to the considerable technological distance that must be bridged between the suppliers and the recipients (Al-Jaafari, 1998; Al-Zayyani, 2001; Tahir, 2003). These factors are as follows:

- the absence of technological policies that regulate the technology transfer process
- the misunderstanding among many planners and decision makers of the technology transfer concept which involves technical know-how besides the physical items
- the lack of specialist engineers and technicians

- the lack of skilled managers who are capable of leading and controlling technical projects
- the lack of foreign technology evaluation capability
- the technology acquisition process is perceived as “commercial” transfer rather than “knowledge” transfer
- the weakness of negotiation skills

In addition to the above, the lack of indigenous technological capability constitutes a major obstacle in the success of foreign technology importation (Al-Zayyani, 2001). All the GCC states sustain an incisive shortage of skilled human resources at all functional levels (i.e. engineers, technicians, specialists, operation managers, etc). Table 4.3 lists the population number and the labour force for each GCC state.

As indicated in Table 4.3, the GCC states depend intensively on expatriates to support their economic growth, including the industrial sectors. The majority of the national labour force in the GCC, i.e. the citizens, occupy jobs that are not technical-based, such as clerical, teaching, administration, solicitors, etc. Thus, GCC countries have a need to fill this gap through foreign workforce contracting. It is obvious that the labour market in the GCC states suffers from severe deficiencies caused by several factors, as follows (Tahir, 2003; Al-Jaafari, 1998):

- the imbalance of educational system outputs which are in favour of social and humanities studies as opposed to the sciences
- the weak links and coordination between the educational systems and industrial sectors
- the lack of financial incentives for technological streams
- the shortage of technological colleges, institutions and centres
- the shortage and shallowness of the technological training programmes

- the absence of national technological policies which emphasise the building and developing of indigenous capabilities



Table 4.3 The population and labour force in the GCC states
Source: GCC Information Centre , 2002.

4.3 Conclusion

The GCC states have common characteristics. At no other time in recent history has a group of developing nations attempted so quickly and dramatically to transform their economies and societies as did the Gulf states during the 1970s (Looney, 1994). All the GCC states have had generally similar development goals: sustained economic development, infrastructure building, development of human resources, and improvement in basic living standards. The public sector in the GCC states

dominates the majority of economic activities. Heavy dependence on oil for revenue, the promotion of the country's infrastructure and a scarcity of technically trained human resources among and within the GCC countries have at times, however, posed problems and constraints on the public sector.

The experiences of these nations, which have been in a unique position to import advanced technologies from abroad, illustrate the promise and problems of technology transfer to developing nations. The rapid expansion of oil wealth in the GCC countries in the early stages of economic development was the major stimulus for technology acquisition.

In spite of the fact that technology transfer from abroad has been a major requirement of all the development strategies pursued by the GCC states, little explicit attention was given to technology transfer in official policies. Among other factors, the absence of national technological policies and the lack of indigenous technological capability in the GCC states represent major factors in the weakness of the technological base and the problems of the transferred technology.

The linked characteristics of the GCC states (i.e. economic, social, political, industrial and technological) are undoubtedly applicable to Kuwait. However, democracy and freedom of the press and public opinion are far more prominent and witnessed in Kuwait than in any other GCC states. This distinctive feature, which is supported and guaranteed by the state constitution, represents a supervisory tool for the public who can, to some extent and through various channels (i.e. media, Parliament, etc.), question and criticise the development projects proposed by the government (Al-Sultan, 1984).

Having shed some light on the general characteristics of the public sector in the GCC, the next step is to investigate the technology transfer and technological capability issues in more depth, by focusing on one of the GCC countries as an example: the State of Kuwait. A profile of Kuwait is presented in the next chapter.

Chapter 5

Profile of Kuwait

Introduction

As stated earlier, the central theme of this research is to assess the technological capability within the public sector in developing countries. In the previous chapter it was illustrated that the heterogeneity of the developing countries in terms of their socio-economic, industrial and technological infrastructure has led to the decision to focus on the GCC countries. Because of the existence of various similarities among its members, it was decided to select Kuwait as an example by which the outcome can be applied to the other members of the GCC. The rationale of this selection is twofold. Firstly, being a Kuwaiti citizen means the researcher is familiar with different issues of country structure, such as socio-economic, political, legislative, etc.; secondly, the availability of access to the public sector organisations.

Kuwait is a rich country. The financial abundance as a result of oil revenue has led to vast socio-economic development in Kuwait. It also facilitated the acquisition of foreign technologies to sustain the socio-economic growth. Although technology transfer to Kuwait has made an enormous contribution to the country's development, it has also underpinned its technological dependency (Al-Sultan, 1995).

Prior to the implementation of the empirical work of the research (i.e. the application of the Panda and Ramanathan model, as described in Chapter 3) it is important first to be familiar with basic facts about Kuwait.

In this chapter Kuwait's various essential aspects are examined. The chapter focuses mainly on economic and political issues as they greatly affect industrial policy and technological matters. Particular attention is paid to the technology initiatives and technology transfer process.

5.1 Background of Kuwait

Kuwait is located on the Arabian Peninsula, bordered by the Arabian Gulf to the east, Saudi Arabia to the south and Iraq to the north. The Kuwait climate is characterised by long, hot and mostly dry summers, with daily temperatures between 43°C and 47°C (110°F and 120°F), sandstorms in June and July and high humidity in August. The fall and spring are pleasant and mild. Winters are short and cold with a limited amount of rainfall.

The land area is 17,818 square kilometres (6,880 square miles), including the Kuwaiti share of the Neutral Zone, which Kuwait shares with Saudi Arabia (Figure 5.1). In 1966 Kuwait and Saudi Arabia agreed to divide the Neutral Zone, and the partitioning agreement making each country responsible for administration in its portion was signed in December 1969. The total number of the population is approximately 2.3 million¹. The topography of Kuwait is almost entirely flat desert.

The official religion of Kuwait is Islam. Freedom of religion is guaranteed by law and foreigners practice Islam and Christianity as well as other religions. There are several Christian churches in Kuwait. The official language is Arabic, though

1. According to the latest statistical report provided by Ministry of Planning in January 2004. (Alwatan Newspaper, issue 10129, 22 April 2004).

English is widely spoken. The Kuwait currency is the Kuwaiti Dinar (KD), which is equal to 1,000 Fils. The exchange rate as of April 2004 is 1.00 KD = US \$ 3.01.



Figure 5.1 Kuwait map

5.1.1 Political structure

Kuwait is a nominal constitutional monarchy. In 1962, Kuwait adopted a constitution, which established a hereditary Emirate government. The executive power is exercised by the ruler (the Amir).

Executive power in Kuwait is vested in the Cabinet or the Council of Ministers. It is headed by the Prime Minister, a position held traditionally by the Crown Prince. The Prime Minister is appointed through an Amiri Decree. The ministers of the Cabinet are appointed by the Amir on the recommendation of the Prime Minister. The Cabinet controls the state institutions. It is responsible for the general policy of the government and its execution. Each minister in the Cabinet holds one or more portfolios. The Prime Minister and his ministers are accountable to the Amir and the National Assembly.

First convened in 1963, the National Assembly's fifty members are popularly elected to four-year terms. Under the constitution, it is given the power to formulate the budget, pass a no confidence vote for a cabinet minister, and act as a supervisory body for the government. The National Assembly also ratifies laws passed by Amiri decree. At the same time the Amir can veto the National Assembly's legislation, or he may even dissolve the assembly.

No political parties are permitted in Kuwait, although there are three quasi-political organisations, two of which are composed of Islamists and tribal constituents, while the other one consists of social democrats, Arab nationalists, and constitutional reformers.

Kuwait is a politically stable state where the rule of law prevails. Political violence is very rare in Kuwait (The World Factbook, 2002). Kuwait has a civil law system, and Islamic law plays a significant role in personal matters.

5.1.2 Education system

Kuwait has devoted noticeable efforts in the development of its educational system. An annual average of 15% of the total expenditure is dedicated to education (Ministry of Education, 2003). There are three basic levels of education in Kuwait – elementary, intermediate and secondary. The first two levels are

compulsory. All stages of state education, including higher education are free. However, private education is not free, although it is generously subsidised.

The higher education system comprises two institutions: Kuwait University and The Public Authority for Applied Education and Training (PAAET). Kuwait University is the main forum of academic discussion in Kuwait. Since its establishment in 1966, the university has grown from just over 400 students to more than 25,000 (Kuwait Information Office, 2003). It provides bachelors, masters and PhD degrees in different majors. PAAET was established in 1982 to incorporate the various educational and training facilities that had been created to fill the need for technical and vocational training in Kuwait. PAAET is comprised of two sectors: Applied Education and Training. It is charged with providing and developing a national labour force to meet the development requirements of the nation. It also aims towards the diversification of Kuwait's national economy by training students for careers beyond the oil industry.

Recently, and in a step to encourage educational development the Government of Kuwait passed a law which regulates the establishment of private universities and colleges.

5.1.3 Consequences of the second Gulf war (August 1990-March 1991)

In August 1990 Kuwait was subjected to an invasion by its northern neighbour Iraq, which left significant scars on the whole economy and society. The infrastructure of the oil industries was ravaged by Iraq when its troops destroyed more than 800 oil wells. The composition of the Gross Domestic Product (GDP) and the performance of the non-oil industrial sectors (i.e. agriculture and fishing, manufacturing and construction) were destroyed or profoundly damaged by the invasion. The burden of financing the second Gulf war and reconstruction after the Iraqi occupation forced the government to liquidate a substantial portion of its huge overseas assets and to borrow from international markets. The war also did

away with most of the financial reserves from foreign investments that Kuwait had prudently accumulated in its Reserve Fund for Future Generations (Kuwait Information Office, 2002).

5.2 Economic overview

Kuwait has a small, relatively open economy that is dominated by its oil industry. With reserves of 94 billion barrels of crude oil, Kuwait possesses approximately 9% of the world's total crude oil reserve. Exports typically account for around 55% of GDP (Economist Intelligence Unit, 2003).

The economy of Kuwait consists of multiple sectors. The composition and participation of these sectors in GDP has been illustrated in Table 4.1 in the previous chapter. Because of the domination of the oil industry in the country's economy, other non-oil sectors, such as agriculture, fishing and manufacturing, play a relatively lesser role in the economy. The major economic aspects are summarised in the following sub-sections.

5.2.1 The public sector role

The public sector in Kuwait plays a dominant role in planning and implementing the country's economic and development strategies. It has been the main supplier of most of the public utilities and services. In general, the public sector in Kuwait can be divided into two major categories (Al-Homoud, 1990). The first category is the public services sector, which runs the government's affairs. It comprises over 30 ministries, public authorities and institutes, such as the Ministry of Defence, Ministry of Oil, Ministry of Public Works, Ministry of Finance, Ministry of Planning, Ministry of Health, Ministry of Education, Ministry of Communications, Ministry of Electricity and Water, Public Authority of Housing and Kuwait Institute for Scientific Research.

The second category is the oil sector and those public firms which are totally owned by the government and are operated on a commercial basis, such as the Kuwait Oil Company, Petrochemical Industries Company and Kuwait Airways.

The Kuwait Government has also established the Higher Planning Council which is responsible for the following issues:

- public finance and the budget deficit
- market behaviour
- human resources development and population policies

The public sector is by far the largest employer of Kuwaiti nationals, 92% of whom work for the government or a government-owned company. Through efforts to “Kuwaitise” its workforce, the government of Kuwait, in effect, has guaranteed employment to all Kuwaiti nationals. While this has had a social benefit, at least superficially, it has resulted in many government ministries being over-staffed and under-productive. It has also made it difficult for private companies to recruit Kuwaitis for meaningful, but rigorous, jobs (Info-Prod Research, 2000).

The economic system is modelled on a social welfare state, and calls for a large measure of government regulation. These regulations restrict participation and competition in a number of sectors of the economy, such as upstream petroleum (includes the exploration and drilling of wells in the petroleum production process), real estate and insurance sectors, and strictly control the roles of foreign capital and expatriate labour (International Monetary Fund, 2003). The government also has interests in many private firms in the country, including most of the nation’s banks. However, the era of government ownership seems to be declining, due to an ongoing effort towards privatisation and rationalisation of the economy as is shown in the coming sections.

The government has taken some serious actions towards economic reform and diversification, such as public finance, privatisation, the adjustment of foreign investment legislation and the role of the public sector and the domestic labour market (Eltony, 2001). In the case of Kuwait, economic diversification means reducing the heavy dependency on the oil sector by developing the non-oil sectors. It also implicitly includes reducing the direct role of the public sector while increasing private sector activities and hence its size and role in the economy. Furthermore, it also means increasing non-oil exports, non-oil revenues and Kuwaiti labour force participation in all economic sectors and professions, and maximising participation of women in the labour force.

As stated earlier, the economic diversification process suffered a major setback as a result of Iraq's invasion.

Table 5.1 illustrates the Gross Domestic Product (GDP) and GDP per capita at current price for the years 1993-2002.



Table 5.1 GDP and GDP per capita at current price for Kuwait (1993–2002)

Source: Central Bank of Kuwait, 2004.

5.2.2 Oil and petrochemicals industries

Kuwait is a typical example of an oil-based economy. Oil and natural gas sales represent the two main natural sources of national income and subsequently have been top priority in the development projects adopted by the government. The oil and petrochemicals sector plays a great role in the building of the modern State of Kuwait, developing its potentials and strengthening its structure. As one of the world's leading oil-producing states, Kuwait is heavily dependent on oil revenues. With the steep rise in oil prices in late 1999 and 2000, Kuwait has reaped a revenue windfall.

As stated earlier, Kuwait contains an estimated 94 billion barrels of proven oil reserves, more than 9% of the world total (Gulf State Newsletter, 2002).

The Neutral Zone area, which Kuwait shares with Saudi Arabia, holds an additional five billion barrels of reserves, half of which belong to Kuwait. The abundance of oil makes Kuwait a vital member of the Organisation of Arab Petroleum Exporting Countries (OAPEC) and Organisation of Petroleum Exporting Countries (OPEC).

From the beginning of the development of the oil industry era, Kuwait's policy-makers have inclined towards participating actively in oil policy and company management. In 1976, Kuwait started to develop its own proficiency in the oil industry. The Kuwait National Petroleum Company (KNPC) was formed in 1960 with the express intention of becoming an integrated oil company. Its founding charter allowed it to engage in almost any activity concerning oil at home or abroad. It began with 60% government ownership; the remaining shares were held by private Kuwaiti investors. The government bought out private investors in 1975.

Kuwait's goal of this form of participation, which was to control its oil industry, was achieved in 1976 when the government bought Kuwait Oil Company (KOC), including the refinery and other installations. It became the sole supplier of oil in Kuwait (Trade Directory, 2002). It participated in foreign refinery operations and established subsidiaries and facilities abroad for marketing oil products. Departments for exploration and other aspects of field operations were established within KNPC to work with foreign companies in the concession area that KNPC had received from the government.

As oil revenues began to mount, officials increasingly favoured investing a larger part of the funds in downstream and upstream oil operations. Downstream in the oil industry means the production, processing, transportation, and sale of petroleum products as a flow process starting at the wellhead. It includes any stage between the point of reference and the sale of products to the consumer.

The petrochemicals industry offered fewer obstacles to industrial development than most other industries. It needed relatively fewer personnel, albeit highly qualified ones, large capital investments and substantial oil and gas sources requirements that fit the country's circumstances. In 1963 the Petrochemicals Industries Company (PIC) was formed, with 80% state ownership and the rest for the public. It began with modest facilities but acquired additional plants over the years through purchase of other companies and construction of new facilities. In 1976 the government bought out the public shares, and PIC became wholly government owned. PIC's chemical complexes were the country's largest manufacturing plants. A key ingredient was a gas-gathering system to use the gases produced in association with crude oil. Until the late 1970s, a considerable part of the gases had been flared. In addition to the gas-gathering system, the government expanded its investment in oil-refining capacity and petrochemical facilities.

In early 1989, PIC and Union Carbide, a USA firm, announced their plan for a joint venture, named EQUATE, to produce polypropylene. Opening in 1997, full production was reached in mid-1998 making EQUATE the largest and most modern petrochemical complex in the Middle East. The US \$2 billion industrial complex sited at Shuaiba, an industrial area in the south of Kuwait, includes a 650,000 metric-ton-per-year ethylene cracker, two polyethylene units with a capacity of 450,000 metric tons per year, and a 350,000 metric-ton-per-year ethylene glycol plant, all of which are currently operating. The complex primarily serves the Asian and European markets. PIC and Union Carbide each have a 45% share in the project, with the remainder owned by Boubyan Petrochemical Company (Kuwait Information Office, 2002).

Kuwaiti officials have also expressed interest in accelerating development of the country's still relatively small petrochemical industry. In 1999, Kuwaiti officials announced that they were planning to open a second petrochemical complex and an aromatics and methanol project by 2005. The tender included international firms from the USA, South Korea, Canada, Great Britain, Japan, Germany, and Italy (Trade Directory, 2002).

As oil revenues rose in the 1970s, the Kuwaiti Government continued its upstream and downstream expansion, establishing the Kuwait Petroleum Corporation (KPC) as a semi-autonomous state organisation in January 1980 to rationalise the organisational structure of its oil industry. KPC became the country's national integrated oil organisation in charge of oil business and related activities internally and externally, embracing Kuwait Oil Company (KOC), Kuwait National Petroleum Company (KNPC), Petrochemicals Industries Company (PIC), the Kuwait Oil Tanker Company, and the Kuwait Foreign Petroleum Exploration Company among its more important wholly-owned subsidiaries. KOC remained primarily responsible for domestic exploration and production of oil and gas, and KNPC was mainly the refining subsidiary.

KPC also entered into joint ventures with and purchased shares in foreign companies involved in various aspects of the oil business. By the 1980s, KPC was among the world's largest corporations. Through its subsidiaries, KPC was involved in all aspects of the oil industry and in many countries of the world. This was a remarkable achievement in view of the fact that only twenty-five years had passed since Kuwait entered the oil industry¹ (The World Factbook, 2002). In 1981 KPC bought the Santa Fe International Corporation, a United States drilling and energy-engineering firm. Other KPC activities abroad included part ownership in refineries and petrochemical plants, exploration and drilling in foreign concession areas, and purchase of retail outlets for petroleum products, such as the branches of Q8 petroleum stations in Europe.

Regarding the natural gas source, Kuwait currently produces only a modest quantity of natural gas. Production stood at 339 billion cubic feet in 2001 – most of it associated gas from oil production. Kuwait plans to make a significant increase in its use of natural gas, especially in electricity generation (Eltony, 2001). A switch to gas would free up a substantial amount of oil for export.

Kuwait also hopes to improve its domestic gas production, both through a reduction of flaring of associated gas in oilfields and through new drilling. Exploratory drilling is currently being undertaken at the Rawdatain oilfield, reaching geological formations much deeper than the oil deposits, which are believed to be gas-rich.

In another gas-related development, Saudi Arabia and Kuwait concluded an agreement in July 2000 on the offshore Dorra gas field, which had been claimed by Saudi Arabia, Kuwait, and Iran. The agreement calls for an equal sharing of the gas resources between Saudi Arabia and Kuwait.

1. This achievement was mainly attributed to the presence of a large number of expatriates in the KPC (Gulf Confidential, 2002).

5.2.3 Other industries

The discovery of oil has inclined Kuwait towards new industries, such as water, electricity and refined petroleum products. Within a short time the government took over the production of water and electricity and subsidised their use.

Industrial development in Kuwait has always faced formidable obstacles (Annual Statistical Abstract, 2001). Kuwait, so rich in oil, is poor in most other natural resources, which limits the manufacturing industries that can be established. No metallic minerals and few suitable non-metallic minerals are locally available. Most raw materials for the early industries – for example, cement – had to be imported. The limited supply of fresh water is another constraint. In a country without streams and with few underground sources, water is crucial to industrial development. The small size of the domestic market restricts production for local consumption to small-scale operations. The open economy, which was maintained before and after the discovery of oil, provided little protection from foreign competition. The shortage of technically trained nationals, and a limited skill base, is another constraint. After the discovery of oil, labour costs escalated, and in a few years wages in Kuwait were higher than those in almost any other area of the Middle East, further hindering industrial development. Also, the commercial tradition in the country predisposes most entrepreneurs to invest in trade rather than manufacturing. This is due to a national paradigm and proverb which states “capital is a coward”¹. As a result of these obstacles, industries, excluding oil-related activities, have expanded very slowly.

Oil operations, particularly, need water, electricity, and refined petroleum products, and these were the first modern industries established in the state (Energy Information Administration, 2003). The government embraced production of water and electricity, expanding the systems and generously

1. The proverb implies that it is safer to invest in a known and familiar field (i.e. trade) than in the unknown and risky field (i.e. manufacturing). (This information was based on a conversation with Dr. Al-Sultan, the Assistant General Director of KISR).

subsidising their use. Air conditioning provided the largest demand, with peak summer loads more than five times minimum winter loads, initiating substantial idle capacity for about six months of the year. The need for larger and more regular supplies of water, no matter how costly, compelled KOC to install the first desalination plant. In 1953 the government installed the first unit, which had a capacity of 3.8 million litres per day. Subsequently, the government claimed that it had developed the most advanced continuously operating desalination facilities in the world.

Although oil spurred the first industries in Kuwait, after the initial push it did not generate much in the way of new industries locally. As a result of the many obstacles that industry faced and in light of the massive oil revenues, the government was involved in all industrial development. The government made some effort at diversification in the 1950s, but the first major push for industrialisation occurred with the establishment of the Shuaiba Industrial Zone in 1964. Located 50 kilometres south of Kuwait city, the zone comprised electricity and water distillation plants, expanded port facilities, metal works and plants manufacturing chlorine, asphalt, cement, pilings, and prefabricated housing. The government provided such necessary facilities as roads, gas, electricity, water, sewage, port facilities, communications, and rented or leased industrial sites at nominal rates. Most of the larger industrial facilities were located in the zone. Other small manufacturing establishments were located in the populated parts of the country.

There are small-scale industries which are beginning to gain national recognition because of their quality and competitive price. Most of these local industries have obtained the ISO 9000/9001 certificate. These include dairy products, wheat products, light building materials, metallic products, plastics, fertilisers, paints, batteries, furniture and textiles, etc.

5.2.4 Foreign direct investment (FDI)

In an effort to attract foreign investment, Kuwait's Parliament promulgated Law No. 8 Regulating Foreign Capital Direct Investment in Kuwait (April, 2001). The law allows an exception to the general rules under which foreign investors conduct business in Kuwait by permitting up to 100% foreign ownership of business entities in certain approved sectors, such as communication services (Kuwait Law, 2003). Implementing regulations, which establish the guidelines for investment under the law, will be forthcoming. The previous law restricted foreign ownership in joint ventures with Kuwaiti firms to 49%. Also, exemptions from import duties and corporate income taxes for periods of up to ten years are officially available only for industrial undertakings approved by the Council of Ministers.

Foreign firms may not, for sovereignty reasons, invest in the upstream petroleum sector, but are allowed to invest in joint venture petrochemical projects. As stated earlier, KPC, for the first time in its history, has concluded a joint venture agreement throughout its subsidiary PIC with Union Carbide for a major investment in petrochemicals. However, this restriction may end with the new plans of the Kuwait Government.

Oil policy makers in Kuwait plan to increase oil production capacity to more than 3 million barrels per day from its current production capacity of 2.4 million barrels per day by year 2005. In pursuit of this objective, in June 2003 Kuwait invited 25 foreign oil companies to submit their proposals for projects worth US \$10 billion to double the size of the northern oil fields near the border with Iraq. This massive foreign direct investment project should come as no surprise. After all, the northern oil fields were long under the security threat of the previous Iraqi regime and this is no longer the case. If this plan is accomplished, Kuwait is going to be one of the pioneers in the area in allowing foreign investment in its upstream oil industry. While most of the countries in the area are trying to decide

on their role in the world oil market, and the role of the private and public sectors in their economic development, Kuwait has consolidated its oil sector, privatised many of the government owned companies and allowed foreign investment in its oil sector.

There are some opinions arguing that Kuwait may not benefit from allowing foreign investment in its upstream oil industry because it does not need the additional capacity, especially at a time when Kuwait is trimming its production along with other OPEC members to increase oil prices (Alhajji, 1999). In spring 2001, Kuwait called on OPEC members to extend production cuts beyond March 2000 when the current agreement expires, and denied violation of its quota. Kuwait is one of the richest oil countries and is able to make such investment on its own. In fact, Kuwait's current and planned investment in the oil sectors of many countries suggests that the decision to allow the foreign oil companies to invest in Kuwait is politically motivated because Kuwait does not lack the capital to invest in its own upstream industry.

Foreign investment in real estate is limited to nationals of the other Gulf Cooperation Council (GCC) member states. Foreigners (with the exception of GCC nationals and Egyptians) are not permitted to invest in stocks directly through the Kuwait Stock Exchange, but they may do so through mutual funds. Other sectors such as telecommunications, health care and airlines are still government-controlled, but may become more accessible to foreign investment if the government implements a privatisation programme (Unified Arabic Economic Reports, 2000).

Foreign owned firms and the foreign owned parts of joint ventures are subject to corporate income tax as high as 55%. The Government of Kuwait has announced plans to submit legislation that would reduce the maximum corporate income tax rate to 30%, and in some instances, reduce US dollar corporate taxes

of the foreign partner to zero. Kuwaiti firms are not subject to the corporate income tax. And Kuwait levies no personal income tax (ibid.).

Kuwait also uses a number of financial institutions to attract investment. The Gulf Investment Corporation, formed by an association with the GCC, promotes direct investment by encouraging joint ventures in the industrial sector with equity and debt funding. There are also Islamic investment groups – The International Investor and the International Investment Group – which cater to USA companies by providing customised financial services and products.

The following table (Table 5.2) illustrates the FDI inflow for the years 1995-2001.



Table 5.2 FDI inward to Kuwait

Source: UNCTAD – World Investment Report, 2002.

5.3 Privatisation

This issue recently became the cornerstone of the government's economic policy. As a consequence of the second Gulf war, the government continues to emphasise its commitment to a structural reform programme which is designed

to reduce its role in the economy and enhance the role of the private sector. However, much of the country's limited private sector activity is driven by public sector spending (Economist Intelligence Unit, 2003). The Kuwaiti Government once owned shares in 62 companies, some of which the World Bank recommended should be privatised. Privatisation in Kuwait involves both the reduction of the government stake in some existing public sector companies and facilitating new opportunities for the private sector to invest in strategic industries previously supported by government funding.

In 1992 the Kuwait Investment Authority (KIA) began implementing a three phase privatisation programme that aims to reconstruct the economy and reduce dependency on oil income (Kuwait Investment Authority, 2003). The first phase has been an outstanding success, drawing in new capital to the market and providing new investment opportunities, which helped revitalise an important sector of the national economy. Approximately US\$ 2.9 billion worth of assets held in local companies have been sold. The second and third phases call for the privatisation of certain state-owned utilities and services, along with part or all of the Kuwait Oil Tanker Company, PIC and Kuwait Airways Corporation.

Progress in privatisation of government entities, however, has been slower. Since the Kuwait Government is by far the largest employer of Kuwaiti citizens (nearly 92% of Kuwaiti nationals), there is a general concern that privatisation will threaten employment of Kuwaiti workers. An intensive debate is on in the Kuwait National Assembly (the Parliament) at each legislative term to constitute a bill that would establish the framework for privatisation of public utilities, which will take this issue into account (*ibid.*).

Moreover, the difficulty lies in the implementation of measures that would radically shift the central role played by the state in the management of the economy and provision of social welfare (Economist Intelligence Unit, 2003).

5.4 The Kuwait Offset Programme

The Government of the State of Kuwait purchases large amounts of goods and services from foreign contractors. As a direct result of these purchases, economic benefits accrue to households and businesses in the countries in which the foreign contractors procure materials and produce the goods and services. The most important of these benefits is long-term economic development through job facilitation and capital accumulation.

It is the desire of the government that these long-term economic benefits be shared on a more equitable basis between Kuwait and foreign countries. Therefore, the government has decided that the best way to achieve this more equitable sharing is through a Counter-Trade Offset Programme which promotes the expansion of the Kuwaiti private sector through long-term, mutually beneficial, collaborative business ventures between the foreign contractors and Kuwaiti businesses, entrepreneurs and private citizens in general. Thus, in 1992, the Council of Ministers of the State of Kuwait established the Counter-Trade Offset Programme through the promulgation of Decision No. 694, which requires all foreign contractors who meet certain criteria to participate in the Counter-Trade Offset Programme through the investment of 30% of the contract value in projects within the country (Kuwait Offset Programme, 2004). The Kuwait Government is pursuing an economic development plan with the following major objectives:

- to contribute to the privatisation programme
- to promote the growth and diversification of the private sector
- to promote the transfer and continual updating of state-of-the-art and knowledge-intensive technologies appropriate for Kuwait

5.5 The Kuwait Free Trade Zone (KFTZ)

The strategic location of a country has always been an important determinant of its trade and commerce. Kuwait is well located to service the emerging markets in northern Iran, Iraq, Turkey and the Commonwealth of Independent States. The Kuwait Free Trade Zone (KFTZ), located in Shuwaikh Port, provides access to these big potential markets (KFTZ, 2004).

Shuwaikh Port, home of the KFTZ, is owned and operated by the Kuwait Ports Authority (KPA). During the past few years, KPA has engaged in massive renovation and modernisation of its management and operation systems resulting in a considerable increase in both efficiency and productivity. The privatisation of the cargo and container handling activities and computerisation of the tariff, financial and administrative systems have made KPA a modern port facility. Investment in the KFTZ entails incentives such as:

- exemption from taxation on all corporate and personal forms of income
- capital and profits are freely transferable outside the KFTZ and not subject to any exchange control
- hundred percent foreign ownership is permitted and encouraged
- policy of promotion of free trade

The KFTZ is quite close to the international airport, a major city – and close to the Iranian border. In addition, it has an ample supply of energy and water, state of-the-art communication systems and transportation systems by sea, land and air.

In keeping with the KFTZ's objective of offering the most technologically advanced services in the world, the telecommunications systems are designed to cater to the investors' local and international needs. Through a decentralised network and utilising fibre optic cabling, KFTZ provides both the basic services

that international customers have come to expect, as well as most of the cutting edge technical services currently available. The high-tech features that will be available include voice mail service, four-level divert, call line ID, remote access to voice mail, direct interface to Internet telephony, etc.

The Future Zone is targeted to maximise business growth for the burgeoning technology sector, including:

- Internet services
- medical sales and research
- e-commerce development
- educational institutions
- software development
- telecomm sales and services
- retail and other

5.6 Kuwaiti foreign investment (outflows)

In 1952, the Kuwait Investment Board (KIB) was established in London to manage Kuwait's portfolio of foreign investments. In 1958, the KIB became the Kuwait Investment Office (KIO) and was managed by Kuwaitis. Kuwait's investments were prudent, combining safety with capital appreciation and income.

In 1982, with increasing amounts of revenue to be invested, the Kuwait Investment Authority (KIA) was established as an independent legal entity that operates under the auspices of the Ministry of Finance. KIA is authorised on behalf of the State of Kuwait to develop and manage the General Reserve Fund, along with the assets of the Reserve Fund for Future Generations. KIO is technically an arm of KIA, but operates independently (Kuwait Investment Authority, 2003).

5.7 Kuwait Stock Exchange (KSE)

The Kuwait Stock Exchange (KSE) was established in 1983 as an independent financial institution based on updated concepts and principles. In order to develop and introduce new investment tools sufficient to mobilise domestic savings and to finance economic development projects, KSE introduced mutual funds that were open to foreigners as well as Kuwaitis.

The government has also passed a law which allows foreigners to trade on the KSE and to own stock in Kuwaiti holding companies. Previously, trading in KSE was restricted to Kuwaitis and the nationals of GCC states. Foreigners could own Kuwaiti stocks only through mutual funds.

Prior to the Iraqi invasion, KSE was the twelfth largest stock exchange in the world. By 1995 it had become the most active market in the Arab world.

5.8 Intellectual property

Kuwait has been a member of the World Trade Organization (WTO) since 1995 and a signatory to the Agreement on Trade-Related Aspects of Intellectual Property Rights (Trips Agreement). As such, it is under an obligation to pass intellectual property laws meeting the minimum standards for the protection and enforcement of intellectual property rights set forth in this agreement. Kuwait is also a member of the World Intellectual Property Organization.

5.9 Technology initiatives in Kuwait

The technology initiatives in Kuwait can be summarised by the following points.

5.9.1 Kuwait Technology Park

Plans for a “technopole” in Kuwait date back more than fifteen years, but the concept has never really attracted the support it needs in order to become a reality. A project for a high-technology park, however, appears finally to have aroused the interest it deserves.

A steering committee has been formed by the Higher Planning Council to carry out a feasibility study for the creation of a high-technology park in Kuwait. Following several meetings and a two-day seminar, the committee presented the Council with a detailed plan for the establishment of a high-technology park and explained the urgent need for such an initiative in Kuwait. The committee urged the concerned authorities to expedite the establishment of the park, on the premise that it would be likely to augment the country’s economic situation (ESCAW, 2003). This “technopole” is intended to:

- constitute an important reservoir of highly-trained Kuwaiti human resources in various fields of science and technology
- facilitate technology transfer to local industries from both international and national science and technology sources
- develop a culture with distinct entrepreneurial traditions
- maintain a well-established R&D infrastructure serving small and medium-sized industries whose businesses depend on high technology

It will be necessary, however, for various economic parties to become involved in this project, including chambers of commerce and industry, universities, R&D institutions and government agencies in charge of science and technology. This could be achieved by establishing a consortium of concerned institutions that will support the project and provide input to enhance the detailed study and lead to the successful establishment of the technopole.

Constraints and possible difficulties to be taken into consideration in designing and implementing the Kuwait Technology Park include the following (ESCAW, 2003):

- at present there is only minimal co-ordination among institutions engaged in science and technology
- the national science and technology strategy is in the process of being developed¹ and cannot yet provide the necessary direction
- R&D efforts are quite often irrelevant to the needs of national development plans
- the few existing mechanisms for translating R&D results into commercial products are inadequate as a result of the weak linkages between R&D institutions and potential beneficiaries
- current science and technology efforts span a wide range of areas, incommensurate with the available resources
- the high turnover of R&D personnel reduces the chances of localising results and expertise.

5.9.2 The Kuwait Technology Incubator

The Kuwait Technology Incubator (KTI) project was initiated by the Kuwait Institute of Scientific Research (KISR) and the Kuwait Small Project Development Company with a view to contributing to the realisation of some of the objectives of national development plans, such as upgrading of the national system of innovation, diversification of the economy and creating jobs. ESCAW was requested to provide advisory services in the planning and design phases of this project, and several missions were carried out for that purpose (Mrayati and Bizri, 2000). The main objectives of the KTI are as follows:

1. The strategy has been developed by KISR, as it is detailed in Chapter 10.

- to establish value-added technology-based businesses in Kuwait
- to facilitate commercial application of KISR technology by local start-up or small high-technology firms
- to foster partnerships between R&D, educational institutions and small high-technology businesses
- to encourage local community public and private business participation
- to establish new high-income job opportunities for Kuwaitis

5.9.3 Other Kuwaiti incubators

Other incubators are currently being studied in Kuwait. In particular, Kuwait Small Project Development Company is negotiating with the Public Authority for Applied Education and Training (PAAET) for the establishment of a technology incubator designed to help graduates of technical training institutes set up their own businesses based on innovative technological ideas. Both the Ministry of Education and the Waqf General Secretariat (endowment authority) will be participating in the project. A study on this incubator is awaiting approval by government authorities (ESCAW, 2004).

These technological initiatives sound promising, however, and as Tahir (2003) and Al-Halwaji (2002) indicated in the previous chapter, their contribution to the development of a solid technological base (and hence, indigenous technological capability) was marginal.

5.10 Technology transfer issues

Kuwait does not have the necessary production facilities and skilled labour force for making a significant impact on its many social, industrial and agricultural requirements. Therefore, for its innovative activities and the technology to improve productivity and quality of life, its indigenous firms, like those of many

developing countries, are crucially dependent on transfer of technology from abroad.

The dominant form of technology transfer to Kuwait is the turnkey operation, particularly when highly sophisticated technologies are involved (Al-Sultan, 1995, Al-Ali, 1991). In most cases foreign contractors are entirely responsible for the execution of the projects, from the early phases to completion. Local firms are almost entirely excluded from participation, except for administrative and legislative issues. Very often a turnkey operation is accompanied by a management contract to carry out the operational and technical services for a limited duration, during which time the capabilities of local labour are developed.

The transfer of technology to Kuwait has contributed greatly to its enormous development in terms of industrial infrastructure and the standard of living. However, in the process of transferring technology many obstacles have been encountered (Al-Sultan, 1995). Among these obstacles is the fragile governmental policy. Although the policy of the Kuwait Government since the 1950s has been to promote the engagement of scientific and technological know-how through the establishment and support of various related institutions and laboratories there has been no explicit national science and technology policy. As a consequence, industry and other production and service sectors in the economy have been obliged to seek foreign consultants for issues concerning technology transfer and acquisition. Another obstacle is the shortage of Kuwaiti skilled personnel who have the ability to absorb and adapt the acquired technology. Kuwait has thus sought outside assistance to fill this gap, which in turn has increased the country's dependence on foreign expertise.

Another factor that has always played a major role in inhibiting effective technology transferred is the lack of adequate qualified expertise to support the decision-making process (Al-Ali, 1991). Normally, the majority of Kuwait's firms (both from industry and government) who search for technical advice and services related to the required technology make contact either directly with

particular organisations (nominated ones) or indirectly through agencies (embassies, professional institutions, friends, etc.). In either case, the quality of the services provided depends entirely upon the expertise of the selected firm(s) without offering clients the opportunity to seek independent advice or to examine the available alternatives. In the light of current economic changes and privatisation in Kuwait, these phenomena are expected to increase.

Table 5.3 presents data on scientific and technical workers and research and development expenditures collected by the United Nations Educational, Scientific and Cultural Organisation (UNESCO). The data for Japan is presented too for comparison purposes. Table 5.3 clearly indicates the weakness of the technology infrastructure of Kuwait compared to a developed country (i.e. Japan).



Table 5.3 UNESCO data of science and technology (2002)

Source: World Development Report, 2003.

According to the available literature, the technology transfer process to Kuwait is most explicit in three areas¹: the oil sector, the military sector and the Kuwait Offset Programme, as described in the following paragraphs.

1. It will be evident in the coming chapters that MEW is also a major source of technology transfer to the public sector in Kuwait.

5.10.1 Oil sector

Since 1975, the oil policy has prohibited participation of foreign oil companies in the production of Kuwait oil. In 1997, the Supreme Petroleum Council approved foreign cooperation in principle through technical agreements with various companies such as British Petroleum, Union Carbide and Chevron. Kuwait has focused on the idea that operating service agreements with foreign companies might allow Kuwait to benefit from advanced technologies supplied by those companies and apply them to the oil fields, especially the northern fields near the Iraqi border. These service agreements are in the form of joint ventures.

Opening the Kuwaiti upstream to foreign investment may have some advantages such as technological transfer and foreign capital investment that would replace government investment. Competitiveness among various companies will insure efficiency at the lowest cost. In addition, Kuwait and other OPEC members will benefit if this foreign investment is diverted from other areas around the world. If Kuwait does not open its oil sector to foreign investment, the US \$ 7 billion that the companies were willing to invest in Kuwait will be directed to other areas around the globe, bringing more oil to compete with OPEC oil. In this case, all OPEC members should open their oil sector for foreign investment.

Some opinions argue that those benefits may not be significant because (KPC) is the seventh largest in the world and well-known for its efficiency and technical abilities (Alhajji, 1999). Its technology is comparable to those of first class companies, especially after the rebuilding of Kuwait and the reconstruction of 80% of the companies' facilities that were damaged during the invasion. Therefore, technology transfer may not be the reason to allow foreign companies to invest in Kuwait. In fact, some technology transfer in the past damaged some of the reservoirs in Kuwait when proliferation was used. In addition, Kuwait does not currently need foreign capital, especially when the amount of investment is small, such as the US \$ 7 billion that the companies are allowed to invest. In a

recent press interview, the oil minister of Kuwait declared that his country had not allowed the foreign companies because it needed capital; the KPC which he heads, has US \$ 10 billion in cash looking for investment. In addition, foreign investment in new fields around the world will not decline if Kuwait and other Gulf countries open their doors to international oil companies. Each country in the world would like to produce oil and encourage oil companies to search for oil through lucrative deals.

5.10.2 Military

The different military branches in Kuwait consist of the Army, the Navy, the Air Force (including Air Defence Force), the National Police Force, the National Guard and the Coast Guard.

Kuwait's main concern was the "chronic" threat from Iraq to its national security¹. In late 1994, incidents continued to occur along the Kuwait-Iraq border, and Iraqi media persisted in referring to Kuwait as the "nineteenth province" of Iraq (Gulf Confidential, 2002). As a result of this threat, the Government of Kuwait had, in 1991, signed a security agreement and a foreign military sales (FMS) agreement with the United States, defence agreements with Britain and France in 1992 and an agreement with Russia in 1993. These agreements, as well as participation in the GCC, involve joint training exercises, thus strengthening the capabilities of the Kuwaiti armed forces (ibid).

The French Government defence support agency – Défense Conseil International has recently completed a number of helicopter-related contracts (Gulf Confidential, 2002).

1. This political situation may change as a result of the military operations in Iraq led by the US and UK coalition in March 2003.

In March 2000, land forces service provider COFRAS completed the last Gazelle light helicopter upgrade for the Kuwait Air Force (KAF). Each airframe and Turbomeca engine was completely rebuilt in Kuwait with technology transfer and training provided to the KAF.

Quality control was certified by Veritas, a French quality assurance agency, and it is thought that the Gazelles will now have another twelve years of useful life. As a result of these efforts, KAF has a full capability of maintaining and overhauling any Gazelle helicopter internationally (ibid.)¹.

5.10.3 The Kuwait Offset Programme

The transfer of high technology appropriate to Kuwait is a primary objective of the Kuwait Offset Programme (KOP). Knowledge-intensive activities are the focus for the development of new manufacturing and service industries² (Kuwait Offset Programme, 2004). These transfers can be achieved through various activities, such as the capitalisation of certain technical skills and knowledge, licence arrangements, and the assignment of highly-skilled technical experts to the businesses that are established. The technology transferred must be updated on an ongoing basis in order to stay abreast of the latest technological developments and innovations and thereby maintain a competitive business base (ibid).

The transfer of commercially viable technology is a key to Kuwait long-term economic development. The assimilation of suitable technologies will promote multiple forms of investment activities in training products and process development, R&D, quality control, production, planning and other areas that will increase efficiency and labour productivity.

1. Being an Officer in the KAF, the researcher is of the opinion that KAF is only capable of doing so with the aid of the expatriates.

2. In the later chapters it will be evident that the main concern was limited mainly to the physical part of the technology transfer process, and the know-how element was often neglected.

Under the title “Economic Benefits to the State of Kuwait” in Appendix C of KOP Guidelines, clause D requests a foreign contractor to provide a description of available competing technologies and their transfer mechanism. A list of all participating foreign contractors is provided, which includes the name of the company, the country, target sector, obligation amount and the date the offset agreement was signed. However, there are no details regarding the type of technology or transferring mechanism (Kuwait Offset Programme, 2004).

5.11 Conclusion

Kuwait has a small, relatively open economy which is driven by oil production and related industries. The public sector in Kuwait at the present time dominates the socio-economic activities. Kuwait’s economic system, modelled on a welfare state, provides for a large measure of government regulation. These regulations restrict participation and competition in a number of sectors of the economy and strictly control the roles of foreign capital and expatriate labour. Nevertheless, the era of government ownership seems to be coming to an end. As a part of ongoing privatisation efforts, the Kuwaiti government has begun to relinquish its interest in the companies it owns, generally by offering its shares for sale on the Kuwaiti Stock Exchange.

The promotion of the country’s socio-economic growth was achieved through the acquisition of foreign technologies. Turnkey projects are the dominant type of technology transfer to Kuwait. Although there were efforts made to promote technology initiatives, their contributions were limited. The shortage of skilled personnel, the fragility of government strategies and the weakness of the technological infrastructure had an adverse impact on the technology transfer process to Kuwait.

For the purpose of investigating the technology transfer process and the level of awareness of technological capability of the public sector in Kuwait, three ministries (Ministry of Health, Ministry of Communications and Ministry of

Electricity and Water) were selected as minor case studies for the preliminary work. The research focused on the Ministry of Electricity and Water as the major case study to implement the model of Panda and Ramanathan. The profiles of these ministries are described in the next chapter.

Chapter 6

Profile of the Case Studies

Introduction

The discovery of oil in the 1940s ushered in a comprehensive and radical change involving different aspects of Kuwait's society: educational, cultural, economic and structural. Health, communication and utility ministries have played a crucial role in laying down the foundation for this change and in satisfying the needs and requirements of cultural evolution. These three ministries have provided vital services for the community. Moreover, based on the nature of the provided services, these ministries are involved with the acquisition of foreign technologies more often. Therefore, these ministries are considered to be suitable candidates to investigate the technology transfer process and to assess their technological capability, as illustrated in Chapters 8 and 9. All of these ministries are owned, operated and maintained by the government.

This chapter provides a summary of the profile of the Ministry of Health and Ministry of Communication. Because it represents the core of the empirical work of the research, an in-depth profile of the Ministry of Electricity and Water follows. It should be noted that the researcher's objective was to focus on technology transfer issues within each ministry. However, the lack of adequate supporting references in the literature and within the ministry publications represented a major obstacle in achieving this objective.

6.1 Ministry of Health (MoH)

The Government of Kuwait is focusing its attention for health services and medical care through the Ministry of Health (MoH). Kuwait has highly developed and comprehensive public health services that are provided to both citizens and residents (Health Statistical Report, 2003). The MoH in Kuwait offers an essentially free health service to all Kuwaiti citizens and at a subsidised fee for residents. This service is disseminated through five health regions covering the whole country. Each region maintains a number of primary health care centres and one general hospital (secondary care level). All the specialised hospitals and centres are concentrated in the separate Sabah health region (tertiary care level). The government has been allocating generous funds to construct hospitals, polyclinics and school clinics across the country. In 2002, the Government's annual expenditure on health was \$ 979 million. The health care cost per capita was \$ 477. In addition to providing health care services to the public, MoH regulates the work of the private hospitals and clinics and continuous monitoring of their performance. As of 2002, the total number of the employees in MoH is 27,877, about 27 % of whom are technicians (most of them are expatriates).

In 2002, there were 298 general and specialized hospitals, health care centres and clinics in Kuwait. In addition, there are 47 hospitals and clinics which are totally owned and operated by the private sectors (Health Statistical Report, 2003). Although widely dispersed with its employees, the ministry maintains an essentially manual system for its records whether administrative or clinical. The MoH has attempted to introduce information technology and integrated health information systems since 1980. However, these attempts resulted in isolated small solutions in several hospitals. On the whole, the MoH continues to suffer from the lack of an integrated health information infrastructure resulting in:

- incomplete and fragmented patient records

- lack of control over drug dispensing and other health services leading to high wasteful expenditure
- unavailability of fast reliable information for proper decision making
- no wide on-line communication facility within the MoH or to international institutions

In terms of technology initiatives, in 1995 the MoH declared and adopted a new strategy to establish a National Health Information System: "Afya" the Arabic word for good health, was chosen as a name for this technological project for the execution of the strategy. A budget of nearly 8.5 million Kuwaiti Dinars (around US\$28 million) was granted for the whole Afya project (ibid.).

AfyaNet will provide the basic communication infrastructure for the health care arena within Kuwait. No integrated health systems are expected without it. It would facilitate internal communication within the MoH and this will positively effect information dissemination and flow. The network will also allow the MoH professionals easy access to the Internet and therefore the international wealth of information. It will also allow them to communicate with each other and engage in on-line live consultations and case studies locally and remotely (telemedicine as an example). Most of all, and with the implementation of the health care information system, the duplication and waste in some services will be controlled leading to cost savings, better decision making, calculated planning, and eventually an overall better health care service (ibid.).

There are certain challenges in this technical project. AfyaNet's scope is very large and the implementation period is long. This is significant when considering:

- a. availability of highly qualified technical staff to support the network
- b. fast technology changes

To lessen the effect of these challenges, the MoH is keen to rely on the network vendor for its support for almost three years from the start of implementation.

During this period extensive staff recruitment and training will take place at the MoH. The technical specifications will be continually upgraded as part of the vendor contract subject to the latest compatible technology at time of delivery. Considering the fact that some facilities are old, inconveniences will be expected at the clinical facilities on both sides (vendor as well as MoH). A major consideration will be given to vendors who previously handled similar installations successfully.

In addition to the Afya project, the majority of the acquired technologies at MoH are associated with radiology (Computed Tomography (CT scan), Magnetic Resonance Imaging (MRI), X-Ray, etc.), intensive care units, anaesthesiology departments and biomedical services.

6.2 Ministry of Communications (MoC)

The communication services were introduced to Kuwait in 1956 by a UK company called British Cable and Wireless. Since then the Kuwait Government has devoted its efforts to developing the communication sector.

Because of the distinctive geographical location of Kuwait in the Arabian Peninsula, the government has given the transport and communications sector top priority to be able to cope with the vast technological development.

The Ministry of Communications has the responsibility for regulating and providing transportation (land and sea), the postal system and telephone network services. Some of the international services provided by the MoC are electronic mail (also called K-Mail), video conferencing, Internet, magnetic card for public phones, telex, AT&T prepaid calling cards, etc. The ministry also provides wireless services such as Smart Card, Motorola Wireless Call, Citizen Band Radio (CB) and Maritime Wireless.

Registration of navigation lines or regular ships, investigation of maritime collisions, issuance of transport certificates, inspection and survey of small ships,

investigation of accidents resulting in oil pollution of the sea are only some of the responsibilities of the ministry.

The newest facility of the Ministry of Communication is the Telecommunication Centre located in the heart of Kuwait City. The Liberation Tower is the most important component of this centre. Constructed by the Ministry of Public Works, this is the fifth tallest tower in the world (Ministry of Communication, 2003).

The ministry consists of eight sectors: communications, planning and administration, finance, customer services, international services, transportation and backing services and the post. The total number of employees was 7,559 at the end of 2002 (ibid.).

6.3 Ministry of Electricity and Water (MEW)

In Kuwait, the electricity and water sector is developing rapidly and is making significant improvements to the country's infrastructure. The increase in population, the development of new residential areas and the expansion of local industries appear to be responsible for the rapid rise in the utilities demand (Eltony, 1995). Kuwait has invested substantially in modern technologies to sustain its needs. Currently, these utilities are entirely owned by the government. The Ministry of Electricity and Water (MEW) is responsible for the generation, operation, maintenance and distribution of both services. The two utilities are fully integrated within dual-purpose power and water cogeneration units, where conventional steam boiler turbine generator systems (SBTG) are utilised to generate power and to supply the required steam for the water desalination process. The dual-purpose plants employ thermal steam turbines and multistage flash desalination units and use different types of fuel available in the country, such as natural gas, heavy fuel oil, crude oil and gas oil.

It should be mentioned that most of the desalination plants were either completely destroyed or dismantled and transferred to Iraq during the occupation

of Kuwait. Enormous efforts were subsequently devoted by the government to repair and reconstruct the entire water and electricity network in the country, a task which has proved to be very costly. During the past few years, MEW has witnessed a shift in its employment policy. This shift is represented in the increased number of Kuwaiti employees and the introduction of new technology to support these employees in performing their duties (MEW statistical year book: water, 2002). However, most of these employees were assigned administrative tasks. MEW acknowledged that the expansion in applying modern technology would only be successful if it was combined with a trained workforce. Therefore, MEW provided its employees at all organisational levels with different training programmes¹. Currently, there are a total of 7,228 (as of 2002) employees working at the MEW. The distribution of personnel and the organisational structure of the ministry are illustrated in Table 6.1 and Figure 6.1 respectively.



Table 6.1 MEW personnel distribution
Source: MEW yearly statistics book, 2002.

1. It will be evident in Chapters 8 and 9 that these programmes were insufficient to absorb the imported technologies.



Illustration removed for copyright restrictions

Figure 6.1 MEW organisational structure
Source: MEW Yearly Statistics Book: Water, 2002.

In the subsequent sections, the water and electricity utilities will be explored in more detail.

6.3.1 The water sector

Kuwait is an arid country. Since its foundation, the State of Kuwait has faced extremely challenging circumstances represented by the scarcity of natural fresh water resources. These resources are limited to a very few brackish water and ground water wells, which are scattered in some areas around the country.

The nature of Kuwait's climate had worsened the situation. The geographical position of Kuwait in a desert region has deprived it of almost all fresh water, which obstructed its development for many years in the past. Being located on the Arabian Peninsula, the characteristics of the climate of Kuwait are those of a typical desert having extreme high temperatures, a high percentage of sunshine and frequently occurring dust storms. Maximum temperatures range from 40° C to 50° C during the hottest season in July and August, while mild and cool days characterise the weather from November to April. During the cooler months of December and January, night temperatures can be as low as 0° C. Occasional rain falls between November and May. It is generally light and amounts to an average of fifteen centimetres (six inches) annually, although thunderstorms can bring as much as five centimetres at a time. Only a small amount of rainwater percolates into the ground because of the high evaporation and the presence of an impervious layer in some regions.

Because of this dilemma, Kuwait is obliged to secure its needs for potable water through various means. During the pre-oil discovery era Kuwait turned to Shaat-Al-Arab, a large natural water reservoir south of Iraq, for fresh water supplies brought by Dhows (large wooden ships). Primitive storage and distribution networks were established to control the utilisation of fresh water locally. Transport of water by Dhows continued for some time before specially designed wooden ships replaced them. This situation has changed radically after the

discovery of oil in the late 1940s. The revenue from oil sales was invested in modern water production facilities that could cater for fresh water demand.

Since the 1950s, Kuwait has relied heavily on desalination to meet its critical need of fresh water for drinking and domestic purposes, particularly with the continuous growth in population and the expansion of local industries and the agricultural sector. It uses advanced technology in desalinating seawater. As a result, Kuwait is considered one of the most experienced countries in the realm of water desalination (Abdel-Jawad et al., 2001).

Management of its scarce water resources is one of the greatest challenges facing Kuwait. The main institutions involved in water resources management are:

- The Ministry of Electricity and Water: MEW is responsible for generation, operation, maintenance and distribution of both services. In addition, research studies, development, exploration, monitoring and granting licences for drilling and using groundwater are other major tasks that MEW is responsible for.
- The Water Resources Development Centre: a highly specialised centre responsible for conducting research in the domain of water resources. It is attached to MEW.
- The Ministry of Public Works: responsible for sewage water networks and collection reservoirs, wastewater treatment and utilisation.
- The Public Authority for Agricultural Affairs and Fish Resources: responsible for irrigation systems and monitoring ground water quality and quantity.
- The Kuwait Institute for Scientific Research: in charge of research related to water resources.
- The Environmental Protection Council: in charge of monitoring water quality.

Multi-Stage Flash (MSF) technique

In the early part of 1952, a plan was endorsed to establish a desalination plant that utilises the submerged tube technique. The basic idea of this technique is to employ a submerged tube to evaporate seawater and pass the evaporation to a condensation chamber. The resulting water is collected in large storage tanks. The inefficiency and the high cost of the submerged tube conventional technique led MEW to seek more appropriate desalination technology. The solution was brought from Westinghouse Company in 1957 when it first introduced the Multi Stage Flash (MSF) technology. The design was based on an old multi-effect system design known as a once-through system. The basic concept of this technique is that the intake water is heated then discharged into a chamber maintained slightly below the saturation vapour pressure of the incoming water, so that a fraction of the water content flashes into steam. The steam condenses on the exterior surface of the heat transfer tubing and becomes water. The unflashed brine enters another chamber at a lower pressure, where a portion flashes to steam. Each evaporation and condensation chamber is called a stage.

Kuwait was the first to adopt this technology and awarded Westinghouse Company the construction of the first commercial MSF desalination plant. Kuwait also took the lead in modifying and upgrading most of the original specification of the MSF technique by MEW engineers to suit its requirement. Initially, the company established a four-stage flash type each with two units of 0.5 MIGD (million imperial gallons per day) production capacities. Subsequently, MEW discovered that from an engineering and economic perspective the size of 6 MIGD proved ideal in terms of steam consumption and chemicals and yielded optimal production. Hence, it became the backbone of the fresh water industry in Kuwait (MEW Statistical Year Book: Water, 2002).

The location of Kuwait along the north west of the Arabian Gulf has a significant effect in supplying abundant seawater, and also made the elements of the

seawater desalination technologies readily accessible. The number of MSF units has grown as the demand for fresh water has increased. In 1979, Kuwait was leading the world with an installed MSF capacity of 102 MIGD. By 2000, the total number of operating MSF in MEW was 44 units, with a total capacity of 315.6 MIGD. The total capacity of the distillation plants will be 345.6 by the year 2006 when the new station (Sabiya) is fully operational. The following figure illustrates the growth rate in the MSF installed capacity in Kuwait over the last 40 years.



Figure 6.2 Growth rate in MSF units installed capacity
Source: MEW Yearly Statistics Book: Water, 2002.

Following its success in Kuwait, the MSF process became the most widely used technology for seawater desalination in the world. Wangnick indicates that the total capacity of all seawater desalination plants worldwide grew from nearly 32

MIGD in 1966 to 3 billion IGD in 1997. The MSF process alone grew worldwide from a total capacity of 30 MIGD in 1966 to 453 MIGD in 1976, and about 2 BIGD in 1996. In other words, the MSF process dominated the world's seawater desalination by almost 95% in 1966, by about 91% in 1976 and about 75% in 1997 (Wangnick, 1998). In 1997, the total installed capacities of MSF plants in the Gulf Cooperation Council (GCC) countries reached almost 81% of the world's total installed capacity. Kuwait alone accounts for about 15% of the world's total installed capacity and 19% of the GCC countries' total installed capacity.

Kuwait has adopted the MSF technology as part of dual-purpose systems providing power and water by cogeneration. These dual-purpose systems have successfully supported the country's fastest growth rate and have backed up the social, economic and industrial developments witnessed in Kuwait during the last four decades. In particular, the MSF process has proved to be the most reliable and safest source of the highest purity and best quality fresh water from the sea, regardless of the feed water quality. In addition this method requires less space and incurs substantial saving in operation and maintenance costs (Al-Wazzan & Al-Modaf, 2001).

Currently, there are six MSF distillation plants distributed over different locations along the Gulf coastline of Kuwait. Each distillation unit consists of a number of stages ranging between 24-26 stages and the capacity of each unit is between 5-6 MIGD. Table 6.2 demonstrates the commissioning date and the total capacity of these plants.

As stated previously, these plants are fully integrated within dual-purpose power and water cogeneration complexes where conventional Steam Boiler Turbine Generator (SBTG) systems are used for power generation and for supplying the required steam for operating the MSF distillers.

Station	Date of Commissioning	Total Capacity MIGD
Al-Shuwaikh	1960	28
Al-Shuaibah North	1965	9
Al-Shuaibah South	1971	30
Al-Doha East	1978	42
Al-Doha West	1983	110.4
Azzour South	1988	115.2

Table 6.2 MSF plants in Kuwait

MSF features

As mentioned above, the MSF process has proved to be the most suitable method for Kuwait's environment. This is particularly significant in Kuwait where the feed water quality is characterised by its high silt density, which could be a major problem for other desalination technologies. MSF remains practically independent of feed water quality.

The following are some of the positive impacts that have resulted in the present extensive use of MSF plants in Kuwait (Abdel-Jawad et al., 2001):

- It would be extremely difficult to maintain the sudden and vast increase in the industrial, social and economic growth in Kuwait that commenced earlier in the 1960s and 1970s without sufficient power and fresh water resources. The MSF and SBTG combinations were the only suitable candidates for the large power and water cogeneration plants needed then.

- The MSF process is thermally driven, which requires relatively high thermal energy inputs. The abundance of gas as the primary source of thermal energy made such extensive application of the MSF process affordable and held in check any concern over its high-energy consumption. MSF units with very large capacities, e.g., the 6-MIGD (operated at normal temperature), which became the standard capacity in Kuwait, favoured the MSF process over other commercially available processes. Such a capacity proved to be very suitable for maximum plant utilisation under the prevailing conditions in Kuwait.
- The history of the MSF technology in Kuwait as well as the other GCC countries reveals no cultural or social concern on the part of the public regarding the extent to which MSF product water is used. The fact that the process involves heating to high temperatures and results in distilled product water made this water fully acceptable without reservation.

Based on its implementation in Kuwait, Al-Wazzan and Al-Modaf (2001) summarised the major advantages of the MSF technology as follow:

- very high resulting water quality
- high independence of feed water quality
- very high reliability and safety record
- less space required
- operation and maintenance efficiency
- minimal or insignificant impact on the environment

Although the MSF process plays a crucial role in sustaining the continuous growth in fresh water demand in Kuwait, there are major drawbacks associated with this technology (ibid.):

- very low water recovery ratio, typically only about 10% of the total feed water to the MSF is recovered as distilled water
- high thermal energy input, which places the MSF process in the highest energy consumption category in comparison to other commercially available desalination processes
- inflexibility in power and water cogeneration systems due to the dependence of MSF on the steam imported from the SBTG as the main source of energy
- relatively high capital cost

Operation and maintenance of MSF plants

Over the last four decades, Kuwait has accumulated a great wealth of knowledge and experience in the operation, maintenance and, as required, development of technical and engineering specifications of MSF plants. Today, MEW independently operates and maintains all MSF plants locally utilising all available local resources including highly experienced staff covering all technical and administrative activities. Operation and maintenance scheduling is designed to maximise the availability of MSF units during the summer months when the demand for freshwater reaches its peak value. Regular annual maintenance is usually scheduled during the moderate and cold weather months, i.e., when the demand for freshwater is less.

Based on the previous facts, " Kuwait, undoubtedly, has successfully transferred, managed and indigenised promptly all the technological know-how aspects of MSF" ¹ (Abdel-Jawad et al., 2001).

1. This statement is somehow misleading because MEW is still heavily dependent on foreign contractors and expatriates to build and maintain its MSF units, as discussed in Chapters 8 and 9.

Reverse Osmosis technique (RO)

Although MSF is still the dominant technology in the desalination field, its high thermal energy consumption prompted the future of this process to be questioned. The energy crisis during the 1970s highlighted the importance of searching for alternative methods to MSF. After decades of continued attempts, the Reverse Osmosis method has proved to be an important and practical one for water desalination and purification. This technology is based on membrane-type desalination, where pressure is applied continuously to the feed water, forcing water molecules through a semipermeable membrane. Water that passes through the membrane leaves the unit as product water; most of the dissolved impurities remain behind and are discharged in a waste stream.

When RO was first introduced in the 1960s, it was considered to desalinate only the brackish water which is much less saline than the seawater, but still far too saline for human consumption. Today, however, the process has been improved and seawater RO units are available on a commercial scale.

The major contributing factor to the increased popularity of RO is that it is inherently more efficient and much simpler than MSF. Unlike the MSF process which requires a large quantity of thermal energy, the RO process operates at ambient temperature, hence requires less energy. In addition, RO units are easier to operate and maintain, and require much less space. Also, due to the design simplicity and low energy consumption, the cost of an RO unit is lower than MSF.

MEW has installed 33 brackish water desalination units employing RO technology, with a total capacity of 9 MIGD. This type of water is used for blending with distilled water, irrigation and landscaping, domestic purposes, livestock watering and construction works. Moreover, MEW has decided to rely on this resource to turn some of it into potable water, which is stored for

emergency usage.

Having recognised the significance of the RO seawater process, in 1984 MEW conducted an RO research programme with the cooperation of the Kuwait Institute for Scientific Research (KISR) and GKSS, representing the Ministry of Research and Technology of the Federal Republic of Germany at that time. The main objective of this programme was to test and optimise the RO process under local conditions. As a result of the continuous development and implementation of RO technology, the encouraging result obtained from applying the RO method to brackish water and the improvement of the membrane materials, MEW is now on the threshold of constructing its first large seawater RO plant at Az-Zour North with a production capacity of 24 MIGD.

Water storage and networks

The water distribution system in Kuwait comprises two networks. One for fresh water and the other for brackish water. Each system has its own underground reservoirs, pumping stations and elevated towers and necessitated facilities.

The MEW plan is to increase the potable and brackish water storage capacity as a stand by for emergencies and for meeting peak consumption. Such a plan involves the construction of reservoirs with different capacities in various locations. Table 6.3 shows the present storage capacity.

The fresh water reservoirs are equipped with infection equipment to disinfect the water from harmful particles. This equipment operates automatically from a control centre connected to pumping stations.

The water produced from distillation plants or ground wells is pumped to the underground reservoirs then to distribution networks and elevated towers located in several areas around the country. The distribution networks consist of main pumping and distribution lines and subsidiary networks. At the current stage,

Table 6.3 Fresh and brackish water capacity
Source: MEW Statistical Year Book: Water , 2002.

these networks do not cover the entire country. In areas where water lines are not yet installed people can easily obtain water from water filling stations located in different areas of Kuwait by means of water trucks.

Chemical works

In order to be drinkable, the produced distilled water needs to be mixed with underground water which is supplied from brackish water wells. Then, the distilled water is disinfected by injecting a chlorine solution to eliminate bacteria and harmful organisms. Finally, caustic soda solution is added to maintain the OH value within the required limits as specified by the World Health Organisation (WHO). This operation takes place in the blending plants in the Chemical Works Administration (CWA). CWA has many different functions. One of the major responsibilities of CWA is to maintain the high standard of the quality of distilled fresh water. It achieves this by continuous examination of samples which are collected randomly from different locations. These samples are chemically analysed in the CWA's administrations lab. These labs have been recently equipped with advanced instruments to carry out tests for all heavy metals which pollute the distilled water, and are supported by highly skilled national staff.

In addition, the CWA supervises the flushing and disinfection process for the new water networks in the new districts, and arranges the training courses for the students from Public Authority for Applied Education and Training colleges.

Consumption rate

The annual consumption of fresh water has been steadily increasing over the past decades. In 1959, the average per capita was about 13 imperial gallons per day (IGD), which is equivalent to 60 litres. This increased dramatically during the following years at a very high rate until it reached more than 109 IGD in 2000, which is equal to 503 litres. Such a massive growth in the per capita consumption could not be sustained without a much faster growth in the MSF production capacity and the construction of new desalination plants, which are required to maintain the fast growth in population and industries (Mukhopadhyay et al., 2000).

Although fresh water resources in Kuwait are limited as was already discussed, citizens and residents are behaving as if it is bountiful. The latest monthly report issued by MEW in July 2002 showed that the daily average consumption rate has reached a critical level necessitating use of the strategic water reservoir of the state. A recent study carried out by KISR has attributed this negative phenomenon to the pricing policy. The estimated cost of desalinated water is around US \$6.5/1000 IG. The consumer is, however, charged at US \$2.7/1000 IG, and the industrial sector is charged even less (US \$0.8/1000 IG). As it is part of government policy to maintain the welfare of the citizens by providing financial support to the utilities, these prices have been in force since 1966 (Al-Rashed et al., 1998).

The continuity of this phenomenon will undoubtedly lead to a perilous water crisis. Therefore, it is crucial to change the current behaviour of consumers (individuals, industries and institutes) through the introduction of awareness programmes for consumers or minimising government subsidies for this service. It is hoped that these actions could lead to an appreciation of the limitation of fresh water resources.

Table 6.4 shows the statistics of production and consumption of fresh water over the period 1975-2000, while Figure 6.3 shows the per capita consumption rate for the same period.



Illustration removed for copyright restrictions

Table 6.4 Consumption of fresh water for the period 1975-2000
Source: MEW Yearly Statistics Book: Water, 2002.

Per Capita Consumption Rate



Illustration removed for copyright restrictions

Figure 6.3 Per capita consumption rate
Source: MEW Yearly Statistics Book: Water 2002.

Water Resources Development Centre

Due to the demand for water the Water Resources Development Centre was established in 1968 in collaboration with the United Nations Development Programme (UNDP) and under the sponsorship of MEW as a specialised centre for research, development and conservation of water resources. The centre is responsible for the following tasks:

- studying present and anticipated demands for water
- carrying out technical, environmental and economic research on water resources
- issuing assurance certificates for various materials to be safely used in the water field in Kuwait
- participating in technical specification committees and different water projects
- conducting training programmes for local college students

The centre includes the following departments:

- Research and Development
- Chemical Lab
- Bacteriological Lab
- Technical Library

Future plans

In addition to the 44 MSF units currently in operation, four additional units are under construction at the Az-Zour South location as part of stage two of the project. All four units are of similar capacities to the existing ones, i.e., 6 MIGD at normal temperature (90°C) and 7.2 MIGD at high temperature (110°C). Construction, operation and take over of all distillation units have been completed and the remaining outstanding work and the handing over of contractual spare

parts are expected to be completed by the beginning of 2004. In stage three, the plan is to supply and erect four distillation units to produce 24-28.8 MIGD. It is estimated to be completed by mid-2004.

MEW is planning to install two additional MSF units at the new Sabiya Power Station, north of Kuwait, each with 12.5 MIGD capacity with provision for increases in the capacity up to 15 MIGD per unit at higher temperatures. These two units are expected to be operational in year 2004. In addition, an RO desalination plant project with a capacity of 24 MIGD at Azzour North is expected to be in service by 2006.

To counteract its water shortage, the government of Kuwait unveiled a US \$2 billion Kuwait-Iran water project. Under this plan, up to 200 million gallons per day of fresh water is to be pumped from Karkheh Dam in south-western Iranian territory through a 540 km pipeline to the coast of southern Kuwait. Of this 330 km will be constructed on Iranian territory, while the rest will be laid under the sea. Kuwait is expected to promulgate its stance after an all-out survey of the plan. It is anticipated that this project will be completed within year 2005 and it will be carried out by a consortium of investors from Iran, Kuwait and the United Kingdom.

6.3.2 The electricity sector

Electricity is a vital element in the development of the economic and social aspects of developing nations. Kuwait is no exception in this respect. The amount of consumed electricity in Kuwait has grown consistently since the 1970s. If past trends are examined to the year 2000, the electricity consumption rate is at least ten-fold the level of the 1970s.

The year 1934 witnessed the birth of the first electricity supply service in Kuwait, which was established by a commercial company. The small station was capable of producing "direct current" (DC) only. The production process started with two

30 KW generators and the power was distributed through 200 volt capacity lines. At the beginning, the number of consumers was rather small. As a result of the rapid progress and growth of all aspects of society, demand rose considerably, rendering the existing plants unable to cope with it. This chaotic situation led the government in 1951 to procure the commercial company and establish the Directorate of Electricity, which later became MEW, to provide and distribute an adequate electric supply. Upon taking over, the Directorate constructed the first power plant near the sea shore to use the seawater for cooling purposes.

Power plants

The growth in the power consumption rate and the establishment of the Shuaiba Industrial Area led in 1965 to the construction of the Shuaiba North power plant, operated by steam turbines with a capacity of 70 MW. In the light of the continuing increase in the electrical power consumption as a result of urban development and industrial expansion, MEW constructed more plants operated by steam or gas turbine units. Steam turbine units have a larger capacity than gas turbine units. Table 6.5 indicates the major specification of these plants.



Illustration removed for copyright restrictions

Table 6.5 Power plants in Kuwait

Source: MEW Yearly Statistics Book: Electricity, 2002.

Although all plants were damaged to a certain extent by the Iraqi troops and were repaired, Al-Shuwaikh and Al-Shuaibah North power stations were so severely damaged that they were beyond repair and their operations were ceased.

To sustain the excessive growth of electrical power demand, MEW has continuously updated this utility. Figure 6.4 illustrates the development of power station installed capacity over the past 25 years.

Electrical networks

In the early stages, the electrical networks employed overhead lines with copper conductors on wooden poles. The operating voltage was 200 DC. Later, the network voltage was changed to 380/220 50 Hertz alternative current (AC). In 1951, the networks' voltage was raised to 11 Kilo Volt (KV) to extend the range of the network to satisfy the continuous growth of electrical load as a result of the increase in the number of consumers. Underground cables were also constructed for power distribution, in addition to overhead lines.



Figure 6.4 Growth of power station installed capacity
Source: MEW yearly Statistics Book: Electricity, 2002.

Consequently, MEW repeatedly constructed lines carrying higher power to feed the newly developed remote suburban areas. Following the continuous increase in demand for electricity it was decided to introduce a new 300 KV network to reinforce the expansion of electrical networks. Such high voltage adequately permits the transmission of large amounts of power to the centres of consumption, i.e. houses, factories, hospitals, etc.

The current structure of the electrical network consists of extra high voltage (300 KV), high voltage (132/33 KV), medium voltage (11 KV), low voltage (415 V) and street lighting.

Supervisory Control Centres (SCCs)

A high capacity and widespread power system including four generating stations, hundreds of substations and thousands of kilometres of overhead lines and cables cannot operate normally and efficiently unless it has control centres to manage the huge tasks assigned. In the light of this, MEW has established Supervisory Control Centres (SCCs). These centres are the heart of the power system organisation which deals with power system operation. The purpose of the SCC is to bring together all the requisite information of each power plant element from different power stations and substations. Then, necessary commands are sent back to these stations and substations for efficient operation of the power system. Briefly, SCCs are responsible for the following:

- to coordinate the activities of power generation, its transmission and distribution
- to secure the continuity of the service to the public
- to ensure the efficiency of the systems
- to ensure the safety of the workers and the equipment

The SCCs are distributed in different locations to cover the entire network. These centres require very sensitive, reliable and accurate advanced systems. These include information collection systems, telephony systems and peripherals, communication systems and peripherals, computer systems and peripherals and auxiliary power systems.

Foreign firms involvement

Since its establishment in 1953 and due to socio-economic and political issues, MEW had devoted efforts to acquiring the latest technologies which could secure the local demand for electricity and water, through highly experienced foreign firms (MEW Statistical Year Book: Electricity, 2002). As a result, it contracted various firms to design and construct the power plants and the SCCs. These firms are:

- Westinghouse
- Siemens
- Mitsubishi Heavy Industry
- Hyundai Engineering and Construction

The following paragraphs briefly discuss the type of involvement of each of these firms with MEW:

- *Westinghouse*

As described previously, Westinghouse was the first foreign firm that MEW contracted in 1957 to design and construct the first MSF desalination plant. Westinghouse cooperation with MEW finished in 1968 when it built two units of 2 MIGD MSF plant.

- *Siemens*

Business ties between Kuwait and Siemens are based on more than 40 years of successful cooperation, with Siemens having established its first office in Kuwait in 1959. Siemens main representative in Kuwait is National and German Electrical and Electronic Service Company (NGEECO), a joint venture with Kuwaiti partners in which Siemens holds a 49% stake. NGEECO offers expert consulting, comprehensive technical support, reliable customer service and end-to-end solutions from nearly all Siemens Group – power generation, power transmission and distribution, automation and drives and industrial solutions and services – as well as from the information and communication and the lighting segments.

Since 1993, NGEECO has been responsible for maintaining Siemens and Hitachi transformer substations in Kuwait. In 1999, the maintenance contract was extended by MEW for a further three years. A turnkey contract worth US\$20 million was signed to supply and commission a transformer substation, extending the Kuwaiti 132 KV network. Siemens also received an order for two additional 132/11 KV substations.

- *Mitsubishi Heavy Industry*

MEW contracted Mitsubishi Heavy Industry to embark on the 2400 MW Sabiya Power Plant project in the north of Kuwait in 1989. The conventional thermal station was planned to provide support for existing power stations under emergency situations and to ensure comfortable coverage of potential power demand into the next millennium. The contract was disrupted by the Iraqi invasion of Kuwait in 1990. Under the reopened contract, Mitsubishi Heavy Industry resumed work to expand the Sabiya oil-fired power plant in 1994. Mitsubishi was engaged in the construction work on a full turnkey basis, including assembly and installation of eight 300 MW boilers and steam turbines. The 2400 MW project was completed in 2001 at a cost of US\$2.3 billion.

- *Hyundai Engineering and Construction*

Hyundai Engineering and Construction and local partner United Gulf Construction Company were awarded a US\$450 million civil work assignment contract for the Sabiya power plant. The Korean group held off competition from local, UK and French construction groups.

The consumption rate

The demand for electricity in Kuwait is characterised by high load in the summer, especially in July and August due to the heavy usage of air-conditioning systems, and low load in the winter. Also, the electrical load fluctuates during the summer holidays because a large number of people leave the country for their vacations.

Although the population size and the scale of industries in Kuwait are small, the consumption rate of electricity in Kuwait is one of the highest in the world (Burney, 1998). Once again, the main reason for this unusual consumption is the extremely cheap price of electricity. The estimated cost of producing 1 KW of electrical power is US\$0.45, while the consumer pays only US\$0.06 (Nadeem and Al-Matrouk, 1996).

Another substantial reason is the lack of structured educational programmes, rather than the current short advertisements through the media, which could direct the general public attention to the dimensions of this problem (Al-Mazidi, 1995). The per capita consumption rate is illustrated in the Table 6.6 and Figure 6.5.

Fuel networks

All of the dual-purpose power plants, i.e. electrical power generation and water desalination, consume the country's natural resources of fuel, namely oil (crude



Table 6.6 Per capita consumption of electrical power in Kuwait
Source: MEW Yearly Statistics Book: Electricity, 2002.



Figure 6.5 The increase of per capita consumption in electrical power
Source: MEW Yearly Statistics Book: Electricity, 2002.

oil, gas oil and heavy fuel oil) and natural gas.

Fuel networks consist of several lines with different diameters and lengths extending to several areas around the country. These lines are as follows:

- major lines (gas and liquid fuel) to feed power stations and water desalination plants
- gas scrubbers for reducing pressure and purifying gas
- the main network lines for natural gas

The following table demonstrates the consumption of energy (oil and natural gas) and the associated cost for the last three years (1998- 2001).



Table 6.7 Energy consumption for the period 1998-2001
Source: MEW Yearly Statistics Book: Electricity, 2002.

Expenditures

The estimated cost of constructing a dual-purpose plant with capacity of 2400 MW and 96 MIGD is approximately US\$2.3 billion 06 (Nadeem and Al-Matrouk 1996). This value excludes the operation cost, maintenance, wages, fuel and the spare parts. A 2400 MW power station consumes an average of 640 tons of

liquid fuel per hour. The average annual cost of total consumed fuel for each station is estimated to be US\$190 million.

Future plans

MEW is intending to build gas turbine units with a total capacity of about 1000 MW at Shuaiba power station.

Also, the annual rise in electrical power demand, which is around 8% and is expected to follow this pattern in the coming years, has led MEW to build a new steam power station in order to meet future demand. The Az-Zour North Steam Power Station project is proposed to have a total capacity of 2500 MW. This project is still in the feasibility study phase.

During the annual GCC meeting in 1997, the ministers of MEW in the GCC countries made an initial agreement to establish a Power Grid Network to link all of the electricity utilities in the GCC. The project will reduce the consumption of electricity and decrease its cost. It is divided into three phases. In phase one the electrical networks in Kuwait, Saudi Arabia, Bahrain and Qatar will be linked. In phase two, Oman and UAE will be linked. The final phase will link the west and the east of the Arab world. Gulf finance ministers asked the Gulf organisation for industrial consultation to conduct a marketing study of the power grid network. The GCC states will request companies implementing the project to pay a certain amount of money annually in return for their use of the network. The estimated cost of this project is US\$3 billion.

6.4 Conclusion

The discovery of oil in Kuwait was the major contributor to the country's massive socio-economic development. Among other sectors, health, communication and utility sectors have played an essential role in this development. MoH, MoC and MEW are owned, operated and maintained by the

government. The government also controls and regulates their provided services. Their infrastructures are mostly based on advanced technology systems and equipment.

These ministries were chosen as case studies for the purpose of investigating the technology transfer process to Kuwait, as well as to assess their technological capability. Since they represent minor case studies (as discussed in Chapter 8) a brief profile for MoH and MoC was presented in this chapter. On the other hand, an in-depth profile of MEW was provided because MEW constituted the major case study of this research.

In the next chapter the adopted research methodology is identified. Also, it discusses the technological capability assessment model that was implemented in this research.

Chapter 7

Research Methodology

Introduction

Research can be described as a systematic and organised effort to investigate a specific problem that needs a solution (Burns, 2000). It is a series of steps designed and followed with the goal of finding answers to the issues of concern to the researchers. Research methodology refers to the ways in which research studies are designed and the procedures by which data are collected and analysed (ibid.).

The central theme of the research is to investigate the role of indigenous technological capabilities on the success of imported technology to the public sector in developing countries, with particular emphasis on the electricity and water sector in Kuwait (MEW). The research is also an attempt to understand how local technological capabilities can be assessed, enhanced and adapted to accommodate the new transferred technology. In addition, the research will attempt to generalise the outcome of the research to include the other GCC countries.

The empirical work of this research was divided into two phases. Phase one investigated the technology transfer process to the public sector in Kuwait and the degree of awareness of indigenous technology concepts. The investigation

was based on the literature review, pilot survey¹ and three minor case studies. The outcome from phase one was used to formulate four research hypotheses.

The purpose of phase two was to test these hypotheses through an in-depth investigation of the technology transfer process to MEW (the main case study), and through the assessment of the indigenous technological capability of MEW, using the Panda and Ramanathan model.

This chapter investigates various management research methodologies and illustrates the adopted methodology for this research, and how it was implemented. It also highlights the adopted method for assessing technological capability of a utility firm.

7.1 Types of research

The process of data collection and analysis in management research has been divided into two broad types, quantitative and qualitative (Sarantakos, 1997). Having emerged in the 1960s, both of these terms signify much more than ways of gathering data; they symbolise divergent assumptions about the nature and purposes of research within the realms of social science. Discussions about the nature and relative virtues of quantitative and qualitative research reveal a mixture of philosophical issues and considerations of the virtues and disadvantages of the methods of data collection with which each of these two research traditions is associated (Bryman, 1993).

Sarantakos defines quantitative research as a “type of research that is based on the methodological principles of positivism and neopositivism, and adheres to the standards of strict research design developed before the research begins. It employs quantitative measurement and the use of statistical analysis” (Sarantakos, 1997: 6). Qualitative research usually emphasises words rather

1. A pilot survey in the form of unstructured interviews has been conducted with the former Under-Secretary of MEW (see Chapter 8).

than quantification in data collection and analysis. It aims towards exploration of social relations, and describes reality as seen by the respondents (Bryman and Burgess, 1999).

In the real world of social science, research does not fall precisely into the above two distinctive categories. Denscombe (1998) suggests three reasons for this. First, in practice, the two approaches are not mutually exclusive. This is obvious since social researchers rarely rely on one approach and they tend to use parts of both. Second, in theory, the distinction is too simplistic. The assumptions relating to both approaches are frequently shared and overlapping. The third reason is that the distinction between the two approaches relates to the treatment of data rather than the research method itself. In addition, quantitative and qualitative methods have a tendency to “shade” into each other, such that it is very rare to find reports of research which do not include both numbers and words (Punch, 1999).

Qualitative and quantitative methods may sound to be opposites derived from different philosophical views, but both are justifiable tools of social research, providing insights into human behaviour. It should be appreciated that one approach is neither better nor poorer than the other; they are simply complementing each other (Gill, 1997). The choice of which method to apply should be based on the informed understanding of the suitability of the method for that particular research topic. Each method uses a specialised form of data collection that is different from the others, and can also provide information the other methods cannot offer. Thus, all methods are useful, relevant, effective and are to be considered as supplementary to each other (Sarantakos, 1997).

There are many different types of qualitative and quantitative techniques in social research. Cook and Reichardt (1979: 39), for instance, state that “by quantitative methods, researchers have come to mean the technique of randomised experiments, quasi-experiments, paper and pencil objective tests, multivariate statistical analyses, sample surveys, and the like. In contrast, qualitative methods

include ethnography, case studies, in-depth interviews and participant observation”.

7.2 The adopted approach

In order to explain the adopted method used in this research it is important first to recall its aim. The central theme of the research is to investigate the role of indigenous technological capabilities on the success of imported technology to developing countries, with particular emphasis on the water and electricity sector in Kuwait (a governmental sector). The study is also an attempt to understand how local technological capabilities can be assessed, enhanced and adapted to accommodate the new transferred technology.

There were very few references in the literature that have discussed the significance of the acquisition and the absorption capabilities for developing countries in general, and in the GCC countries in particular. Moreover, there were also very few studies that emphasised the assessment of these capabilities in order to understand their effect on the acquired technology in Kuwait (see for example Al-Sultan et al. ,1999). Thus, the researcher possesses a low degree of understanding of the problem situation. As a result, the nature of this research can be described as exploratory. Exploratory research is “usually undertaken when there is not enough information available about the research subject” (Sarantakos, 1997: 7). Punch (1999) sees exploration as a process that is useful for developing an accurate picture of the research object. In certain cases exploratory research is undertaken in order to provide a basis for further research, while in other cases it is undertaken to gain information on the issue itself.

Punch (1999) observes that exploratory studies are characterised by focusing on evolving hypotheses and propositions for further inquiry and by “what” questions. A similar view is proposed by Blaikie (2000) who perceives a case study as an

analysis of a phenomenon that can be an event or a range of interlinked events in which the researcher can identify some theoretical principle in practice.

Since exploratory research constitutes a central element of the qualitative methods and offers assistance in formulating and testing hypotheses and theories (Punch, 1999; Strauss and Corbin, 1998 and Blaxter et al., 2001), it was decided that the qualitative approach would be the most appropriate one for this research.

As stated previously, several research methods are associated with the qualitative approach, among which is the case study. Case study method forms the basis for this research. A brief illustration of this method and the justification for applying it in this research is presented in the next section.

7.3 The case study method

Case study is a method that is widely employed in qualitative research. In keeping with other approaches in qualitative research, the case study aims to understand the subject in depth in its natural environment and recognise its complexity and its context. It is a strategy where, most of the time, the research questions are “How?” and “Why?” (Punch, 1999 and Yin, 1994). Case study method enables the researcher to focus on a contemporary phenomenon, taking into account the context in which it is located, without having much control over the setting. In this kind of strategy the boundary between phenomena and context is blurred and several techniques of data collection can be used (Yin, 1994).

Yin explains three basic conditions that affect the selection of case study method (see Table 7.1):

- the type of research question posed
- the extent of control an investigator has over actual behavioural events
- the degree of focus on contemporary as opposed to historical events



Illustration removed for copyright restrictions

Table 7.1 Relevant situations for different strategies
Source: Yin, 1994: 6.

From Table 7.1 it can be noticed that case study is suitable for research that focuses on “how” and “why” questions, has no control over behavioural events and focuses on contemporary events. These three conditions can be applied to this research as follows. First, this research tried to answer questions of how rather than what, who or where. The question for the research was “how can public sector organisations in developing countries assess their capability to acquire and absorb imported technology?” Second, this research was conducted in a real-life situation and the investigation focused on contemporary events (the assessment of technological capability of a public sector firm in a developing country). Finally, the research had no control over behavioural events. Vaus (2001) further adds that case studies are considered useful tools for collecting information and hypotheses formulation. Gummesson (1991) stresses that the use of the case study for research purposes is also becoming increasingly widespread in management research. In many countries, doctoral theses dealing with marketing, strategy, organisation, and so forth are often based on

case studies. Furthermore, according to Hipkin (2004), case studies are widely used in technology transfer researches.

Patton (1990) is of the opinion that case study method suits research in developing countries where research based on academic literature is limited, and the data collection process through large scale quantitative survey may be impractical, time consuming and expensive.

Based on all of the above views, and to obtain richer data and outcomes through the qualitative approach, this research has used the case study method for formulation and testing of research hypotheses .

7.3.1 Advantage of case studies

Sarantakos (1997) identified four criteria that distinguish a case study from other methods, as follows:

Openness. This refers to the openness of the qualitative research to all aspects of the research process. The action of research has no restrictions or standardisation, which could be limited by or be directed to predetermined goals or paths of action.

Communicativity. This means that case studies perceive reality as emerging through interaction between researcher and respondent, who are working together for a common goal. Communication and action represent reality. This reality is grasped and recorded by the researcher.

Naturalism. Being an aspect of qualitative research, naturalism signifies the trend to investigate relations in their natural status, as they appear in everyday life.

Interpretability. Social reality is defined as “interpreted” reality and not objective reality. Only interpreted reality becomes meaningful and significant for the research.

An increasing number of researchers, as cited by Sarantakos (1997), who have employed case studies in many contexts, stressed a number of uses of this method as follows:

- they offer supplementary information
- they offer valuable information on cases prior to the undertaking of the study
- they illustrate larger studies by offering insights into specific aspects of these studies

This wide range of applications of case studies makes them a valid form of research and a useful method of data collection (Sarantakos, 1997).

7.3.2 Criticism of case studies

A common criticism of the case study concerns its generalisability. This criticism does not reflect the fact that case study is a research method that intends to test and improve hypotheses and theories through the collection of empirical data. It is “generalisable to theoretical propositions and not to populations or universes” (Yin, 1994: 10). Punch proposes two main ways that allow case studies to produce generalisable results. The first is by conceptualising. To conceptualise means that the researcher develops one or more new concepts to explain some aspect of what has been studied. The second way is developing hypotheses. To develop hypotheses means that, based on the case studied, the researcher puts forward one or more hypotheses which link concepts or factors within the case. These can then be assessed for their applicability and transferability to other situations. “In both instances, the finding from a case study can be put forward as being potentially applicable to other cases” (Punch, 1999: 154).

The second frequent complaint is the problem of bias. It is argued that case study provides no way of preventing the researcher's bias from influencing the analysis of the collected data. Yet, the same problem exists when conducting experiments, designing a questionnaire or conducting historical research (Yin, 1994).

The third criticism is that case studies consume a lot of time and generate massive amounts of data that are difficult to analyse. Yin argues that this view may incorrectly confuse case studies with other data collection strategies, such as participant observation and ethnography which normally require long periods of time in generating the required data. As he explained, case study does not depend solely on these two techniques: "one could even do a valid and high quality case study without leaving the library and the telephone, depending upon the topic being studied" (Yin, 1994: 11).

7.3.3 Case study design

Research design is the logical linking of the research question to the data collection and analysis. According to Yin, designing for case studies comprises five important components:

1. the study's questions
2. its propositions or hypotheses, if any
3. its unit of analysis (e.g., person, organisation, country, etc.)
4. the logic linking the data to the propositions or hypotheses
5. the criteria for interpreting the findings

The above components were implemented in this research as follows. As a guideline for building up the research strategy, the following general question was proposed: "*How can public sector organisations in developing countries assess their capability to acquire and absorb imported technology?*".

Four hypotheses were formulated as a result of the data collected in phase one (Chapter 8). A hypothesis is “an assumption about the status of events or about relations between variables. It is a tentative explanation of the research problem, a possible outcome of the research, or an educated guess about the research outcome” (Saranatakos, 1997: 134). The purpose of formulating hypotheses in this research was to offer a framework when collecting and interpreting the data. In this sense, the formulated hypotheses contained a possible solution to the research problem, which were tested by the evidence gathered by this study, as demonstrated in the following two chapters.

The Ministry of Electricity and Water represented the unit of analysis for the case study.

Although the first three components are obviously clear, Yin states that for case study design there is no sufficient detailed guideline to conduct the last two components, so it is left to the researcher’s best judgment.

There are several sources of data in case study research. Among these are documentation, direct observation, participant observation, interviews, archival records and physical artefacts. A combination of interviews and documentation collection techniques were used in this research. This combination had the advantage of the methods complementing each other and establishing the authenticity of the research findings by triangulation. Also, it allows the addressing of a broader range of historical, attitudinal and behavioural issues. Thus, the conclusion is likely to be more “convincing and accurate” (Yin, 1994). Both of these techniques are described below.

Interviews

Interviewing is one of the most common approaches in social science research and has been applied extensively by many researchers. It is an excellent method

of accessing and understanding people's perceptions, meanings, definitions of situations and constructions of reality (Punch, 1999).

For a case study, interviews are one of the most important sources of information (Yin, 1994). They are a form of questioning characterised by the fact that it employs verbal questioning as its principle technique of data collection (Marshall, 1997).

The importance of interviews is summarised by Burgess. He argues that interviews entail the researcher probing deeply into the problem to uncover new clues, open up new dimensions and secure vivid, accurate inclusive accounts that are based on personal experience (Burgess, 1982 cited; Smith and Lowe, 1999).

Interviews are considered an appropriate tool particularly in the following situations:

- where the required information is complicated or highly confidential
- where the researcher possesses easy access to the gatekeepers
- where the nature of the required information cannot be obtained with other techniques
- because it is necessary to understand the constructs that the informant uses as a basis of his/her beliefs about a particular matter or situation

The researcher tried to direct his effort to follow certain requirements for successful interviewing, such as being an active listener, looking interested, perceptive and sensitive to verbal and non-verbal cues. For example, in order not to lose potential interviewees, in many situations the researcher found himself obliged to show interest and respect and even ask questions that are in fact unrelated to the research topic, just because the interviewees insisted on talking about themselves and about subjects that were insignificant to the interview. In

addition, the researcher made every possible attempt not to jump to conclusions and to refrain from projecting his own opinions or feelings into the situation.

The major advantages of interviews are flexibility, high response rate, easy administration, control of the identity of the respondent and the opportunity to observe non-verbal behaviour (Birley and Moreland, 1998). However, the major limitation of this technique is that an interview is less effective than other methods when sensitive issues are raised (Gill, 1997). For example, people tend to write about sensitive matters rather than talk about them. Also, an interview is more costly and time-consuming than other methods, such as questionnaires, especially when analysing the collected data. Finally, prior to conducting the interview, preliminary field work is essential to determine the number of required interview sessions and their length. These matters depend on the verbosity of the interviewee, their willingness to talk and the value of what they are saying (Burns, 2000).

Following the general research question it seemed that interviews would be the most useful tool for the research. There are many factors that influenced the employment of the technique in this research. First, its flexibility: interviews can be adjusted to meet many diverse situations; second, interviews allow control of the environment under which the questions are answered; third, the more complex issues can be raised and discussed because the presence of the interviewer can assist in clarifying any misunderstandings (Bailey, 1987). The fourth factor is that the researcher had wide and close friendships with many senior managers and members of the labour force in the proposed organisation (Ministry of Electricity and Water) that entitled him to easy access to the key personnel in this sector.

There are many types of interview, each of which differs from the others in structure, purpose and role of the interviewer. Interviews can be mainly classified into three categories: structured, semi-structured, and unstructured (Frey and

Oishi, 1995). The main differences between them are the degree of structure, depth and standardisation of the interview.

This research adopted the semi-structured interview for several reasons. First, semi-structured interviews lie somewhere between unstructured and structured interviews, which means they contain the merits of both. Second, the interview questions are in a general form which get the interview going and keep it moving. Rather than having a specific interview schedule, or none at all, an interview guide may be developed for some parts of the study in which, without fixing wording or fixed ordering of questions, a direction is given to the interview so that the content focuses on the crucial issues of the study (Burns, 2000). Third, one of the major characteristics of semi-structured interviews is that there are no determined response categories and no fixed alternatives. This feature makes this type of interview useful in case studies because it gives respondents the necessary time to reply in a way they think more appropriate and allowing them to explain further if necessary. Finally, the task of question preparation is eased by the fact that there is no need for pre-established categories for responding, since some issues are extremely difficult to categorise.

Two methods are normally applied in recording the content of interviews; written note taking and tape-recording. Both techniques were used in this research, with more emphasis on tape-recording for the following reasons. First, tape-recording allows concentration in the interview, so the researcher can focus on the interviewee, give appropriate eye contact and non-verbal communication. Also, it helps preserve the interview for future recall and evaluation if needed. Lastly, tape-recording is an advantage when the researcher lacks the skills for note taking, such as speed (Blaxter et al., 2001). This is a problem that the author suffers from, in spite of practising. Tape-recording may, however, make respondents anxious and less likely to reveal important information. Fortunately, this wasn't the case in this research. None of the respondents rejected the request of using the recorder during the interview, except a few of them who

requested that the recorder be switched off once or twice during the interview. In fact, three of the interviewees requested a copy of the tape. The other drawback of tape-recording is that it takes a long time to transcribe and analyse. This problem is illustrated in more detail in the next sections.

The role of note taking in this research was limited to the documentary recording of any emotional expression of the interviewees. As Baily (1987) points out, in some cases this is thought to be important because some expressions and words may have useful meanings in the context of the issue being investigated. In addition, note taking was applied when the respondents requested switching off the tape recorder during some intervals in the meeting.

It is worth noting that at certain points in the data collection stage face-to-face interviewing was not feasible. Hence, the interview question was mailed to the respondents and the follow up with them was maintained through emails and telephone conversations. This process is described in more detail in Chapter 9.

Documentation

Documents, both historical and contemporary, have always been used as a rich source of information in social science. While some studies depend entirely on documentary data, other research, for example case studies or grounded theory, relies on collecting documentary data in conjunction with interviews and observations (Punch, 1999). In the context of the case study the relevance of documents is grounded in the fact that they can be used to confirm and augment evidence from other resources (Sarantakos, 1997).

Yin (1994) asserts that documents play an explicit role in any data collection when conducting case studies. He attributed this to three reasons. First, documents can be helpful in checking the accurate names or titles of organisations and any other related information that is involved in the field work.

Second, documents can provide evidence to corroborate data collected from other sources. Finally, inference, in some cases, can be reached through documents.

Documentary methods demonstrate a number of limitations and strengths (Strauss and Corbin, 1998). The most common limitations are as follows. Documents are not always complete or up to date. Also, some documents are not easily accessible. Moreover, documents in most cases are biased, since they represent their author's view. The major advantages of using documents are that they can provide high quality information, are more economical than other research methods and often they represent the sole source of information (particularly for past events).

7.3.4 Sampling in case study

Sampling is an important issue to be considered when doing social research, since it is usually impractical to study everything or everyone in the whole population. Sample size depends largely on the purpose of the research, what will be useful, what will have credibility and what can be achieved with available time and resources. Case study research is no exception. Although the selection of a case might be straightforward, sampling is required within the case because it is impossible to study everything about everyone in it (Punch, 1999).

According to Joyner and Onken (2002), there are no rules for sample size with respect to qualitative approach.

Punch (1999) stresses that probability sampling is rarely used in qualitative research. Instead, purpose sampling is often used, which selects samples in a deliberate way, with some purpose or focus in mind.

For case study research, sampling in general involves identifying the case, setting the boundaries by indicating the aspects to be studied and constructing a

sampling frame (Miles and Huberman, 1994). After that, the great variability makes a general description of sampling very difficult. As an example, sampling within a case involves selection of focus within the case being studied, whereas multiple case sampling is directed more at replication across similar and contrasting cases (ibid.).

Whatever sampling strategy is applied Punch asserts a clear principle that concerns the overall validity of the research design and stresses the fitting in of the sample with other components of the study: "There must be an internal consistency and a coherent logic across the study's components, including its sampling. The sampling plan and sampling parameters (settings, actors, events, processes) should align with the purposes and the research questions of the study" (Punch, 1999: 194).

As illustrated earlier the aim of this research was to assess the technological capability of the public sector in developing countries, with particular focus on Kuwait. Four cases were selected for this purpose. Three of these were considered as "minor cases" because they were involved in the preliminary phase of the data collection process and served as an introduction to the main case. The sampling frame of this research was focused on firms whose infrastructures are technology-based and are frequently involved in technology acquisition. Also, within each case, the decision was made to focus on personnel who occupy an executive position. This issue is illustrated in more detail in the next chapter.

7.4 Data analysis

"The most serious and central difficulty in the use of qualitative data is that methods of analysis are not well formulated. For quantitative data, there are clear conventions the researcher can use. But the analyst faced with a bank of qualitative data has very few guidelines for protection against self-deduction, let alone the presentation of unreliable or invalid conclusions to scientific or policy-

making audiences. How can we be sure that an 'earthy', 'undeniable', 'serendipitous', finding is not, in fact, wrong" (Miles, 1979: 591, cited Punch, 1999: 200). This statement clearly signifies the complexity of the process of qualitative data analysis.

According to Blaxter a "chronic" problem of qualitative research is that it is accomplished chiefly with words, not numbers. Words are "fatter" than numbers and usually have multiple meanings (Blaxter et al., 2001). It is very important for the researcher to realise that there are various ways of looking at and analysing social events, and therefore multiple perspectives and practises in qualitative data analysis. Hence, as Coffey and Atkinson (1996) point out, there is no single way or methodological framework to analyse qualitative data. Much depends on the purpose of the research and the integration of the method of analysis from the start with other research components.

Throughout the literature many strategies have been developed to assist researchers in analysing qualitative data. However, this research is interested in strategies that focus on case studies. Case study analysis according to Buehler (1985, cited: Miles and Huberman, 1994) is a process of working around a hypothesis, trying to find to what extent a hypothesis corresponds to the identified fact. If no correspondences exist, the hypothesis is reformulated. This process is a continuous one until a universal relationship is established. Yin indicates that analysis contains methods that in essence attempt to address the initial propositions of the research. He listed various techniques used for case study analysis (Yin, 1994). Another technique, and has some resemblance with the Buehler approach, is "explanation-building". In this technique explanation is based on a series of iterations. Initially, a statement or hypothesis is formulated about the subject. Then, the outcomes are compared with this hypothesis to verify any existing discrepancies. If discrepancies are recorded, the hypothesis is reviewed and revised according to the outcomes. This process is repeated as

many times as is needed. Several analysis approaches fall under this technique, as described below.

7.4.1 Interview analysis

For qualitative research data analysis can be achieved either during or after the collecting of the data. For the interview method the data analysis normally commences when the data collection process is completed. This is because the information only makes sense when interviews are transcribed.

Broadly, the task of analysing interviews involves two closely related processes: managing the collected data and analysing them by abstracting the important information from these data.

The major task in managing the collected data is transcribing. Transcribing is the process of converting verbal words into readable format. It is recommended that this transcribing of the tape is done at the end of each interview before proceeding to the next one. Dunne (1995) suggests several advantages for this. First, it assists in overcoming the problem of the mass of data resulting from interviews. Second, the interview is still fresh and the researcher can add his own comments on what was said and how the interviewee was looking and behaving at that time. Next, any missing or significant piece of information can be identified and followed up straightaway with the interviewee instead of letting time elapse until the memory fades. Finally, the sooner the interview is transcribed the sooner a researcher can proceed to the next stage of the analysis.

This approach was employed in this research as follows. Since all of the interviews were tape recorded, the interviews were transcribed at the end of each interview session. Next, the transcripts were checked, edited and prepared for analysis. Prior to analysing the data each interviewee was provided with a copy of the relevant transcript for comment. This procedure was deemed necessary to

minimise bias. There were minor changes to the content of these transcriptions after they were collected from the respondents.

It is well known that transcribing a tape's content is time-consuming. Therefore, writing the transcription directly onto the computer and then moving relevant blocks of text to fit into the writing has proved to be a useful technique in reducing the required time.

Following transcription, the next step is analysing the data. During the analysis process of the interviews the focus was on identifying emerging patterns concerning various issues, such as organisational policy, technology transfer process, technological capability assessment, accumulated know-how and know-why, and so forth. In order to achieve this, this research has adopted a common model developed by Miles and Huberman (1994) in phase one and in part one of phase two of the data collection process. For part two of phase two the data were analysed using the criteria that was established in the Panda and Ramanathan model (see Chapters 8 and 9 for more analysis details).

Miles and Huberman label their approach "transcendental realism". This approach has three components: data reduction, data display and drawing and verifying conclusions, as depicted in Figure 7.1. Miles and Huberman consider these components as three concurrent streams or activities, interacting throughout the analysis. The model and its implementation in this research can be summarised as follows:

- *Data reduction*

As a part of the analysis process, data reduction occurs continually throughout the process. The main objective is to reduce the amount of collected data without stripping the data from their context. Data reduction can be achieved through editing, segmenting, categorising, summarising, coding, memoing, theme finding, conceptualising and explaining. For the purpose of this research the data was

edited and categorised into three groups; technology strategy, technology transfer and indigenous technological capability.



Figure 7.1. Components of data analysis: transcendental realism model
Source: Miles and Huberman (1994)

- *Data display*

Because qualitative data are typically bulky, dispersed and voluminous, data display helps in organising, compressing and assembling information. Miles and Huberman regard data display as essential and a major avenue to valid qualitative analysis. Data can be displayed in different ways, such as in diagrams, graphs, networks, charts, tables, etc. Displays are used at all stages of data analysis, since they enable the organising and summarising of the information and show the stage that the analysis has reached.

In this research the data was displayed using diagrams and tables to investigate any existing relations or patterns between the above three groups, as shown in the next two chapters.

- *Drawing and verifying conclusions*

The aim of data reduction and display is to assist in the interpretation of data and the drawing of conclusions that will answer the research question satisfactorily. This step is one of the most significant in the research. The type and direction of the actual interpretation is left exclusively to the researchers, since there are no existing rules that have been developed to guide them (Bryman, 2001). Nevertheless, Miles and Huberman have proposed tactics that can be used to generate meaning, testing and confirming findings. The tactics that were implemented in this research are clustering, counting and noting relationships between variables. Clustering means that processes, events, opinions and sites that have similar characteristics must be sorted into categories and grouped together. Counting is when the presence and frequency of occurrence of significant events is identified. Finally, noting relationships between variables can be achieved by identifying the relationship between variables through the using of matrix displays or other similar ways. The implementation of these tactics in this research is demonstrated in Chapters 8 and 9.

7.4.2 Documentation analysis

Documents, whatever their nature (statistics or words, official or unofficial, public or private), cannot be taken at face value. They are artificial and partial accounts, which need to be critically assessed for research purposes (Blaxter et al., 2001).

Documentary analysis proceeds by extracting from each document those elements which are considered to be important or relevant and grouping the findings together or setting them alongside others that are believed to be related (ibid.).

For documentation analysis, the content analysis method was employed in this research. This is a method that aims at qualitative (or quantitative) analysis of the content of texts, graphs, pictures, films and tables. Content can be analysed by

the application of two techniques: manifest content or latent content or both (Sarantakos, 1997). The manifest content refers to the visible, surface text, the actual part of the text as manifested in the document. The analysis here involves the visible content of the document and counting frequencies of appearance of the research unit.

The latent content is the underlying meaning conveyed through the documentation. The researcher focuses on significance messages, meaning and symbols that are hidden between the lines.

After ascertaining the unit of analysis (in this case the documentation related to the Ministry of Electricity and Water), items that appeared to be important and meaningful to the research question were identified and evaluated.

7.5 Pilot study

A pilot study is a small-scale replica and rehearsal of the main study. The aim of a pilot study is to discover possible weaknesses, inadequacies, ambiguities and problems in all aspects of the research, so that they can be corrected before the actual data collection process commences. This can be achieved through the testing of the research methods and research instruments and their suitability.

In addition, a pilot study assists researchers in familiarisation with the research environment in which the research is to take place.

Many authors in the literature assert that pilot studies are not usually employed within the context of qualitative research. However, a pilot study may be chosen according to the personal convenience of the investigator (Marshal, 1997; Oppenheim, 1998; Blaxter et al., 2001).

It was thought that a pilot study was needed for this research to refine the data collection plan with respect to both the content of the data and the procedures to be followed.

The employment of a pilot study in this research produced several advantages. First, it helped to assess the accessibility of the respondents in the three Kuwait ministries (refer to Chapter 8 for more detail). An initial visit to these ministries had led to the refinement of the interview candidates' list. Initially, by using the organisation structure of these ministries, a list of interviewees was written which contained all the key leaders in these ministries, i.e. the ministers, the under-secretaries (US) and assistant under-secretaries (AUS). During the pilot study it was found that it was impractical to interview all the personnel on the list for various reasons (sickness, unavailability, vacant position, etc.).

Secondly, the pilot study helped in evaluating the convenience of the site. Thirdly, the wording of the interview questions was tested and rephrased accordingly. Finally, and most importantly, the pilot study assisted in determining the unit of analysis. Initially, the researcher intended to select the Ministry of Oil to be the case study of the research. The reason for this was that the oil industry is the largest and the most vital sector in Kuwait. Also, this sector is frequently involved in the procurement of advanced technology. However, the pilot study revealed that it would be impractical to use the Ministry of Oil as a case. The geographical locations of the ministry and its peripheral departments (plants, refineries, storage centres, etc.) are not easily accessible due to stiff security procedures. Furthermore, officials in the ministry claimed that most of the information related to the contracts and contractors (which is essential for the research question) is regarded as confidential and access to the required data would be restricted. As a result the idea was abandoned.

The pilot study did indeed prove that the best candidate for this research would be the MEW.

7.6 Expert group

In phase one and two of the data collection process (explained in Chapters 8 and 9) the researcher attempted to evaluate the awareness of various concepts among the executive personnel in the selected ministries. For testing purposes of these concepts an expert group was utilised. The group consisted of five members. These members were selected from different sectors, as shown in Table 7.2. The members of the expert group were requested to define terms that would be used as a criteria to assess the responses of the interviewees. These terms are technological capability, technology transfer process, acquisition capability and absorption capability.

No.	Sector	Position
1	Kuwait Institute for Scientific Research (KISR)	Assistant General Director
2	Kuwait University (Faculty of Management Science)	Associated Professor
3	Bahrain Centre for Studies and Research	General Director
4	The Public Industrial Authority (governmental body)	Technical Projects Manager
5	Al-Ghanim Industrials (private company)	The General Manager

Table 7.2 The expert group

7.7 The adopted model

The Panda and Ramanathan model (1996) (introduced in Chapter 3) constituted the base for the main case study. It was used to study the technological capability profile of the Kuwaiti Ministry of Electricity and Water, as presented in Chapter 9.

A five-step procedure¹ has been suggested to assess the technological capability of a firm. The assessment procedure starts with the identification of the value addition stage that the organisation is currently involved in. Once this has occurred, the next step is to find specific activities in the value addition stages executed by the organisation. This process leads to the identification of the required technological capabilities. Step three involves the development of a set of indicators which can be utilised for the assessment.

As stated in Chapter 3 Panda and Ramanathan have illustrated their model through case studies of two firms in the electricity utility sectors. The model and these case studies were significant to the research as they provided a guideline for the implementation of the model in a developing country, i.e. Kuwait.²

It is worth mentioning that it appears that Panda and Ramanathan have specifically developed this model for firms in the private sector:

“In many regions of the world it is being transformed from a monolithic state-owned enterprise into a number of public-owned small companies. In many countries the government is in the process of playing the role of a regulator, while actual generation, and in some cases transmission and distribution, are moving into the hands of the private sector. ... In an increasingly free market, people are expected to choose the amount, type, and source of energy that will provide each desired service at least cost.” (Panda and Ramanathan, 1996: 561-563)

Therefore, part of the contribution of knowledge that this research may add is to test the applicability of this model in a public sector firm, as described in Chapter 9.

1. These steps are illustrated in Figure 3.2 in Chapter 3.

2. The authors have applied the model on a developing country firm (Electricity Generating Authority of Thailand (EGAT)) and benchmarked it against a developed country firm (Electricit— de France (EDF)).

7.8 Validity and reliability

The validity and reliability issues refer to the audit of the research. The attainment of these issues is one of the basic principles of management research. Validity is concerned with “the integrity of the conclusions that are generated from a piece of research” Bryman (2001: 30), whereas reliability is concerned with the question of whether the results of a study are repeatable (Sekaran, 2000).

Four tests are commonly used to establish the quality of any empirical management research. Among these tests, three are relevant to case study research,¹ as described below (Yin, 1994):

- **Construct validity:** establishing correct operational measures for the concepts being studied.
- **External validity:** establishing the domain to which a study’s findings can be generalised.
- **Reliability:** demonstrating that the operations of a study – such as the data collection procedures – can be repeated, with the same results.

The testing of construct and external validity and reliability for this research is as follows. Yin (1994) explains that construct validity can be increased through multiple sources of evidence, establishing a chain of evidence and letting key informants² review the draft case study report. The multiple sources of evidence in this case study were pilot survey, interviews and documentation which were also used to form a chain of evidence. Four key informants³ reviewed the case study report (i.e., this chapter), and agreed that the contents were appropriately justified. This process formed the construct validity.

1. For exploratory case studies only. An additional test would be needed for explanatory case studies.

2. Yin stresses that the participants of the case studies have to be among the informants.

3. Two of them were research specialists and the other two were the subjects of the study.

External validity deals with the problem of generalising a study's findings beyond the immediate case study. This issue has already been discussed in section 7.3.2. It is the objective of this research to generalise the outcome to embrace the GCC,¹ which would provide a basis for external validity.

Finally, the goal of reliability is to minimise the errors and biases in the research. Drew et al. (1996) propose ten steps to maintain reliability in research.² Based on these steps, this research has maintained points 4 and 5 regarding the internal reliability, and points 2, 4 and 5 regarding the external reliability. Consequently, the reliability for this research has been maintained.

7.9 Conclusion

An appropriate research methodology permits a research to be conducted systematically and smoothly, as well as to gain fruitful outcomes. This chapter reviewed various research strategies and methods relating to the purposes and nature of this research. It also described the methodology that was adopted in conducting this research.

Based on the literature review, this chapter designed and described the methodology adopted for conducting this research. Because this research was exploratory in nature with few prior empirical results from previous studies to guide the researcher, a qualitative approach was used to examine the issues that were the focus of the research. It was decided that a case study would be the most suitable method. Although the research is qualitative based some elements of quantitative measurement were used for verification purpose of certain results, such as the measurement of variability (range).³

1. Refer to Chapters 4 and 10 for more details.

2. See Appendix A for details.

3. See Chapters 8 and 9 for more details.

This research seeks to contribute to practice and theory in the technology transfer field through exploratory and hypothesis testing stages. The subsequent chapters present how the methodology was deployed in this research and the corresponding outcomes obtained.

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Chapter 8

Data Collection and Analysis (Phase one)

Introduction

As stated previously, part of the objective of this research was to assess the capability to acquire and absorb technology within the public sector in Kuwait, through the application of the Panda and Ramanathan model. The first step to achieve this was the assessment of the awareness of the technological capability concept among the public sector authorities. The term “awareness” hereby indicates the “knowledge” of all related aspects and components of technological capability, i.e. concept, recognition, development mechanisms, etc.” (Ernst et al., 1998: 24).

As described in Chapter 3, the existence of local technological capability has various advantages, among which are the ability of the organisation to identify its needs, the determination and selection of appropriate technology and the application of the appropriate channel of transfer. Furthermore, it sustains the organisation’s operation by reducing the cost of production or services and by improving reliability and maintenance procedures.

The Panda and Ramanathan model assumes that awareness of the concept and recognition of the potential of indigenous technological capability already exists among the decision makers in organisations. This assumption might be true for

the organisations in a developed country. However, this is not necessarily the case for organisations in developing countries as most of them lack the understanding and appreciation of the value of possessing a certain level of indigenous technological capability (Kondo, 2001; Abdulhaq, 1985).

Based on this view it was imperative to understand and analyse, prior to the application of the Panda and Ramanathan model, the level of perception of the decision makers in the public sector in Kuwait in terms of the awareness of indigenous technological capability and the recognition of its importance in the success of transferred technology. As a result, and in order to promote a better understanding of the research question, the data collection stage of the research was divided into two phases. Phase one (conducted in September to December 2002) relates to minor cases for three ministries belonging to the public sector in Kuwait. These are the Ministry of Health, the Ministry of Electricity and Water and the Ministry of Communications. The evaluation of the technology transfer process, the technological capability concept and the application of the Panda and Ramanathan model in MEW is illustrated in more detail in phase two (conducted in February to July 2003), which is described in Chapter 9.

It is worth noting that prior to phase one the researcher embarked on a pilot survey. A pilot survey in the form of an unstructured interview has been conducted with the former under-secretary of MEW (see Appendix B). The objective of the survey is to explore the relationship between imported technology and the indigenous technological capability in MEW.

8.1 Phase one

Phase one was structured to achieve two objectives. The primary objective was to explore the perception of the “technology transfer” concept at the executive level in the public sector in Kuwait. By executive level is meant positions where strategic decisions for technology acquisition are made. According to the

regulations of Kuwait's public sector, the decision-making process is normally limited to the ministers', under-secretaries' and the assistant under-secretaries' positions. It was found, during the pilot study (see Chapter 7), that personnel in lower positions – who are acting as advisers – were involved indirectly in the decision-making process. Undoubtedly, this necessitated the inclusion of these personnel in the data collection process.

In addition, and in order to understand the effect on the indigenous technological capability, the technology transfer process was also investigated.

The secondary objective of phase one was to evaluate the degree of awareness of the “indigenous technology capability” concept at the same level.

The above three ministries were selected for this phase from other ministries because their services are vital and necessary to Kuwaiti society. Also, the activities of these ministries are frequently linked with high and sophisticated technologies. All of the above ministries are entirely owned and fully operated by the Kuwait Government.

8.1.1 The interviews in the ministries

The methodology for phase one was mainly based on semi-structured, face-to-face interviews held with a range of officials from the three ministries including under-secretaries, assistant under-secretaries (AUS), general managers, chief engineers, operation managers, planning managers and branch managers. The interviews for phase one were conducted in various locations; the ministries' headquarters, departments, workshops and telephone switchboards (Ministry of Communications).

The procedures for conducting the interview data were as follows. At the beginning of each interview the respondent was briefed about the research

purpose and objectives, and all related terms, such as “technology”, “strategy” and “indigenous” were clearly defined to eliminate any misinterpretation. Also, the interviewees were requested to explain the nature and responsibilities of their jobs. As mentioned in the previous chapter, some interviewees were assured – upon their request – that their responses would be kept strictly confidential. The average duration of each interview was one hour, though some took a longer time. Some of the individuals asked to have a copy of the interview questions prior to the interview to prepare prompt answers. This necessitated the written translation of the questions from English into Arabic.

The total number of conducted interviews for this stage was 33, comprising 9 interviews in the Ministry of Health, 12 interviews in the Ministry of Communications and 12 interviews in the Ministry of Electricity and Water. The frequent involvement and acquisition of transferred technologies, the complexity of the existing technologies and the diversity of responsibilities are the main reason that more interviews were conducted with staff in the Ministry of Electricity and Water and Ministry of Communications than in the Ministry of Health. The interview questions are shown in Appendix D.

As mentioned earlier, the interview questions were structured to reflect respondents’ perceptions of two major issues: the concept of technology transfer and its success and the potential of indigenous technological capability.

The interviews held at the three ministries were as follows:

Ministry of Health (MoH)

No.	The interviewees	No. of meetings
1	The Under-Secretary	2
2	Assistant Under-Secretary (AUS) for Information Systems	1
3	AUS for Planning and Administration	1
4	AUS for Technical Affairs	1
5	The General Manager of Health Services	1
6	The Director of Anesthesiology Departments	1
7	The Director of Radiology departments	1
8	The Chief Engineer of Biomedical Services	1
Total number of interviews		9

Table 8.1 Interviews in MoH

Ministry of Communications (MoC)

No.	The interviewees	No. of meetings
1	The Under-Secretary	2
2	AUS for Sea Transportation	1
3	AUS for Land Transportation	1
4	AUS for Information Systems	1
5	AUS for Administration Affairs	1
6	The General Director of Postal Services	1
7	The General Director of Communication Networks	1
8	The Director of Operation and Maintenance (Communication)	1
9	The Director of Planning and Development	1
10	Chief Engineer of Digital Networks	1
11	The Branch General Manager of Al-Ali Telephone Switchboard	1
Total number of interviews		12

Table 8.2 Interviews in MoC

Ministry of Electricity and Water (MEW)

No.	The interviewees	No. of meetings
1	Ex-Under Secretary	2
2	AUS for Power Station and Distribution Plants Projects	2
3	AUS for Information System and Supervision	2
4	AUS for Administrative Affairs	1
5	AUS for Power Station & Distribution Plants (Operation & Maintenance)	2
6	AUS for Technical Services and Main Workshops	1
7	AUS for Planning, Training and Control Centres	1
8	Chief Engineer of Workshops (Electrical)	1
Total number of interviews		12

Table 8.3 Interviews in MEW

8.2 Interview outcomes

As stated in the previous chapter, part of the analysis process, which was adopted from the Miles and Huberman model (1994), was the implementation of clustering, counting and noting relationships between variables. The three tactics propose the grouping of similar responses (categorisation) and the use of a matrix display to identify any relationship that might exist between these categories and the counting of frequency of occurrence of significant responses. The application of these tactics in this research is illustrated in Table 8.4. The results were grouped into three categories: technology strategy, technology transfer and dependency, and indigenous technological capability as described below. Note that the “Respondents” column corresponds to the above interviewee list in the same order, i.e. No. 1 in the MoH column corresponds to the under-secretary, No. 2 in MoC corresponds to the AUS for Sea Transportation, etc.

8.2.1 Technology strategy

The legend for the “technology strategy” column in Table 8.4 is as follows:

“Yes” and “No”: represents the answers to the question regarding the existence of a technology strategy in the ministry and whether this strategy is documented or not.

“Work plan”: indicates the number of respondents who preferred to describe their strategy as work plan.

“Remarks”: contains miscellaneous responses of the interviewees.

According to 85% of the respondents (23 out of 27) none of the three ministries has an explicit or documented technology strategy. In fact most of the executive level personnel (63%) preferred to describe their planning process as a “work plan” rather than a “strategy”. In most cases the work plans contain information such as the up-coming tasks, the associated time frame of these tasks, the required manpower and the required budget.

The work plans are normally initiated by different sections and workshops at lower levels of the organisation and submitted upwards to the appropriate department for approval. Then departments at different levels of the organisation, after coordinating with each other, in their turn submit these work plans to the executive level for approval. Normally, the executive level sends feedback to the departments for more clarification or possible amendments before granting final approval of the work plan.

There is no due date for the initiation of the work plans; however, this course of action occurs annually since it is linked to the annual budget of the state and the ministry accordingly. Such “upward decision-making process” is illustrated in Figure 8.1. The executive level in Figure 8.1 indicates the centre of the decision-

Respondents	Technology strategy				Technology transfer						Indigenous technological capability				
	Yes	No	Work plan	Remarks	Def.	Depd.	Type	Adopt.	Succ. acq.	Succ.	Infl. factors	Def.	Importance	Relation to T.T. Success	
MoH	✓	✓	✓	crisis managt.	✓	✓	Turnkey	1 & 4	1 & 4	✓					
		✓	✓	wasted effort	✓	✓	Turnkey	1 & 2 & 3	2 & 3 & 5		1 & 2 & 3	✓	✓	✓	
	✓					✓	Collaboration	3	1		2 & 5				
	✓	✓	✓	wasted effort			Turnkey	2 & 4	1 & 4		3 & 4				
	✓	✓		crisis managt.	✓	✓	Turnkey	1 & 3 & 4	2 & 4 & 5	✓	2 & 3 & 6	✓	✓	✓	
	✓	✓		crisis managt.			Turnkey	1	1						
	✓	✓	✓	random actions	✓	✓	Collaboration	3 & 4	1 & 4		1 & 2				
	✓	✓	✓	random actions	✓	✓	Turnkey	1 & 2	2 & 5	✓					
MoC	✓	✓	✓	wasted effort	✓	✓	Turnkey	1 & 3 & 4	2 & 3 & 4		1 & 2 & 3	✓	✓	✓	
	✓	✓		wasted effort		✓	Turnkey	4	3 & 5		2 & 4				
	✓	✓	✓	random actions		✓	Turnkey	2 & 3	1		3 & 6				
	✓	✓	✓	crisis managt.	✓	✓	Turnkey	1 & 2 & 4	2 & 4		1 & 2 & 4				
	✓	✓	✓	wasted effort		✓	Turnkey	1	1		4 & 6				
	✓	✓	✓	random actions		✓	Turnkey	2	2 & 3		1 & 2				
	✓	✓				✓	Collaboration	1	3 & 4	✓					
	✓					✓	Turnkey	4	1		1 & 3				
	✓	✓	✓	random actions		✓	Turnkey	2 & 4	3 & 4		1 & 5	✓	✓	✓	
	✓	✓	✓	crisis managt.		✓	Turnkey	1 & 2	1 & 2		3 & 5 & 6				
	✓	✓				✓	No idea	3	1		1 & 4 & 5				
MEW	✓	✓	✓	wasted effort		✓	Turnkey	2 & 3	2 & 4 & 5		1 & 4 & 6				
	✓	✓	✓			✓	Turnkey	1	1 & 5		1 & 2 & 3				
	✓	✓	✓	wasted effort	✓	✓	Turnkey	1 & 2 & 3	2 & 3 & 5		1 & 3 & 5	✓	✓	✓	
	✓	✓		crisis managt.		✓	Turnkey	1 & 3	2 & 5	✓					
	✓	✓				✓	No idea	1	1 & 5		4 & 5				
	✓	✓		random actions		✓	Turnkey	3	3		1 & 2	✓	✓		
	✓	✓	✓	crisis managt.		✓	Turnkey	1	2 & 3		3 & 4				
	✓	✓	✓	wasted effort		✓	Turnkey	2 & 4	1	✓					

Table 8.4 The interview matrix of phase one

making process (ministerial, under-secretary and assistant under-secretary levels). To further illustrate this plan assume that Workshop 'X' decides to purchase a specific item of equipment. It has to raise a request vertically to the relevant department. The request has to precisely specify the type of required equipment and also justify the chosen type in terms of its importance and relevance to the Workshop's function. The department then studies the request and upon approval submit it to the executive level for final approval.

Although the rest of the respondents were positive about the presence of a technology strategy they have agreed that it is not documented.

Some respondents (see Table 8.4) argued that it would be a "wasted effort" to set up a strategy without first resolving major impediments that are currently present in the organisation. "Hidden unemployment, bureaucracy, favouritism and nepotism and restrictions to the organisation's budget by the regulations of the Ministry of Finance" are a few examples of such impediments.

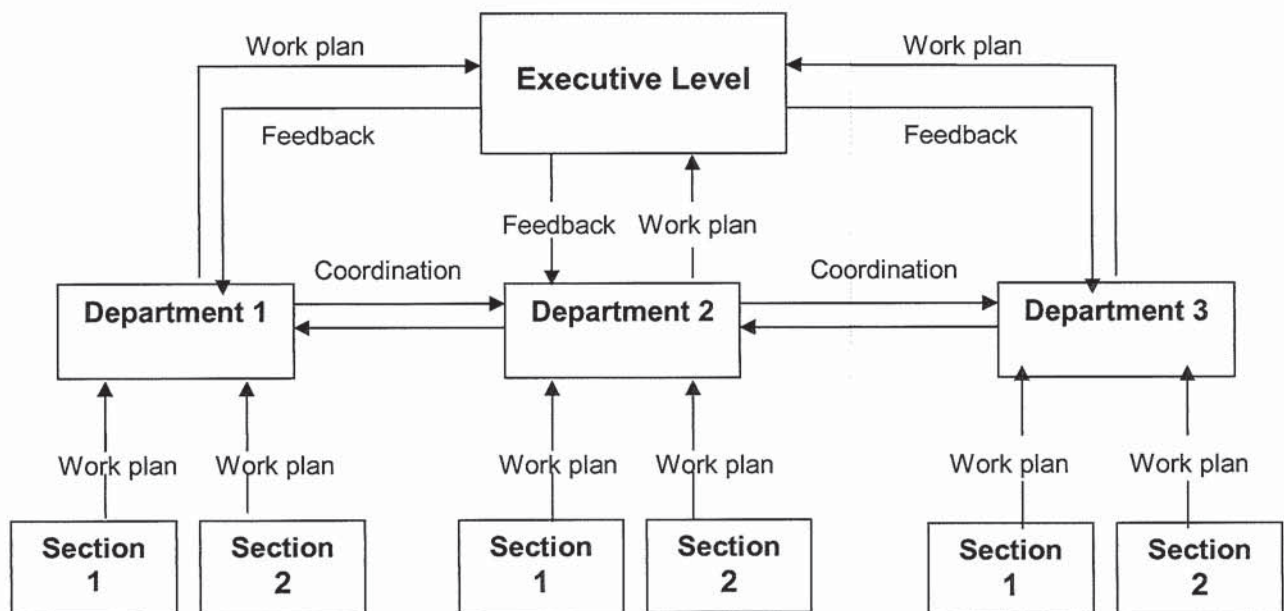


Figure 8.1 The upward decision-making process

Some respondents (22%) stated that due to the lack of an explicit technological strategy the nature of their work can be precisely described as a bunch of “random reactions to an action”. Other respondents (26%) asserted that their operations could be described as “crisis management”.

8.2.2 Technology transfer and external dependency

The legend for the “technology transfer and external dependency” column is as follows:

Def.: represents the number of appropriate definitions of technology transfer concept.

Depd.: represents whether the ministries are dependent on foreign contractors in the transferring process of technology.

Type: describes the dominant mechanism of technology transfer to the ministries.

Adopt: lists the objectives of technology adoption (the numbers correspond to points 1-4 below).

Succ. acq.: indicates factors that constitutes a successful transferred technology (the numbers correspond to points 1-5 on page 216).

Succ.: describes the status of the technology transfer process (success or failure).

Infl. factors: represents the major influencing factors that affect the technology transfer process (the numbers correspond to points1-6 on page 219).

All of the respondents agreed that the technology transfer process plays a vital role in the development of the public sector and its services in Kuwait.

Very few respondents (18%) were able to provide the appropriate definition of technology transfer (see Chapter 2 for definition). In general, respondents perceive the technology transfer process as the acquisition of the appropriate technology that assists the organisation to achieve its objectives. In their view, the occurrence of any of the following points¹ represents success in technology acquisition (refer to Table 8.4):

1. the physical movement of the hardware from supplier to the receiver within the specified duration
2. the satisfaction of local needs
3. the improvement of services and productivity
4. the ability to use all of its features
5. minimal cost incurred in the transfer process

For technology acquisition purposes, particularly for advanced technologies, the vast number of respondents (89%) stressed that the three ministries rely heavily on the foreign transferor for planning and implementing the transfer. They have also indicated that the ministries usually depend on the transferor for the operation and the maintenance of the technology for a specific duration, which is normally defined as between one to three years. The local staff should take over at the end of that period after accomplishing the necessary training. However, this is not usually the case, as most of the respondents pointed out. Practically speaking, the ministries favour the extension of the contract period to ensure the smooth flow of the services provided. According to the respondents, this is mainly attributed to the weakness of the training programmes, the limitation of the technical skills of the trainees and more importantly the unwillingness of the contractor to cooperate with the trainees since this could jeopardise its interests. Respondents agreed that such dependency for decades on foreign contractors is mainly because of the lack of the required technical skills and know-how.

1. *ibid.*

Based on their answers, the major objectives of technology adoption can be summarised as follows¹ (see Table 8.4) :

1. to provide the public with excellent, sophisticated and vital services
2. to save on costs
3. to improve the quality of services
4. to help meet the shortage in skilled labour

When the respondents were asked what factors contributed to the success of the transferred technology their reply was similar to the above points except for two respondents (from the Ministry of Communication) who emphasised the importance of the technology supplier understanding the environment and social structure of the recipients.

According to all respondents the technology acquisition process occurs on a continuous basis. The duration of acquisition varies according to the complexity of the technology.

Furthermore, 82% of the respondents concurred that turnkey is the dominant mechanism of technology transfer to Kuwait for the following three reasons:

- the abundance of financial resources
- this type of transfer takes less time
- it is more efficient, in terms of transferring and installing the technology, than other mechanisms.

Based on the discussion with respondents, the technology transfer process can be summarised as follows. The selection and transfer process of the required technology is initiated by assessing the needs of the organisation. Next, the required specification is drawn up. Then, a request is submitted to the

1. The points were ranked according to the frequency of occurrence with the highest score being at the top.

appropriate level for approval along with the required specification and a justification memorandum.

After being approved a bidding request is initiated for tenders. The successful bidder has the full responsibility of transferring, installing, operating and maintaining the acquired technology. In addition, the bidder has an obligation to provide the necessary means of technical training to the local personnel.

The majority of respondents agreed that in the past the role of local staff in this process in most cases was limited to administration and legal issues. However, they assured me that this approach has changed. Accordingly, in recent years local staff were continuously encouraged to participate in the technology transfer process with the aim of gaining the necessary experience. As a result, in recent projects experienced local staff are officially involved in needs assessment, setting specifications, the negotiation process and on certain occasions the physical transfer of the technology.

Some respondents pointed out that such an approach at times had proved to be a disadvantage. In some cases some local staff had been involved in unethical practices by submitting false comments in favour of rival companies when they were consulted.

Notwithstanding, 78% of the respondents (see Table 8.4) shared the opinion that the technology transfer process to Kuwait cannot be described as successful for many reasons. First, because of poor decisions taken by some authorities; they argued that in many cases decisions for the adoption of the required technology were inappropriate. Normally, these decisions are very costly and consume a lot of time and effort. As a result, the overall performance and productivity are degraded. As an example of poor judgment of decisions, the Under-Secretary of the Ministry of Communications stated that he had discovered – upon his appointment to this position – that some of the newly installed communication systems for land lines, which cost millions of US dollars, were not compatible with the infrastructure of the country and only about 20% of their features were

utilised. This clearly indicates, according to him, that “the assessment and the selection process of this technology were incorrect”.

Second, some respondents believed that some imported technologies are not appropriate for the Islamic climate of the society. Their argument is that these technologies are embedded with new norms, values and paradigms which are considered alien to the local society. For example, they mentioned that although the Internet technology has numerous benefits it allows easy access to sites encouraging immorality and violence.

Finally, two respondents in MoH stated that in some cases the operational and maintenance expenses of a technology many times exceed the costs of its acquisition. To further elaborate, they mentioned one incident when the purchase price of a sophisticated supplemental machine for an X-Ray device in one of the Ministry of Health departments was US \$ 97,000. One of the major components in this machine is so delicate and vulnerable (they attributed it to a possible defect in the design of the component) that it has to be replaced frequently, at least twice annually. The cost of the replacement is about US \$ 33,000. This implies that after 18 months of using this machine the operation and maintenance cost (US \$ 99,000) has exceeded the original purchase price. Therefore, the acquisition process of this technology was not a success at the outset, since it was not reliable.

Respondents generally attributed these “failures” of the technology transfer process to Kuwait to the following factors (see Table 8.4 for details). The points were ranked from high to low according to their frequency of occurrence.

1. the lack of necessary technical and managerial skills
2. the inabilities of some high authorities to take the right decision
3. the presence of strong “political lobbies” which interfere and disturb the decision process

4. the lack of technical knowledge and experience
5. some managers have failed to consider crucial issues when making decisions, such as social, cultural and environmental ones
6. in most of the cases local staff (especially the technicians) do not take over the work from the foreign contractor at the end of the contract as planned

To further clarify point 3 above, almost half of the respondents (48%) raised a serious issue that the “political lobby” in Kuwait uses its influence to manipulate the decision-making process to its favour. For example, ministries on several occasions – under political pressure – had awarded contracts to foreign bidders in spite of the fact that this bidder was not qualified and did not satisfy most of the conditions of the bid. As a result, ministries ended up with technologies that did not meet their requirements. Although such trends might be witnessed in one way or another in the industrialised countries, none the less the phenomenon is widespread in developing countries, mainly due to the absence or weak performance of legislative authorities.

The remainder of the respondents argued that technology transfer was successful because it assisted in establishing the infrastructure of the country and provided prosperity to the Kuwaiti community.

8.2.3 Indigenous technological capability

The legend for the indigenous technological capability is as follows:

Def. : indicates whether respondents provide the appropriate definition.

Importance: indicates the number of respondents who regard indigenous technological capability as important to the public sector.

Relation to T.T. : represents respondents who support the notion that there is a crucial relationship between indigenous technological capability and the success of the transferred technology.

Very few respondents (4 out of 27) were able to give a clear and accurate definition of technological capability (see Chapter 3 for the adopted definition). The focus of these definitions was mainly on the innovation of new technologies.

Regarding the relationship between technological capability and the success of transferred technology, as is shown in the above section, only 18% of respondents mentioned the importance of these capabilities in the success of the transferred technology.

The majority of respondents (78%) thought that indigenous technological capability is not critical to the public sector. They argued that the public sector normally functions well without the need to possess technological capability. Some of the respondents even argued that it would be wasted time and effort if the public sector makes an attempt to develop indigenous technology as long as the technology is available in the market and can be obtained easily.

Although the remainder of the respondents claim that they do appreciate the importance of indigenous technological capability, they failed to present evidence to support that claim, except in the field of personnel training. Respondents assured that it was part of their responsibilities to provide the necessary means to develop the essential skills of local staff to operate and maintain the acquired technology. Therefore, they continuously assessed the performance of staff and aimed to expand their abilities through training courses, international conferences and workshops.

It is worth mentioning that 34% of the respondents have raised a potential issue; the role of motivation in enhancing employee productivity. They have expressed

their anxiety about the overall productivity and performance of the workforce. They have assured that the current incentives¹ are not sufficient to stimulate employees to improve their performance, particularly the technical staff, i.e. the engineers and technicians. They have recommended that the government could either introduce better incentive schemes or head for the privatisation of the ministries.

8.3 Conclusion of phase one

As has been illustrated and discussed above, this phase was an attempt to identify the perception of the decision makers in the public sector of two major issues: technology transfer and indigenous technological capability. The outcome of this phase reveals that the public sector in Kuwait suffers from a deficiency in managing the technology. This deficiency is symbolised in three major issues: technology strategy, technology transfer and technological capability. A discussion of each of these issues follows.

8.3.1 Technology strategy

It is widely recognised that the development and adoption of an appropriate strategy for effective transfer and utilisation of imported technologies is essential (Dahlman and Westphal, 1984). The results show that none of the three ministries, MoH, MoC and MEW, has an explicit, well-formulated and documented technology strategy.

Most of the developing countries do not appear to have established the necessary procedures to employ fully effective strategies and policies for successful transfer of technology (Salami and Reavill, 1997). In the case of Kuwait, it seems that despite realising the great importance of technology for the development of the country's infrastructure, the Kuwaiti Government did not

1. Incentives such as the basic salary, annual bonus and promotion system.

employ strategies for transfer and dissemination of technology to the public sector. The absence of a national technological strategy represents a major drawback and causes obstacles to successful technology transfer to Kuwait (Al-Otaibi and Al-Sultan, 2004; Al-Sultan, 1984).

8.3.2 Technology transfer

Albeit that Kuwait faces no difficulties with regard to Flow A and Flow B according to Bell's classification¹, it is evident from the interviews that technology transfer to Kuwait suffers various difficulties and in many cases is considered to have failed. Recall that the mere importation and operation of the hardware does not constitute successful transfer of technology. In fact, the combination and the systematic integration of the two elements, that is the hardware and the tacit knowledge, represent a major factor in the success of the transferred technology.

The interviews clearly indicated that there is a deficiency in the decision maker's understanding of the technology transfer concept. Generally speaking, the technology transfer process in respondents' perceptions is limited to the acquisition of hardware with very little or no consideration for the other elements, such as know-how and accumulated experience. In other words, technology transfer, in their view, is restricted to the tangible material artefacts. Levin has an interesting argument in this matter. To quote: "given this understanding, transfer of technology is restricted to moving 'things' from vendor or developer to an end user ... the challenges in technology transfer are to find the right and best equipment, buy it and install it. The problem is then limited to selecting from a vendor's portfolio the most profitable or efficient machines and tools. The rest of the transfer process is routine – install it, give employees some training, and high-quality products or services then turn out. However, all experiences from the field suggest that it may be not so simple and easy. Technology transfer consists of moving the physical objects, acquiring skills for operation and an

1. See Bell's classification of technology transfer in Chapter 2.

understanding of the knowledge and cultural understanding built into the machines” (Levin, 1997: 299).

In addition, it appeared that the authorities of the three ministries are unaware of the major advantages that normally yield from the technology transfer process, which is the acquisition of the imbedded know-how and the development of technological capability. This shortfall could be attributed to the ultimate dependency for decades on turnkey contracts and the low level of domestic participation.

Another very important issue is that the technology transfer process is mostly seen and being dealt with in a political light. It is widely known that the ultimate dependency on industrialised countries for the required technologies is viewed as a chronic and serious political problem. Such a policy of dependency has proven to have, in some cases, adverse impact on the technology transfer process, as seen in the case of Kuwait. Decision makers in the three ministries have overlooked the importance of a national technology strategy in coping with this problem.

Furthermore, and due to severe socio-political pressure, decision makers at these ministries can't risk providing low-level or incomplete services to the public, particularly in the health and electricity and water sectors (Al-Sultan, 1995).

8.3.3 Technological capability

There is a consensus that the international technology transfer process can only occur successfully and effectively when some or all of the capability related to a specific production process, product or service has been acquired or developed (Kondo, 2001; Paukatong et al., 2003). Capabilities, as described in Chapter 3, are made up of human skills, knowledge and accumulated experience. The interviews revealed that there is very little awareness and consideration of the

importance of indigenous technological capability on the success of transferred technology among the authorities of the public sector in Kuwait. In fact most of the decision makers in the three ministries misunderstood the concept of technological capability and confused it with innovation.

It is important to emphasise here that a successful transfer of technology involves much more than the physical movement and the operation of the hardware at the recipient location, particularly if it is accomplished by a foreign contractor. It involves all of the technological efforts on the part of the recipient to learn to operate and assimilate the transferred technology (Dahlman, 1987). As Levin pointed out, the major challenge in technology transfer is to use the transfer process as a vehicle for the establishment and development of indigenous technological capabilities (Levin, 1997).

The interviews also revealed that the three ministries are almost totally dependent on foreign firms when acquiring and operating the imported technology. Madu (1989) stressed that such dependency can be attributed to the weakness of the technological capabilities of the transferee. However, if a country relies heavily on foreign firms in the acquisition of technology it does not necessarily mean that there is no need to acquire or develop indigenous technological capability (Dahlman, 1987).

Respondents asserted that technology transfer to Kuwait experiences many problems. Despite giving logical reasons behind these problems, none of them mentioned the possible effect of the absence or weakness of indigenous technological capability.

Based on the outcome of the interviews, it seems that these ministries have neither shown interest in building up these capabilities nor have set up plans to acquire them in the future. This situation, as the interview results indicated, could be ascribed to the following reasons. First, the government did not draw up plans

or implement strategies for enhancing the level of indigenous technological capability through the transfer of technology. Second, the plentiful financial resources, which permit the purchasing of off-the-shelf technologies. Third, the urgent need for vast development of the infrastructure of the country with minimum risk and high quality. Fourth, the shortage of skilled personnel. Finally, the limitation of specific studies or research that emphasises the potential role of indigenous technological capability.

Although the result of phase one indicated the presence of noticeable levels of indigenous technological capabilities, it appeared that these were developed unintentionally as a result of the accumulated technology transfer process. Also, the level of these capabilities appears to be insufficient to support the technology transfer process to Kuwait.

During this phase a major issue was raised by some of the authorities, which is concerned with the principle of employee motivation. This issue is discussed further in Chapter 10.

8.3.4 Research proposition and hypothesis development

From the initial observations based on phase one the proposition can be formulated that “the absence of an explicit government science and technology policy and the lack of an appropriate level of technological capability in the public sector in Kuwait represent major obstacles to the transfer of technology to Kuwait”.

Since the effects of the absence of a sectoral strategy framework on the transferred technology to Kuwait have been investigated by other authors (see, for example, Al-Sultan and Al-Ali), the focus of this research is on the effect of technological capability on the international transferred technology to the public sector in Kuwait.

In light of the above proposition, the following hypotheses were formulated:

H1: The lack of awareness among the public sector authorities of indigenous technological capability constitutes an obstacle to effective transfer of technology to Kuwait.

H2: The lack of awareness, experience and proper assessment tools have prevented the public sector in Kuwait from assessing their technological capability.

H3: The lack of an appropriate level of acquisition and absorptive technological capabilities in the public sector constitutes an obstacle to an effective transfer of technology to Kuwait. It also perpetuates the dependency on foreign firms in transferring technology.

It is worth mentioning that the Panda and Ramanathan model was designed specifically for firms in the private sector (see Chapter 3). Consequently, this research is an attempt to evaluate the applicability of the model to the public sector. Hence, the following hypothesis was added to the previous ones:

H4: The Panda and Ramanathan model is applicable to the public sector in Kuwait.

Based on the above argument, phase two of the data collection stage was proposed. The aim of this phase was twofold. First, to investigate in more depth the technology transfer process and its consequences on the indigenous technological capability of MEW. Second, the awareness and the current status of technological capability of MEW were scrutinised. The outcomes of these investigations were used to test the research hypotheses H1 and H2. Furthermore, the third research hypothesis, H3, was tested by assessing the acquisition and absorption capabilities of MEW through the employment of the Panda and Ramanathan model.

It is important to state the rationale for selecting MEW. First, it represents one of the largest and fastest growing industrial sectors in Kuwait. MEW is highly associated with large volumes of trade in equipment and technical services which represent challenges in full utilisation of them. This implies that the sector is a good candidate as a whole to conduct such a study since it is frequently involved in large technical projects. Second, MEW provides vital services for the public, that is, water and electricity. Third, the proposed methodology was originally developed for firms in the electricity generation field. Finally, there is ready access to the required data in Kuwait.

The assessment process of acquisition and absorption capabilities of MEW was achieved through interviews with the executive level of MEW and the utilisation of the Panda and Ramanathan model. This process is illustrated in more detail in the next chapter.

Chapter 9

MEW Case (Phase Two)

Introduction

As described in the previous chapter, the data collection process consisted of two phases. Through the initial analysis of the three minor case studies in phase one it was evident that the technology transfer process to the public sector in Kuwait is not effective and endures several problems. As a result of this proposition four hypotheses were formulated. Testing of these hypotheses was the core of phase two.

Phase two was divided into two parts. Part one evaluated the MEW authorities' awareness of technological capability. Also, the technology transfer process in MEW was investigated to determine the degree of dependency on foreign contractors and to identify any difficulties incurred through the process. Part two assesses the technological capability of MEW through the application of the Panda and Ramanathan model and tests the applicability of this model to the public sector in Kuwait.

9.1 Part one

Part one commenced with a preliminary visit to MEW to identify the key personnel for interviews. The Assistant Under-Secretary (AUS) for power station and water distillation projects, who acts as a deputy to the Under-Secretary, was

supportive in providing the required data. He provided a list of key personnel who are considered to be at the executive level. The list comprised the following personnel:

1. AUS for information systems and supervision
2. AUS for administrative affairs
3. AUS for water projects
4. AUS for water (operation and maintenance)
5. AUS for power station and distribution plants (operation and maintenance)
6. AUS for technical services and main workshops
7. AUS for planning, training and control centres
8. AUS for electrical distribution networks
9. AUS for electrical transmission networks
10. Chief engineer of work shops (electrical)
11. Chief engineer of work shops (mechanical)
12. Director of water resources development centre
13. Director of training and manpower
14. Director of financial affairs
15. Senior manager of purchase and imports department
16. Directors of the power stations
17. Director of technical services
18. Director of study and research
19. Director of main workshops

He also made the official introduction to them and arranged all the necessary meetings. Five out of seven directors of the power stations were interviewed due to the unavailability of two directors (Al-Doha East station and Al-Shuaibah North station). The total number of interviews with the executive level personnel was 24. Each interview lasted approximately one hour, though a few of them lasted longer. The interview questions are listed in Appendix E. The outcome of these interviews is described next.

The analysis process for this part followed the same approach that has been discussed in Chapters 7 and 8, i.e. the implementation of the Miles and Huberman model (1994). The responses were grouped into two categories: awareness of technological capability and technology transfer process. The two categories are discussed further below. Refer to Table 9.1 for detail.

9.1.1 Awareness of technological capability

The “Resps” column in Table 9.1 corresponds to the above interviewee list in the same order, i.e. No. 1 in the table is the AUS for information systems and supervision in the list.

The legend of “Awareness of technological capability” column is as follows:

- TC:* the number of respondents who were able to define the term “technological capability”
- Acq:* the number of respondents who were able to define the term “acquisition capability”
- Absp:* the number of respondents who were able to define the term “absorption capability”
- Impt:* represents respondents who argued that technological capability is partially important (lower levels for organisation)
- Enhcmt:* respondents who argued that the technology transfer process has enhanced the technological capability of MEW. The numbers correspond to points 1-5 below (page 234)
- Ass. Crta:* indicates respondents who argued that MEW lacked the experience and assessment tools to evaluate its capability
- Familr:* indicates the number of respondents who were unfamiliar with the technological capability assessment issue
- Hind. Factors:* represents the attributed factors that hindered the acquisition or development of technological capability of MEW. The numbers correspond to points 1-10 below (page235)

Very few respondents (see Table 9.1) were able to define technological capability.¹ The rest of the definitions varied and mainly focused on the capability to design and develop a new technology. The following are the respondent definitions of the term “technological capability”:

- the ability to manufacture the required technology locally
- the ability to innovate
- the capability to modify imported technology to suit local environment
- the ability to produce new technology and sell it internationally
- the ability to manage technical projects independently
- the capability to qualify national cadre to replace foreign cadre

Most respondents were also unable, or failed to provide a full definition of acquisition capability and absorption capability, as is shown in Table 9.1. Consequently, the three definitions were clearly explained to the interviewees at this stage because the rest of the questions were dependent on their understanding of these concepts (see, for example, questions 3, 5 and 9 in Appendix E).

Sixteen (63%) of the respondents argued that indigenous technological capability is important for operation and maintenance purposes only. In other words, they considered it important for the lower levels of the organisation. The rest of them believed that it is important for every level of the organisation. However, they treated the indigenous technological capability concept as synonymous with nationalisation.

1. The following definitions (adopted from Chapter 3) were used as criteria to evaluate respondents' answers:

Technological capability: the knowledge and skills, managerial and technical, that organisations need to acquire, assimilate, use, and adapt new technology.

Acquisition capability: the ability to assess local needs, search, assess, negotiate, procure and transfer technology.

Absorption capability: the necessary capacity to better understand the principles of technology firms are using.

Fourteen (58%) of respondents were of the opinion that the accumulated technology transfer process had enhanced the technological capability of MEW through the following:

1. with more than 45 years experience, MEW has become an expert nationwide in the Multistage Flash technique (MSF)
2. the improvement of performance of operators and maintenance staff
3. the shortening of the learning process of technical staff
4. the enhancement of communications with vendors
5. strengthening of relationships with other governmental agencies or establishments, such as the KISR

Six (26%) of the respondents indicated that they have not noticed significant change since all of the executed projects were turnkey. The rest were unsure.

All respondents agreed that MEW lacked the appropriate experience and the necessary assessment criteria to assess their technological capabilities. In fact, 74 % of them pointed out that this is an issue that they had never considered or come across before. As a result, they were unable to systematically determine the current organisational capabilities to acquire and absorb technology.

In general, MEW authorities have two main criteria to evaluate MEW's capabilities. The first one is the uninterrupted rate of services provided by MEW. The second criterion is the rate of complaints from the public, particularly through the media. They believed that as long as these two criteria are within a predetermined acceptable level, it reflects the prompt performance of the ministry.

According to the respondents MEW has electrical, mechanical, and systems and equipment calibration workshops, which are run by local staff that are to a certain extent capable of repairing and maintaining the acquired equipment. However,

none of these workshops have the capability of manufacturing the required spare parts due to the lack of knowledge (the know-how).

Respondents have made it clear that their major priorities are to set plans that focus on the improvement of the skills of their human resources, mainly at middle and lower levels of the organisation. When they were asked what kind of skills they should focus on their reply was management and administration, the effective operation of the equipment and the maintenance procedures.

When the respondents were asked about the factors that have hindered the acquisition or development of indigenous technological capability their responses varied. The following points represent these factors:

1. this concept is relatively new to most of the public authorities
2. the influence of internal and external politics on the country
3. the absence of an explicit governmental technology policy
4. the interference of National Assembly (Parliament) members with ministries' policies and affairs
5. the overcoming of disguised unemployment
6. incentives are rare, especially in training programmes
7. the socio-economic structure of the country which seeks vast prosperity
8. the lack of expertise and specialists that are able to conduct studies and research in this field
9. the appointment of unqualified personnel to leading positions
10. some of the technology suppliers are not cooperative

To elaborate on the last point, the Chief Engineer of power station projects stated that the alignment of turbines with the generators is a delicate and very critical process. However, the installer keeps the procedures for this alignment secret,

despite the many requests from MEW's engineers¹.

Another respondent emphasised that the cut in the training budget has influenced staff skills. He gave an example of one of the condensed and highly specialised training courses for engineers which used to be held at the Central Electricity Generating Board (CEGB) in the UK. The duration of the programme was six months during which time the trainee served in various departments of the plant. This useful programme, he added, was terminated years ago.

In addition to the above points, the AUS for information systems and supervision emphasised one important issue. He believed that the resistance to change by various staff, particularly managers, is a critical factor in inhibiting technological capability development in MEW. For instance, his sector proposed the automation of the information systems in all MEW divisions. The objective of this project was to facilitate work, reduce paper work and speed up routine processes such as employees' attendance, performance evaluation and annual reports of human resources. Also, this process could save cost in some publications, such as the statistical year book. However, all attempts to execute this project were confronted by enormous resistance. In the end, very few departments were automated, which he considered as a total failure of the project. The main reason behind this resistance, as he perceives it, is the inability, especially on the part of senior managers, to deal with computers and software programmes such as word processing and sending and receiving emails. He believed that the execution of the project would expose their limited skills and abilities, and hence their career would be in jeopardy.

1. It should be appreciated that such practices from technology suppliers are common unless the agreement between the two parties specifies the degree of cooperation in this issue.

9.1.2 Technology transfer process

The legend for "Technology transfer process" is as follows:

<i>Acq:</i>	represents the degree of dependency (in percentage) on foreign contractors in the acquisition of technology
<i>Absp:</i>	represents the degree of dependency (in percentage) on foreign contractors in the absorption of technology
<i>Mod:</i>	represents the degree of dependency (in percentage) on foreign contractors in the minor modification of technology
<i>Avg:</i>	the average score (in percentage) of all respondents
<i>Rng:</i>	the variability measurement of the scores
<i>Succ:</i>	indicates respondents who argued that the technology transfer process was a success

Respondents stated that MEW is extremely dependent on foreign firms for transferring and operating the required technology. However, the degree of dependence varies according to the activities involved, as shown in Table 9.1. Respondents were requested to put their answers in the form of a percentage.

The technology transfer process that is described in this section is confined to the construction of a new power station. In this case, the Sabiya power station was selected to demonstrate the technology transfer process. The rationale behind this selection is attributed to three main factors. First, Sabiya station is the latest and the most advanced station compared with the others (it was commissioned in late 2001), which facilitates the collecting of the required data. Also, the data were up-to-date. Hence, the degree of accuracy of the assessment process will be augmented. Second, when an investigation about other stations was carried out it was found that the possibility of locating vital data for the research was very poor due to the loss of a large quantity of records during the occupation of Kuwait by Iraqi troops.

The third reason, which is significant, is that the AUS for power station and distillation plants projects stated that the process of building all of the stations was similar. He also added that the work procedures, both administrative and technical are almost identical. Therefore, he strongly recommended using the Sabiya power station as a representative case study. In fact he offered his assistance and full support in arranging the required meetings and granting access to the necessary data.

The installation of equipment and systems in Sabiya station necessitated nearly seven years from initial conception to final commissioning. According to the respondents' classification, the process of installing the Sabiya power station passed through various stages. These stages are: needs assessment, consultation bidding, feasibility study, specifications setting, bidding issue and awarding, supervising and monitoring and project commissioning, as depicted in Figure 9.1.

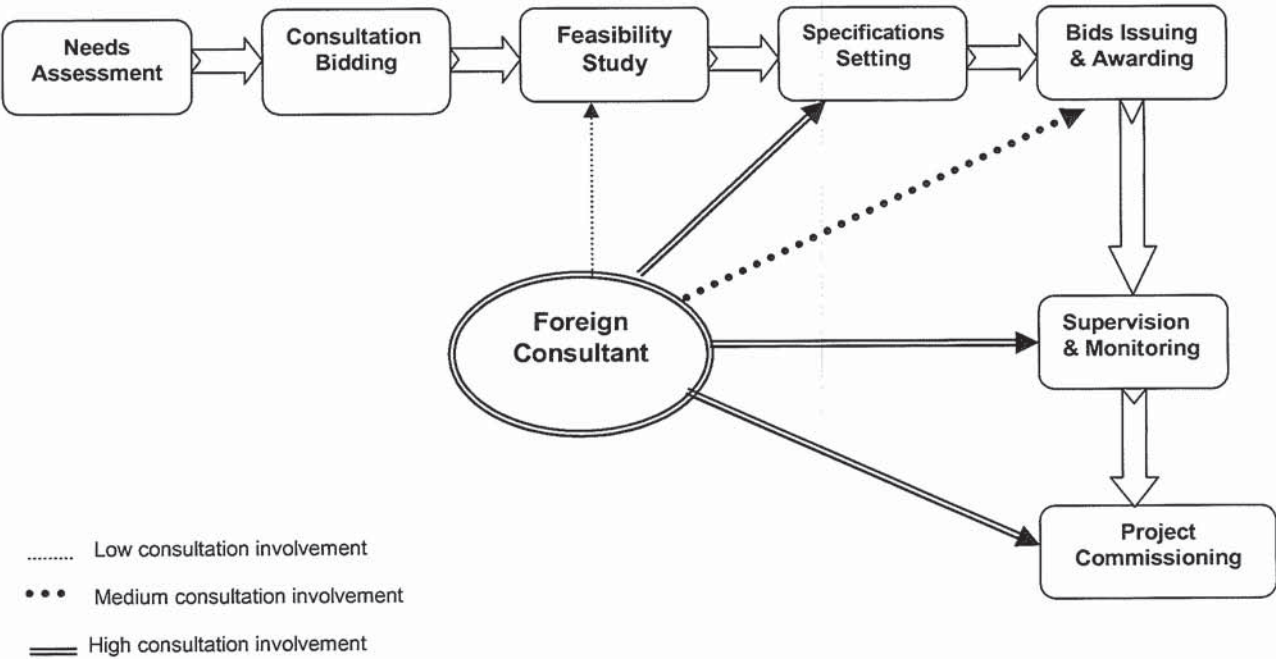


Figure 9.1 MEW technology transfer process (Sabiya project)

Respondents were requested to assign a percentage of work achieved by local staff for each stage (see Table 9.2). These stages are described in the following paragraphs.

Resp	Needs assessment		Consultation bidding		Feasibility study		Specification setting		Bids issuing & awarding		Supervision & monitoring		Project commissioning	
	%	Range	%	Range	%	Range	%	Range	%	Range	%	Range	%	Range
1	100		100		70		40		40		40		30	
2	100		90		80		60		40		40		30	
3	100		100		75		50		50		50		50	
4	90		100		85		55		40		40		50	
5	90		95		75		65		40		50		30	
6	95		90		70		60		50		40		40	
7	100		100		70		50		40		60		35	
8	95		100		70		50		50		50		50	
9	90		95		65		40		40		50		40	
10	100		85		70		40		45		40		30	
11	95		100		70		55		45		50		40	
12	100	10	90	15	75	25	50	25	40	20	40	20	50	20
13	95		100		80		40		60		50		30	
14	100		95		70		40		40		40		30	
15	100		100		65		50		50		55		45	
16	100		90		70		50		40		45		40	
17	90		100		75		60		40		40		30	
18	100		100		70		40		50		40		40	
19	100		100		75		50		40		60		40	
20	95		95		80		40		40		40		30	
21	100		90		70		50		60		40		40	
22	100		100		70		40		40		50		30	
23	100		100		75		40		55		40		45	
24	100		95		70		50		40		40		30	
Avg.	97		96		73		48		44		45		35	

Table 9.2 The percentage of activities accomplished by MEW's local staff

- *Needs assessment*

The process of needs assessment began in 1988 when the National Control Centre (NCC) issued a report representing a trend analysis of the current and anticipated consumption rate of the electricity and water. It was found that the rate exceeded the average calculated per capita consumption, which is 8,321 KWH per year for electricity and 22,695 IMG per year for water. The report illustrated that with such a rise in consumption it is unlikely that the capacity of current stations would sustain the demand for the next five years. The report,

which recommended an expansion of the current capacity or building a new station, was submitted to the Under-Secretary. Based on this report the Under-Secretary set up a special committee containing members from various departments and workshops of MEW. Normally, the members of this committee are experts whose experience is not less than 10 years. These members were selected from the following departments and workshops:

- Finance
- Civil Works
- Planning and Training
- Consumer Affairs
- Electrical
- Mechanical
- Environmental
- Legal and Administrative

In addition to the above, the directors of all power stations were also members of the committee. The main objective of the committee was to study the report and verify its claim. After careful consideration, the committee concurred with the report and approved the need for building a new power station. During this stage the capacity, type, approximate cost and the schedule of the new power station were determined. The whole process of this stage was executed solely by MEW without any external assistance (97% indigenously).

- *Consultation Bidding*

At this stage MEW specified the required consultation engineering services for the project and issued a bid for consultation services. After careful evaluation of the bidders it selected the appropriate consultant which was Merza and Mcleman Consulting Engineers, a British company (96% indigenously).

- *Feasibility study*

The special committee conducted a feasibility study of the new project. As part of the study it contacted various government bodies to obtain their comments on

the project, specifically site selection and future expansion plans (such as Ministry of Defence, Ministry of Oil, Ministry of Housing and Ministry of Planning). According to the AUS for power station and water distillation projects, MEW is capable of conducting the feasibility study, but the involvement of a foreign consultant at this stage was necessary for three reasons. First, to verify the results reached by MEW. Second, to assist in conducting environmental impact assessments and mitigation planning. Third, to gain a second opinion to convince the government of the potential of the project and get its approval. The involvement of the consultant is shown in Figure 9.1 as a dotted line which signifies its low involvement (approximately 73% indigenously).

- *Specifications setting*

At this stage MEW and the consultant collaborate in setting the required specifications for the new power station (shown as a solid line in Figure 9.1). The specifications were set to cope with the expected expansion of the suburban and the industrial sectors. This stage comprised the following tasks:

- testing of fuel type
- allocation of water resources
- selection of the appropriate site
- establishment of the drawings of the plant construction
- finalising of the project schedule

In addition, one of the major objectives of MEW in this phase is to avoid the technical problems that were encountered in past projects. For example, a desalination plant uses a special barrier that is installed at the sea intake to block oil spills. In the previous projects this costly barrier was frequently damaged as a result of sea motion. In the Sabiya project MEW installed a more reliable and less expensive system. It can be noted from Table 9.2 that the involvement of the foreign consultant in this stage has increased to over 50% (approximately 48% indigenously).

- *Bids issuing and awarding*

Basically, this stage is composed of three activities. These are searching for the technology, technology evaluation and negotiating and selecting the appropriate one. MEW has an updated archive which contains data on the available technologies of major utility-specialist firms and possible alternative sources worldwide. The available data assists MEW in searching for the required technology. Normally, these data are provided by the specialised firms through their representative in Kuwait. The evaluation and selection process of the technology depends on several factors, among which are:

- firm's experience and reputation
- product quality
- ease of operation and maintenance
- price
- after-sales service

Most of the respondents stressed that during the evaluation phase the entire acquisition and implementation process of the new technology was considered, and not merely the financial and technical merits and risks.

Normally, as part of the evaluation and selection process a team of the committee visits locations in other countries where the candidate firms have installed similar equipment to visualise it physically and to obtain some necessary data about the equipment from the owners, such as its reliability, any encountered technical problems and ease of operation. This only applied to the bulk equipment, such as turbine and steam generators. However, that wasn't exactly the case in the Sabiya project. Because the equipment from a candidate company was introduced late to the market and hadn't been purchased yet by any country, the team visited the company headquarters to examine the prototype.

For the purpose of issuing bids the Sabiya project was divided into 9 major parts as follows:

- sea works
- steam generators and their peripherals
- turbine generators and their peripherals
- gas turbines
- civil works
- fuel transportation lines
- site preparation
- fuel and water storage
- safety and security systems

By mid-1990 and following careful studies of the bidders' proposals and extensive negotiations the above activities were awarded to the successful bidders. The consultant assisted in the preparation of bids issuing and evaluation (approximately 44% indigenously).

- *Supervision and monitoring*

The events of the Iraqi invasion in Kuwait in August 1990 temporarily halted the implementation of the project. In 1994 MEW re-awarded the contracts to the same bidders except the fuel and water storage contract which was awarded to a different company through a new bid. The cost of the whole project had risen by approximately 17%.

Once the contracts were signed the special committee assigned a specialised team to monitor the installation process. The team consisted of civil, mechanical and electrical engineers as well as representatives from the quality assurance department. Unlike before, the new strategy of MEW was that the team was permanently located at the project site. This procedure was deemed necessary to facilitate the work and speed up the process. While the prime task of the team was to supervise the work and ensure compliance with contract, it was also an

opportunity to gain the required knowledge for the installation phase. As indicated in Figure 9.1, this process occurs in conjunction with the foreign consultant (approximately 45% indigenously).

- *Project commissioning*

The final stage of the Sabiya power station was the testing and commissioning of the units. The last unit was commissioned in late 2001. According to the AUS, the role of the foreign consultant is very crucial at this phase, since MEW lacks adequate experience to achieve this step on its own (approximately 35% indigenously).

It is evident from Table 9.2 that the degree of MEW involvement in Sabiya station is in inverse proportion to the complexity of the phases of the project¹. This relationship is demonstrated in Figure 9.2.

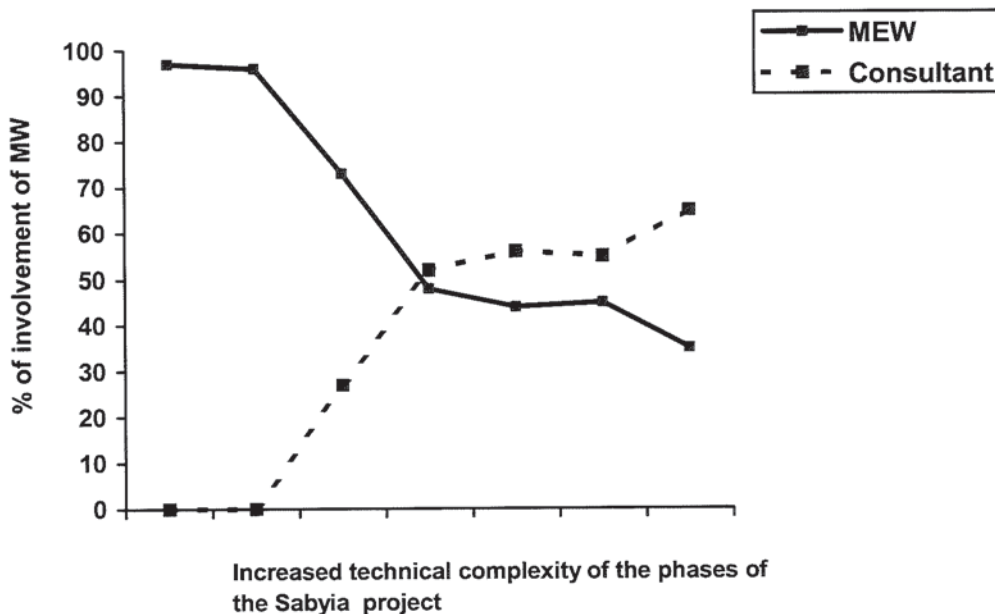


Figure 9.2 The relationship between project complexity and degree of involvement of MEW. (Based on data from Table 9.2).

1. This excludes major activities such as construction and installation which MEW was not involved with.

Respondents have pointed out that the following are the major problems encountered during the Sabiya project:

- the shortage of skilled personnel to carry out some technical tasks
- government bureaucracy
- the lack of solid negotiation skills of MEW's team
- the lack of trust in local staff abilities from some leaders in other public organisations, such as the Ministry of Planning and the Ministry of Finance

When they were asked to evaluate the technology transfer process in MEW, few of them (21% – from Table 9.1) said that it was a complete success because it had accomplished the objective of providing the public with water and electricity services.

The majority of the respondents (79% – from Table 9.1) believed that it was partially a success (they share the same reason with the other respondents). However, at the same time it was also a failure and 85% of them believed that this is due to the fact that the utility is totally under government control. This had led the work policy of the ministry to be restricted by various practices, such as the appointment and termination of employees, budget planning, maintenance operation and quality monitoring. Only very few of the respondents (15%) have actually attributed the failure of the process to the ultimate dependency of MEW on foreign expatriates to run the stations.

9.2 Conclusion of part one

9.2.1 Technology transfer process

The outcomes of the interviews have undoubtedly indicated that the technology transfer process in MEW experienced many difficulties. It is obvious from Table 9.2 that MEW depends to a great extent on foreign contractors in acquiring and absorbing technology. With more than five decades of dealing with desalination

and power generation technologies, MEW is still not able solely to acquire and operate the transferred technology. Recalling what has been stated in Chapter 8, with such deficiencies in managing the imported technology the transfer process cannot be described as a success.

9.2.2 Technological capability

While organisations in industrialised countries have realised the importance of technological capabilities and have an explicit commitment to building them, most organisations in developing countries lack such a view (Ernst et al., 1998). It is widely recognised that the first step towards assessing and building technological capability is the awareness by management of its importance, the need to develop such capability and the willingness to try to do so (ibid., Abdulrahman, 1999). This statement implies that the absence of such awareness may have an adverse impact on the level of the organisation's technological capability. As explained in the previous chapter, the term "awareness" reflects literally the understanding and recognition of the related subject (in this case the subject is technological capability). As figures in Table 9.1 show, the respondents' answers reflect a divergence in defining technological capability, acquisition capability and absorption capability. This divergence indicates that the majority of the authorities of MEW have a serious deficiency in understanding these concepts. They are either totally unaware or have partial understanding of these concepts. The researcher believes that this majority conforms with the socio-political-technological situation in Kuwait, i.e. no official efforts have been executed to encourage the perception of such concepts by key personnel in the public sector. Furthermore, the chronic pattern of turnkey technology transfer and the lavish spending on services by the government (capital-intensive society) has not allowed such a concept to develop.

Such results reflect the fact that no attention has been given to technological capability and other related concepts in Kuwait. Thus, it wouldn't be hugely

surprising if a ministry which has been involved with scientific and technological activities for almost half century has not built up or developed local capabilities to deal with such matters. Al-Sultan et al. (1999) conducted a study to assess the technological capabilities in the major and vital sectors in Kuwait (the oil and petrochemicals industry). The outcome of the study, which concurred with the above results of MEW, revealed that the country was almost put in jeopardy soon after the liberation from the Iraqi invasion due to the lack of indigenous capabilities to be able to repair and rebuild the damaged sector.

Another indication of the lack of awareness of technological capability among the public sector authorities is that one of the major recommendations of the Symposium on the National Policy for Science and Technology for Kuwait is to establish and strengthen an “awareness” of the indigenous technological capability¹.

It seems that the lack of awareness of technological capability has also subsequently prevented MEW from assessing its capability. As Ernst asserted earlier, the awareness of technological capability is a prerequisite to the implementation of the assessment process. In the case of MEW the interview results have indicated that MEW had never assessed its technological capability. The chief reason for this is that this issue is considered new to most of the MEW decision makers (74%). In other words, they were unaware of this process and its advantages. In addition, there is no indication that MEW possesses the proper criteria and assessment tools to carry out the assessment. MEW relies on very basic, unreliable and non-scientific criteria in evaluating its capability, that is the uninterrupted service provided and public satisfaction. Moreover, MEW uses low profile tools, such as number of attended training programmes, the personal annual reports and the attendance percentage, when measuring employees' capabilities.

1. See section 10.4.1 in Chapter 10 for details.

To conclude this part, there is no practical evidence that the authorities in MEW have recognised the significance of technological capability. Such ignorance has produced negative consequences: the perpetuation of dependency on foreign firms in the acquisition and absorption of the imported technology, the non-development of indigenous cadre and the inability to conduct technological capability assessments.

Based on this fact, it can be assumed that hypotheses (H1) and (H2) have been confirmed as they relate to MEW.

9.3 Part two

9.3.1 Implementation of the methodology

As stated earlier, the methodology of Panda and Ramanathan has been used to assess the technological capability profile of the Kuwaiti Ministry of Electricity and Water. The main objective of this assessment is to test the third (H3) and fourth (H4) hypotheses, which were discussed in the previous chapter.

The implementation of the methodology comprises two stages. Stage one includes the first three steps shown in Figure 9.2. Stage two then encompasses steps 4 and 5. Both stages are now described.

9.3.1.1 Stage one

The interviews of part one had led to the identification of the value addition stages performed by MEW, the technological capabilities needed to perform the necessary value addition and the determination of indicators for assessing each capability. This information represents steps one, two and three of the model respectively, as shown in Figure 9.3¹.

1. The figure was reintroduced in this chapter for illustrative purpose.

Based on Panda and Ramanathan's classification of utility companies, "type 8" is the most relevant to MEW (see Appendix F). Under this type the utility company is defined as involved in "electricity generating, transmitting, distribution and service". According to the proposed methodology the required capabilities associated with this type are tactical, supportive and steering capabilities. However, the outcome from part one interviews revealed that MEW is also engaged in some aspects of design, engineering and construction activities. This suggests that MEW possesses some elements of strategic technological capabilities. Additionally, MEW is involved only in some tactical value-adding stages (production and servicing capabilities).



Figure 9.3 A model for assessing technological capability
Source: Panda and Ramanathan, 1996.

Figure 9.4 illustrates the capabilities and sub-elements that MEW is currently involved with. It can be shown from this figure that the total number of technological capability elements with which MEW is currently involved is 21. The identification of these capabilities covers step 2 of the model.

Based on Panda and Ramanathan's categorisation of indicators (step 3) it has been determined that there are 54 relevant indicators required to assess these elements.

As mentioned previously, the interest of this research is to assess the capability of MEW to acquire and absorb the imported technology. Therefore, and for analysis purposes, the MEW capabilities were arranged into two groups: acquisition group and absorption group. However, because this step is not contained in the model and because of the variations in the definitions of acquisition and absorption an overlap could exist across these capabilities. The two groups are illustrated in Table 9.3.

Acquisition group (see Appendix H for the sub-elements)		Absorption group (see Appendix H & I for the sub-elements)	
DEC1	Capability to evaluate the project in terms of technical, economic, financial, environmental and social factors	DEC3	Capability to adapt purchased or generated technology
COC1	Capability to support project feasibility studies & do site engineering	ACC2	Capability to identify, assess, negotiate and finalise the terms of acquiring raw materials, supporting facilities, spare parts and consumables
COC3	Capability to perform erection & commissioning activities for mechanical, electrical, control & instrumentation items	ACC4	Capability to identify, assess, negotiate and finalise the terms of human resource to be acquired
ACC1	Capability to identify, assess, negotiate and finalise the terms of the technology to be acquired	SUC1	Capability to provide training
ACC3	Capability to identify, assess, negotiate and finalise the terms of the finance to be acquired without any external support	SUC3	Capability for providing information support & networking
ACC5	Capability for planning, monitoring and coordinating resource acquisition process and vendor development.	SUC5	Capability to adhere to high standards of safety and Security
SUC2	Capability to undertake strategic planning	STC1	Capability for path finding
STC2	Capability for decision making and implementing	PRC1	Capability to effectively utilise and control the conversion technologies of the main and auxiliary process
STC3	Capability to integrate the organisation's activities	PRC2	Capability for carrying out quality assurance, inspection and inventory control
		PRC3	Capability for troubleshooting, and for carrying out preventative, routine and breakdown maintenance
		PRC4	Capability to perform production planning, and equipment and maintenance scheduling
		SEC11	System average restoration index. It is defined as the ratio of interruption duration to the number of interruptions

Table 9.3 The acquisition and absorption groups

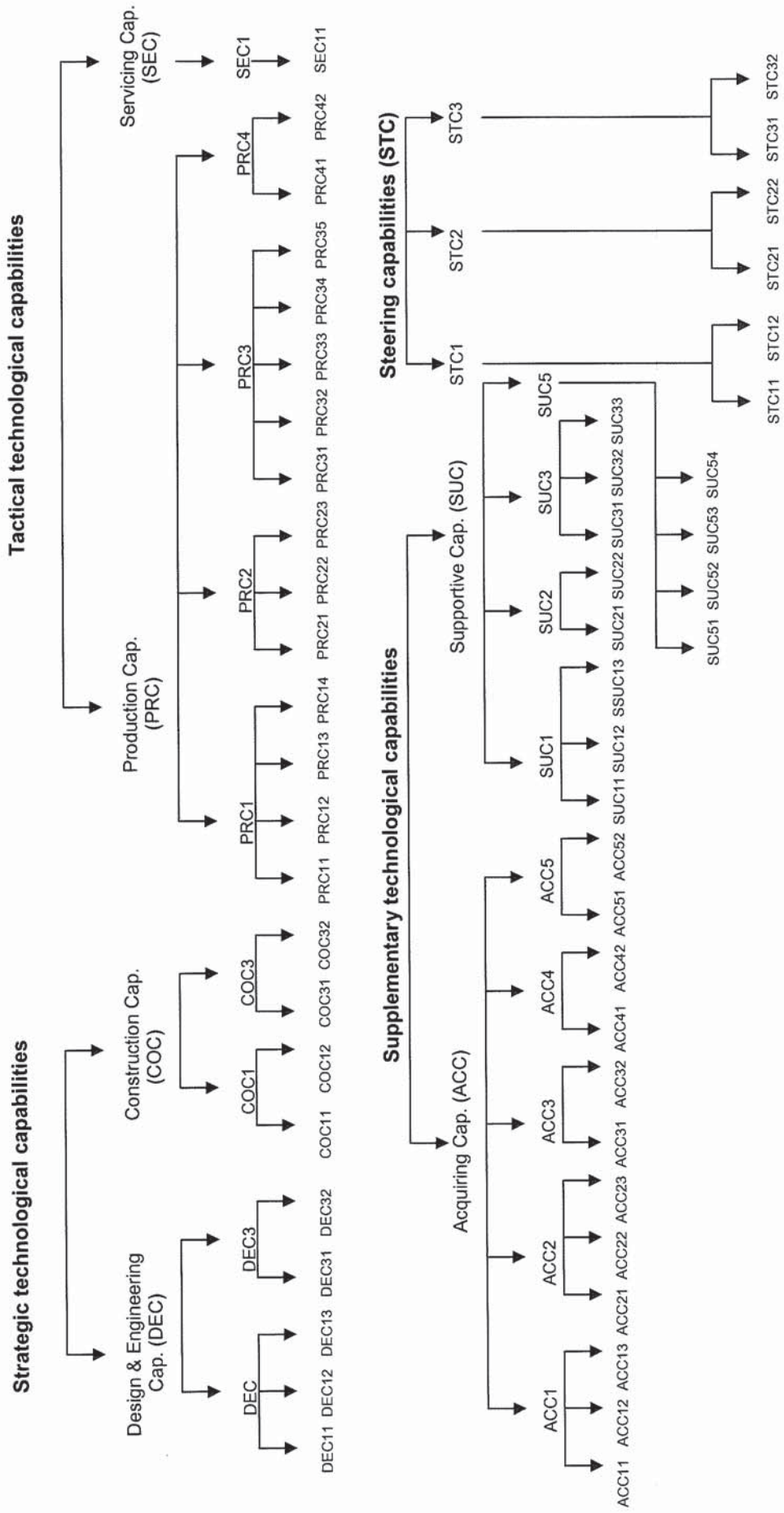


Figure 9.4 Technological capabilities of MEW and their sub components (based on Panda and Ramanathan model).

9.3.1.2 Stage two

As indicated earlier, step 4 of the model involves assessing technological capabilities of a firm under study, a state-of-the-art firm and benchmarking the two firms. For the purpose of the interviews, the assessment elements and indicators of the technological capabilities of MEW were arranged in a form of question list. This procedure was thought essential because it allows the interviewee to respond to enquiries without the assistance or the presence of the researcher, if circumstances necessitate this. Moreover, the list was divided into two parts: managerial and technical (see Appendices H and I). The managerial part includes all the assessing elements that are of a management nature and pertains to the executive level of MEW (under-secretaries, assistant under-secretaries, chief engineers, directors, senior managers).

The technical part embraces technical assessment elements and pertains to the power plant under study (Sabiya station). Table 9.4 summarises the managerial part interviews that were held at MEW headquarters.

The Interviewee	No. of meetings	Meeting duration
AUS for power station & distribution plants projects	3	1 hr 45 min
AUS for information systems & supervision	1	40 min
AUS for administrative affairs	2	45 min
AUS for water projects	1	35 min
AUS for water (operation & maintenance)	1	50 min
AUS for power station & distribution plants (operation & maintenance)	2	55 min
AUS for technical services & main workshops	1	50 min
AUS for planning, training & control centres	1	45 min
Chief engineering of workshops (electrical)	2	1 hr 15 min
Chief engineering of workshops (mechanical)	1	1 hr
Director of water resources development centre	1	55 min
Director of training and manpower	1	40 min
Senior manager of purchase & imports department	1	1 hr
Total	18	11 hr 55 min

Table 9.4 Interviews at MEW headquarter

Most of the interviews lasted about one hour, although some exceeded that time. At the beginning of each interview a copy of the question list was provided to the interviewee to review and follow each question simultaneously with the interviewer. This method has proven to facilitate communications. Each interviewee was requested at the start to introduce himself (name, service years, qualifications, etc.) and describe the function of his sector or department. Interviewees were asked questions that are directly related to their duties and responsibilities. The interviewees and the associated assessment elements (from the Panda and Ramanathan model) are shown in Table 9.5 (see Appendices H and I for details).

As indicated above, the total number of questions asked at MEW headquarters was 182. This figure represents the 54 technological assessing indicators associated with MEW. Some questions which are indirectly related to the main function of the departments or sectors were asked for validation purposes. For instance, the AUS for administrative affairs, the AUS for power station and distribution plants (operation and maintenance) and the Chief Engineer of workshops (electrical) were asked about the degree of reliability of the available information system and its up-to-date status. This task denoting the indicator SUC32, as indicated above, is under the responsibility of the AUS for information systems and supervision. In order to verify the answer that was provided by him for this question, the same question was asked to other functional departments.

Additionally, a sample¹ of workers from different lower level departments (administration and technical) was randomly selected to verify responses that are related to human resource management, safety and security issues and reliability of information systems, which were provided by personnel at the executive level, as indicated in Table 9.6.

1. These personnel were randomly selected by the Statistical Department at MEW headquarter upon the request of the author.

The interviewee	Associated elements and indicators from the model
Assistant Under-Secretary (AUS) for power station & distribution plants projects	DEC1, DEC3, COC1, ACC1, ACC2, ACC3, ACC5, SUC1, SUC2, SUC5, STC1, STC2, STC3
AUS for information system & supervision	DEC3, COC1, ACC22, SUC1, SUC2, SUC3, SUC5, STC2
AUS for administrative affairs	ACC41, ACC42, SUC2, SUC31, SUC32, SUC5, STC1, STC2, STC3
AUS for water projects	DEC1, DEC3, COC1, ACC1, ACC2, ACC3, ACC5, SUC1, SUC2, SUC5, STC1, STC2, STC3
AUS for power station & distribution plants (operation & maintenance)	DEC31, DEC32, COC3, SUC2, SUC32, SUC5, STC2,
AUS for water (operation & maintenance)	DEC31, DEC32, COC3, SUC2, SUC32, SUC5, STC2,
AUS for technical services & main workshops	COC3, SUC2, SUC5, STC2
AUS for planning, training & control centres	ACC4, SUC1, SUC2, STC1, STC2, STC3
Chief engineer of workshops (electrical)	COC32, SUC32, SUC5, STC2
Chief engineer of workshops (mechanical)	COC32, SUC5, STC2
Director of water resources development centre	ACC4, DEC11, DEC12, SUC5, STC2
Director of training and manpower	SUC1, SUC2, SUC5, STC1, STC2,
Senior manager of purchase & imports department	ACC23, ACC31, ACC32
Total	182

Table 9.5 The interviewees and the associated elements and indicators

The other part of the interview questions, i.e. the technical part, was designed specifically for power stations. As mentioned earlier, Sabiya power station was selected to be the unit of case study. Therefore, the technical part was applied to this station. The next section describes briefly Sabiya power station.

The department/station	No. of interviewees	Associated elements and indicators from the model
Consumer affairs	3	SUC11, SUC31, SUC32, SUC54, STC11, STC31, STC 32
Instruments and testing	2	
Contracts and tenders	3	
Personnel affairs	3	
Az-Zour South station	3	
Emergency services	2	
Doha West power station	3	
Stores	2	
Computer centre	3	
Public relations & information	3	
Total	27	

Table 9.6 Interviews of the employees at MEW

Sabiya power station

The station is located north of Kuwait at Sabiya Bay. In the initial phase of the project, the main concern of MEW was to establish a state-of-the-art station which embraced the latest proven technology in power generation and water desalination, and at the same time to avoid the technological problems that were encountered previously with other stations. As a result, the station is currently considered unique in the whole region with the utilisation of what is called the Digital Control System (DCS). DCS allows operators to control the starting up and shutting down of all main and auxiliary systems automatically at a central control room, through an easy interactive system and touchable displays. The station was constructed by four foreign firms. The firms' names, nationality, work speciality and the cost of the contract are presented in Table 9.7.

Company name	Nationality	Work speciality	Contract cost
Hyundai Engineering & Construction Co.	Korea	Civil works	US \$ 375 m
Mitsubishi Heavy Industries Ltd.	Japan	Turbines & Boilers (Mechanical)	US \$ 1.249 b
Gulf Dredging Co.	Kuwaiti	Sea water intake	US \$ 39 m
Polymex-Cekop	Poland	Fuel & Water Storage	US \$ 19 m
Consolidated Contractors International	Greece & Kuwait	Fuel Lines	US \$ 28 m

Table 9.7 Firms involved in Sabiya station project

The station was officially commissioned in 2001. It consists of 8 steam units with a capacity of 300 MW for each. The total capacity is 2400 MW. The station was built at cost of US\$2.3 billion. The total number of employees at the station is 269. This figure includes directors, managers, engineers, foremen, technicians, operators and clerks. The power station is organised into 8 departments: Operation, Electrical Maintenance, Mechanical Maintenance, Maintenance and Calibration of Control Equipment, Laboratory, Planning and Safety, Technical Services and Training and Administration. Table 9.8 illustrates the interviews that were conducted at the station.

Each of the interviewees was interviewed once. The average time for each interview was roughly 45 minutes. The total number of questions was 54. As shown above, although the majority of the elements belong to the technical part list (see Appendix I), there are some questions that are related to the managerial part which was discussed earlier. These questions were directed to the general director and his assistants, since their positions are considered executive. Also, some of these questions were raised to the chief engineer because of his multi-role position (managerial and technical). The rest of the interviewees were asked questions that were purely technical and directly related to their functions. It is worth stating that the assistants of the general director, chief engineers and the manager of technical services and training have raised an interesting issue

regarding the skills of their workforce. They were complaining about the weak level of the graduates upon their appointment in the station, particularly the technicians. They have stressed that they were obliged to re-train them in order for them to meet their requirements. The training period varies from 6 months to a year.

The interviewee	Associated elements and indicators
The General Director	DEC3, ACC22, ACC23, ACC42, ACC41, SUC1, SUC2, SUC5, STC1, STC2, STC3
Assistants to the General Director	DEC3, ACC22, ACC23, ACC42, ACC41, SUC1, SUC2, SUC5, STC1, STC2, STC3
Chief engineers	COC32, SUC32, SUC5, STC2, PRC11, PRC12, PRC13, PRC14, PRC31, PRC33, PRC34, PRC35,
Manager of electrical dept.	PRC14, PRC31, PRC32, PRC33, PRC41
Manager of mechanical dept.	PRC14, PRC31, PRC32, PRC33, PRC41
Manager of operation dept.	PRC14, PRC31, PRC32, PRC33, PRC41
Manager of planning and safety dept.	PRC21, PRC22, PRC35
Manager of technical services and training	PRC23, PRC42
Total	54

Table 9.8 Interviews of senior staff in Sabiya station

In addition to the above interviews, several personnel¹ in different departments were interviewed for validation purposes, as indicated in the previous section. These personnel were normal technicians or administrators. These interviewees are listed below in Table 9.9.

There now follows a discussion of the analysis of the acquisition and absorption capabilities of MEW based on the criteria set by the model of Panda and Ramanathan (for detail see Table 9.10 and Appendix J).

¹ These personnel were randomly selected by the Statistical Department at MEW headquarter upon the request of the author.

9.3.2 Assessment of acquisition capability

For all projects beyond 100 MW capacity, MEW depends on a foreign consultant for technology acquisition. During the last 10 years MEW has evaluated an average of less than one large project per annum without external assistance. Complex projects are normally handled in coordination with a foreign consultant. The contractor is fully responsible for plant design. Nevertheless, MEW is capable of handling minor layout changes to suit its needs.

The department / station	No. of interviewees	Associated elements and indicators
Electrical	3	SUC11, SUC31, SUC32, SUC54, STC11, STC31, STC 32, PRC34
Mechanical	3	
laboratory	2	
Operation	5	
Planning & safety	3	
Technical services & training	3	
Maintenance & calibration of equipment	2	
Administration	4	
Total	25	8

Table 9.9 Interviews of employees at Sabiya station

MEW depends on foreign consultants to perform contractual activities, such as bid evaluation, contract negotiation and letter of award placement. MEW depends extensively on foreign contractors for the performance of civil construction works. However, MEW is partially dependent on external assistance in construction specification preparation and construction cost estimation. Although MEW depends on the foreign consultant for erection and commissioning activities for mechanical, electrical and control and instrumentation items, it can perform tasks of medium level complexity, such as the involvement in erection and commissioning of off-site mechanical and

electrical items. The infrastructure of the database network in MEW is simple. Therefore, the extensiveness of its database for acquiring various power plant related technologies is rated low. All of the financial procurement activities are executed solely by MEW, except for a few occasional reviews by the external consultant. The capability to plan, monitor and coordinate resource acquisition and vendor development is assessed by two indicators.

The first indicator is the average time over-run during the resource acquisition process as a percentage of the schedule time. Although MEW has a high percentage (48%), the managers attributed this to the government bureaucracy. The second indicator is the percentage of new vendors developed during the last 10 years. MEW has a strict policy in dealing with vendors, which reflects its caution in developing relationships with new vendors (in the last 10 years only 20% of the contracts were awarded to new vendors).

No performance contracts exist at various levels of MEW. What actually exists is a type of specification of responsibilities at some levels. One of the assistant under-secretaries, who requested to keep his identity secret, pointed out that the organisation has well-defined job descriptions for all levels at MEW. However, it is not implemented for two main reasons. First, the authorities are entitled to add additional tasks when required with no concern as to any legal action from employees. Second, it protects MEW from any financial obligations. MEW's employees enjoy a medium degree of participation in task planning. Additionally, the company's effectiveness in liaising is also rated medium by the authorities in MEW.

9.3.3 Assessment of absorption capability

The cost of adaptation activities as a percentage of the cost of technology purchased and the level of complexity of the adaptation process indicated that MEW possesses a low capability to adapt purchased or generated technology.

Although it has a technological database that contains rich data on spare parts, consumables and supporting facilities, MEW cannot perform all the material acquisition activities on its own. Thus the organisation's capability to identify, assess, negotiate and finalise the terms of acquiring raw materials and related items is low. MEW's human resource database is at a low level and it often hires external personnel with more than 10 years experience. The average hours of staff training per year, the degree of optimality in the internal and external training index and the degree of dependence in various training activities indicated that the capability of MEW to provide training is rated medium. Considering the degree of computerisation, the reliability of the information systems and the level of networking within the organisation and external agencies, it appears that MEW has a medium level of capability for providing information support and networking. The organisation's capability for path finding is graded low due to two factors: the percentage of employees sharing the vision of the top management (which is less than 50 %) and the level of commitment from the top management towards technological leadership (between 20% – 50%).

The Sabiya station has a high availability factor, high level of successful start up (100 %) and no accidental shutdowns. Hence, the overall capability to utilise and control the conversion technologies of the main and auxiliary process can be rated high. The station operates at a high pollution level and maintains a low degree of means of pollution monitoring. Therefore, MEW's capability for carrying out quality assurance, inspection and inventory control is assumed to be low. The unplanned capability loss factor and automatic grid separations of Sabiya station are at medium level. Moreover, the maintenance complexity index is rated low. The degree of dependence on external experts in the operations and maintenance procedures cannot be determined at this point because the plant is still under warranty. As a result, the overall capability for MEW for conducting preventative, corrective, improving and predictive maintenance can be graded low. MEW appears to be capable of achieving a high level of actual unit availability and medium level in maintenance man-hours utilisation. Thus, the

capability to perform production planning and equipment and maintenance scheduling appears to be medium.

9.3.4 Benchmarking

Step 4 of the model requires benchmarking of the outcome of the assessment process of the organisation under study against a state-of-the-art firm. The Powergen company was selected for this purpose. The rationale for this selection is as follows. First, Powergen is a leading company in the UK utilities market. Second, there is an element of similarity between Powergen and MEW as both of them are involved in electricity generation, transmission, distribution and service. In addition, MEW and Powergen both have experience of government ownership and operation (Powergen until 1995). Third, the location of the company in the UK aided the communication between the researcher and the key personnel in the company. Finally, the researcher was introduced to a general manager in the company by a member of academic staff. This ensured that the researcher received the necessary support for the research. A brief profile of Powergen is described next.

9.3.4.1 Powergen

In 1990 Powergen was launched as a public limited company owned by the government. It resulted from the privatisation of the Central Electricity Generating Board (CEGB), and has since grown from an electricity generator into a producer, distributor and retailer of electricity in the UK and abroad; a gas and telephone services supplier; and an Internet Service Provider (ISP). It is also involved in the construction and operation of power station sites across the world. In 1995 the government sold all of its stakes in Powergen to the public (Powergen, 2003).

In 2002 Powergen announced the acquisition of TXU's UK retail business. TXU, based in the State of Dallas in the USA, is one of the largest investor-owned energy service companies in the world, with assets of US \$ 43 billion. This made

Powergen the UK's largest electricity retailer and a powerful force in the competitive UK energy market. There are seven Powergen power stations across England and Wales with a total capacity of 7.4 GW.

In 2000, Powergen's stations generated 43.2 tera (1000 billion) watt-hours of electricity – 14.3% of the total used in England and Wales. The majority of the generation output is produced from the coal- and gas-fired plants. Powergen also operates one oil-fired plant and a hydro plant, which are called into action at times of high demand. Powergen have a 50% stake in Corby Power Limited which owns a 350MW gas-fired CCGT power station in Northamptonshire. Powergen is also investing in the power plant of the future – with Siemens, as partners – in Cottam Development Centre, which develops, tests and commercially operates the latest world-leading gas turbine technology. As of 31 December 2000, the total number of employees in Powergen is 11,742 (Powergen, 2003). Powergen's company structure is mapped out below.

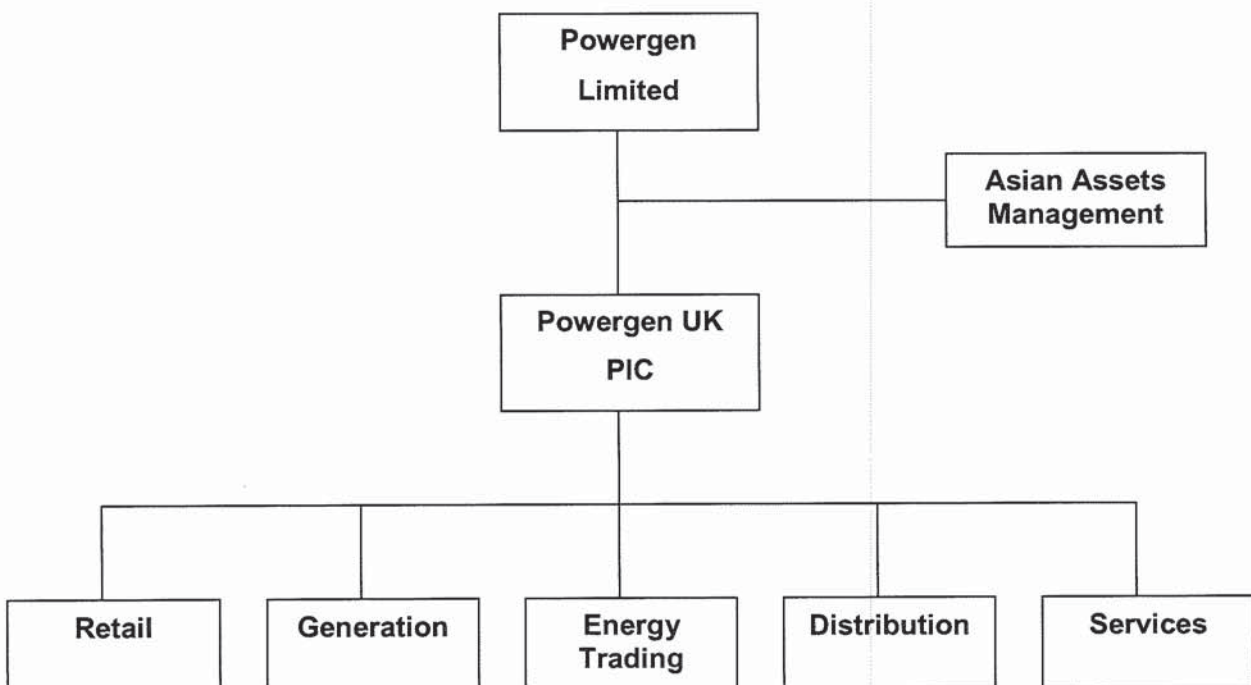


Figure 9.5 Organisational chart of Powergen

The researcher contacted the General Manager of Power Technology at Nottingham to arrange for the interview. Unfortunately, face to face interviewing was not feasible due to the tight schedule of the manager. As a result the questions were posted to him (Appendices H and I). Also, through telephone conversations with him, some ambiguous answers were clarified. Having collected the necessary data, the next step is to compare the findings of both firms.

9.3.5 A comparison of MEW and Powergen

The final step in applying the model is the determination of the gap between MEW and Powergen. This could lead to the identification of the weak areas where corrective actions are required. Powergen is involved in all strategic and tactical value-addition stages. For the purpose of comparison, only the common technological capabilities of both organisations are analysed. Table 9.10 illustrates the result of the assessment process of both organisations. The evaluation criteria (adopted from the model) are presented in Appendix J.

The findings were quantified. In order to present an approximation of the comparison results in a percentage and graphic form, numerical values were assigned to the ordinal values for each indicator as presented in Table 9.11. Note that the “high”, “medium” and “low” values in Table 9.10 refer to the indicator values and not the level of the capability elements. To elaborate, indicator ACC32 denotes the degree of dependence for the procurement of finance. The MEW response was that all financial procurement activities are executed by themselves, except a few occasional reviews by external consultants. The categorisation of this indicator according to the assessment criteria is “low”, which means low dependency on external consultants and, hence, MEW is given top score, i.e. 3. Appendix K illustrates the value assignments for each indicator. The implementation of the above scheme is illustrated by Tables 9.12 and 9.13.

Indicator (See appendix D)	Value for MEW (see appendix F)		Value for Powergen (see appendix F)	
	Description	Ordinal value	Description	Ordinal value
DEC11	6	Medium	50	High
DEC12	2	Low	45	High
DEC13	Level 2	Medium	Level 3	Low
DEC31	6	Low	8	Low
DEC32	Level 3	Low	Level 2	Medium
COC11	Partial dependence	Medium	Not dependence	High
COC12	1 st level	Low	3 rd level	High
COC31	0	Low	13	High
COC32	Low level	Low	High level	High
ACC11	71 %	Low	100 %	High
ACC12	Level 3	Low	Level 1	High
ACC13	Level 1	High	Level 3	Low
ACC21	49 %	Low	100 %	High
ACC22	Level 3	Low	Level 1	High
ACC23	Level 1	Low	Level 3	High
ACC31	85 %	Medium	100 %	High
ACC32	Level 3	Low	Level 3	Low
ACC41	Level 3	Low	Level 1	High
ACC42	17 %	Medium	60 %	High
ACC51	48 %	High	-	N/A
ACC52	20 %	Medium	-	N/A
SUC11	14.2	Low	64.7	High
SUC12	12 %	Medium	17.8 %	High
SUC13	Less than 10 %	Low	10 % - 50 %	Medium
SUC21	N/A	-	N/A	-
SUC22	83 %	Low	90 %	Medium
SUC31	Less than 50%	Low	More than 90%	High
SUC32	Level 2	Medium	Level 1	High
SUC33	Level 3	Low	Level 1	High
SUC51	N/A	-	N/A	-
SUC52	N/A	-	N/A	-
SUC53	117	High	63	Medium
SUC54	Level 2	Medium	All	High
STC11	Less than 50 %	Low	Less than 50 %	Low
STC12	Less than 20 %	Low	20 % - 50 %	Medium

Table 9.10 The assessment of technological capabilities of MEW and Powergen

Indicator (see appendix D)	Value for MEW (see appendix F)		Value for Powergen (see appendix F)	
	Description	Ordinal value	Description	Ordinal value
STC21	Does not exist	Low	Exist at all levels	High
STC22	11	Low	39	High
STC31	69 %	Low	93 %	High
STC32	Level 3	Low	Level 1	High
PRC11	8.6 %	Low	100	High
PRC12	84.7	Medium	75	Medium
PRC13	100 %	High	100 %	High
PRC14	0	Low	10	Low
PRC21	1.8	High	1.0	Medium
PRC22	Level 3	Low	Level 2	Medium
PRC23	0.33	Low	2.5	High
PRC31	5.1 %	Medium	5 %	Medium
PRC32	13	High	0	Low
PRC33	N/A	-	N/A	-
PRC34	Level 3	Low	Level 4	Medium
PRC35	Under warranty	-	5 %	Low
PRC41	1.0	High	0.95	High
PRC42	0.63	Low	0.90	Medium
SEC11	N/A	-	2.5	Medium

Table 9.10 (continued)

	Panda & Ramanathan	This research
Top score	High	3
Middle score	Medium	2
Lowest score	Low	1

Table 9.11 The conversion table for this research

Indicators	Value	Indicators	Value	Indicators	Value	Indicators	Value	Indicators	Value
DEC11	2	ACC13	1	SUC12	2	STC11	1	PRC22	1
DEC12	1	ACC21	1	SUC13	3	STC12	1	PRC23	1
DEC13	2	ACC22	1	SUC21	N/A	STC21	1	PRC31	2
DEC31	1	ACC23	1	SUC22	1	STC22	1	PRC32	1
DEC32	1	ACC31	2	SUC31	1	STC31	1	PRC33	N/A
COC11	2	ACC32	3	SUC32	2	STC32	1	PRC34	1
COC12	1	ACC41	1	SUC33	1	PRC11	1	PRC35	N/A
COC31	1	ACC42	2	SUC51	N/A	PRC12	2	PRC41	3
COC32	1	ACC51	1	SUC52	N/A	PRC13	3	PRC42	1
ACC11	1	ACC52	2	SUC53	1	PRC14	3	SEC11	N/A
ACC12	1	SUC11	1	SUC54	2	PRC21	1		

Table 9.12 Assigned values for MEW

Indicators	Value	Indicators	Value	Indicators	Value	Indicators	Value	Indicators	Value
DEC11	3	ACC13	3	SUC12	3	STC11	1	PRC22	2
DEC12	3	ACC21	3	SUC13	2	STC12	2	PRC23	1
DEC13	3	ACC22	3	SUC21	N/A	STC21	3	PRC31	2
DEC31	1	ACC23	1	SUC22	3	STC22	3	PRC32	3
DEC32	2	ACC31	3	SUC31	3	STC31	3	PRC33	N/A
COC11	3	ACC32	3	SUC32	3	STC32	3	PRC34	2
COC12	3	ACC41	3	SUC33	3	PRC11	3	PRC35	3
COC31	3	ACC42	3	SUC51	N/A	PRC12	2	PRC41	3
COC32	3	ACC51	N/A	SUC52	N/A	PRC13	3	PRC42	2
ACC11	3	ACC52	N/A	SUC53	2	PRC14	3	SEC11	2
ACC12	3	SUC11	3	SUC54	3	PRC21	3		

Table 9.13 Assigned values for Powergen

The following graph represents the level of technological capabilities of both organisations, MEW and Powergen.

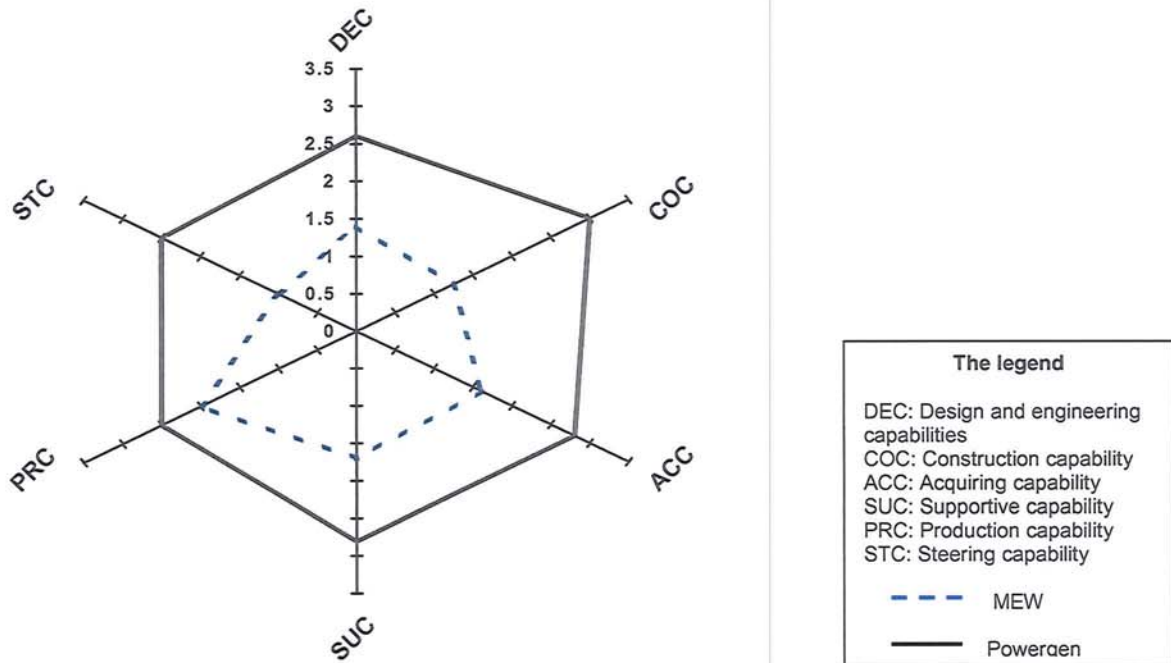


Figure 9.6 Technological capability level of MEW and Powergen

The lines represent the average score of the indicators of each technological element. The calculation of the average is illustrated in the following example. The MEW's STC element has six indicators as follows:

Indicators	STC11	STC12	STC21	STC22	STC31	STC32
Value	L	L	L	L	L	L
Score	1.0	1.0	1.0	1.0	1.0	1.0
Average score	1.0					

Note that the N/A entries were ignored in the calculations for both firms.

By studying Tables 9.10, 9.11 and 9.12 and Figure 9.5 the superiority of Powergen's technological capability over MEW and the presence of a vast gap between the two firms can be clearly recognised. Table 9.13 summarises the results.

Total number of indicators	54
Number of equal indicators	7
Indicators in favour for MEW	1
Indicators in favour for Powergen	40
Data not available for MEW	6
Data not available for Powergen	6
Value of total indicators	144*
Value of MEW indicators	67
Percentage of total indicators (MEW)	46 %
Value for Powergen indicators	128
Percentage of total indicators (Powergen)	89 %
* 6 N/A entries were omitted from calculations	

Table 9.14 Statistics of MEW and Powergen indicators

As indicated in Table 9.14, the technological capability assessment process reveals that MEW's capabilities scored 46%, while Powergen scored 89¹%. Panda and Ramanathan used ordinal values in assigning for each capability element. This scheme has been modified by the author for quantifying purposes as seen in Table 9.15.

1. This figure could probably be higher if the other capability elements (such as creation and marketing capabilities) were included in the assessment. As mentioned earlier, the interest was to assess the similar capabilities of both organisations.

Ordinal value	Numerical value (%)
High	80 - 100
Medium - High	61 - 80
Medium	41 - 60
Low - Medium	21 - 40
Low	0 - 20

Table 9.15 Ordinal and the assigned numerical values

9.4 Conclusion of part two

From Tables 9.13 and 9.14 it can be seen that MEW's technological capability lies in the lower level of the middle range of the scale (41% - 60%). Clearly, such classification is not efficient to support MEW's functions. Hence, MEW has an obligation to depend on foreign contractors.

As has been illustrated in the previous part, the technology transfer process in MEW suffers from many technical and managerial difficulties due to various factors. In the light of this and based on the low score of MEW in the assessment process (46%), it is evident that the current level of the acquisition and absorption technological capabilities represents a major factor in these difficulties and appear to be inappropriate. As a result, the third hypothesis (H3) is confirmed.

The last hypothesis (H4) assumes that the Panda and Ramanathan model is applicable to the public sector. Remember that this model was specifically designed for the private sector. Based on the implementation of the model in MEW, it seems that this model is appropriate to assess the technological

capability in a public sector organisation for the following reasons. First, all of the activities that MEW is currently involved with (electricity generating, transmitting, distribution and service company) have been recognised by the model according to its utility classification.¹ Second, most of the required capabilities and their sub-elements to achieve the above activities have been identified by the model (for example, engineering capability, construction capability, servicing capability, etc.).² Finally, most of the designed indicators used to assess the technological capabilities were applicable to MEW. For instance, capability to provide training (SUC1), capability to identify, assess, negotiate and finalise the terms of the technology to be acquired (ACC1), capability to support project feasibility studies and do site engineering (COC1), etc.,³ were measurable by MEW staff.

Nevertheless, there are some areas in the model that need to be modified to suit the particular situation of the industry and country. Within this research context, some indicators were modified to fit the utility aspects, as illustrated next. Note, however, that the modification of the model was only carried out for capabilities and indicators which are applicable to MEW. For example, creation capabilities which assess innovation activities were omitted from the assessment process, and hence from the modification procedure, since MEW lacks this capability.

The major modification of the model was associated with the time span. Panda and Ramanathan specified five years time span for assessment of some of the activities. This time span is not appropriate for assessing activities in a public sector firm since most of the projects have an average execution duration of between 4 and 7 years. Therefore, the time span was modified to 10 years for the following indicators: DEC11, DEC12, COC11, COC31, ACC11, ACC21, ACC31, ACC52.

1. See Appendix F.

2. See Appendix G.

3. See Appendix G.

Another modification was applied to the supportive capability elements and indicators. Indicator SUC51 assesses the number of fatalities per 10,000 employees per annum. Since the total number of employees in MEW is 7,228, a ratio of 1:10 was applied. As a result, the number was reduced from 10,000 to 1,000. Also the associated criteria were reduced accordingly. The same ratio was also used in indicators SUC52 and SUC53, which were reduced from 1000 to 100 employees per annum.

Also, it would be preferable to neglect the sub-capability ACC3. This is a capability to identify, assess, negotiate and finalise the terms of the finance to be acquired without any external support. It is widely known that the financial affairs in the majority of developing nations are under the total responsibility of the government. In the case of Kuwait, the country's budget is under the control of the Ministry of Finance and MEW has no influence in this issue at all. Therefore, it would be meaningless to assess this capability.

Chapter 10

Conclusions and Research Implications

Introduction

This research has addressed the issue of the technology transfer process to developing countries, from the point of view of the technology acquirer. As was pointed out earlier, in Chapter 2, developing countries are defined as all countries in Africa, Asia and Latin America with the exception of Australia, Japan, New Zealand, Russia and South Africa. This research has specifically focused on the assessment of the technological capability of the public sector in the GCC countries, with particular emphasis on Kuwait. A model developed by Panda and Ramanathan (1996) formed the basis for the research question. The model was applied to assess the acquisition and absorption technological capabilities of the Ministry of Electricity and Water in Kuwait.

The review of relevant literature showed the limitation of studies which link technology transfer to the level of technological capability in the public sector in developing countries, particularly the assessment process of this capability. This research was an attempt to fill this gap.

The conclusions drawn in this chapter were based on the assessments carried out in all the previous chapters and from the evidence which emerged from the case studies. It also discusses the limitations and contributions of the research, and provides proposals for further research.

10.1 The aim of the research

The aim of this research is to assess the indigenous technological capability of the public sector in developing countries, with specific reference to Kuwait. This was achieved through the investigation of the role of indigenous technological capabilities in the success of imported technology. Particular attention was paid to the assessment of acquisition and absorption capability through the application of the Panda and Ramanathan model. The research focused on Kuwait as an example of the GCC countries. In addition, the research aimed to propose a framework to enhance the technological capability of the developing countries, as well as the performance of the public sector.

10.2 Summary of the research methodology

Because this study was descriptive and exploratory in nature, a qualitative approach was applied to investigate the research topic. Among the different methods of qualitative approach, the case study method was adopted for this research. Three minor cases studies and one main case study were used to collect data.

Based on the findings from an extensive literature review and the preliminary sectoral visits, the research question and four hypotheses were formulated. These hypotheses were then tested using interview-based survey and documentation. The survey results provided empirical data and evidence for subsequent statistical analysis.

10.3 Summary of the outcomes

Based on the analysed data resulting from the empirical work (Chapters 8 and 9), the main outcomes of the research can be summarised according to the following points:

- the technology transfer process to MoH, MoC and MEW is not effective
- the dominant type of technology transfer to MoH, MoC and MEW is the turnkey contract
- no explicit technology policy exists in MoH, MoC and MEW, in particular, or in the public sector in general
- there is a deficiency in understanding the concept of the technology transfer process among the majority of the authorities¹ in MoH, MoC and MEW
- the authorities of MEW lack an awareness of the importance of indigenous technological capability in supporting the technology transfer process
- MEW has not assessed its technological capability due to the lack of awareness of its essential nature, the lack of experience and proper assessment tools
- the current level of acquisition and absorption capability of MEW is insufficient to absorb the imported technology
- Although MEW has developed (possibly unintentionally) a certain level of technological capability over five decades of transferring technology, it has not captured and applied it.
- with minor appropriate modifications, the Panda and Ramanathan model is applicable to assess the technological capability of MEW

10.4 The implications of the research

Various implications pertaining to technology strategy, technology transfer and technological capability issues stemmed from this research. These implications are described in the following subsections.

10.4.1 Technology strategy

It is well appreciated that an appropriate technology strategy is a prerequisite for an effective transfer and utilisation of imported technology. As can be seen in the

1. "Authorities" here indicates personnel who are involved in the decision-making process. In most cases they represent the executive level of the ministries.

findings of phase one, the three ministries have no explicit technology policy for transfer and dissemination of technology. Rather, they depend on an internal planning process (the work plan). This work plan concerns simple routine tasks and reflects only short-term objectives. Hence, it is incapable of supporting the technology transfer process.

Despite the fact that the Kuwait Government, since the 1950s, has been promoting the engagement of technological know-how through the establishment and support of various related institutions and despite its frequent involvement for decades in the acquisition of foreign technologies, the government has not recognised the need for a technology policy, and the logic of including a technological component in a meaningful industrial development plan. This represents a major drawback which causes obstacles to successful technology transfer to Kuwait.

Several attempts have been made to bring the attention of the Kuwait Government to this issue. Among these efforts was the Symposium¹ on National Policy for Science and Technology for Kuwait. This symposium was arranged by the Kuwait Institute for Scientific Research (KISR) in December 2003 in collaboration with more than 80 governmental bodies, including all ministries, concerned agencies, parties and personnel within the State of Kuwait. The focus of the symposium was on various related issues, such as the need for such a policy within the context of current globalisation, its effect on industries' infrastructure and the experiments of other countries in formulating and implementing this policy. KISR requested the participants to share their views on these issues. At the end of the symposium's sessions KISR took the initiative to propose a Science and Technology Policy for Kuwait to the government for approval. KISR feels that the absence of such a policy has caused several adverse impacts on the country, particularly on matters pertaining to international

1. The symposium took place after the investigation of this research was achieved.

technology transfer. Also, the symposium stressed the importance of establishing awareness among decision makers of the role of indigenous technological capability in supporting the science and technology infrastructure.¹

It is essential for the government of Kuwait to seize this opportunity either to approve the above proposal or formulate a comprehensive and coherent national strategy for the effective transfer and utilisation of imported technology, and for the strengthening of the country's technological capability.²

Within the context of adopting a technology policy, the Kuwait government should be aware that the technology strategy should be implemented through the adoption of technology plans as integral parts of a national development plan. The technology plans, as Abdulrahman (1999) suggests, should embrace essential responsibilities such as budgeting, management, coordination, stimulation and execution of technological activities and cover specific requirements at the sectoral and intersectoral levels for the assessment, transfer, acquisition and adaptation of technology. In other words, these plans should reflect short-term, medium-term and long-term strategies, including the determination of technological priorities and the identification of sectors in which imported technology would be required.

The Government of Kuwait in particular, and developing countries in general, can learn from the successful experiences of technological development of NICs. For example, as was indicated in Chapter 3, South Korea's industrial and technological strategies can be used as useful guidance. The adoption of a set of effective and appropriate industrial and technological strategies has been among the most important factors of Korean success.

1. The Symposium on National Policy for Science and Technology for the State of Kuwait, 8 December 2003 (KISR b, 2004).

2. This issue is of particular concern at the current time as Kuwait is in the process of embarking on two major projects: the Electronic Government and the development of the northern oil fields.

10.4.2 Technology transfer

As is the case with most developing countries, Kuwait depends crucially on imported technologies for the development of its industrial infrastructure and the standard of living. However, based on the outcomes of the minor case studies and the MEW case, the technology transfer process to the three ministries in Kuwait suffers from many difficulties. It appears that these difficulties emerged and accumulated as a result of various factors, as discussed below.

The internal political lobby

The outcomes of phase one indicated that almost 50% of the authorities have complained about what they called the “internal political lobby”. This factor actually reflects the problem of corruption. As was defined in Chapter 4, corruption within the public sector is the systematic use of public office for private benefit that results in a reduction in the quality or availability of public goods and services, and enormous economic costs.

Corruption normally affects various aspects of the public sector in Kuwait, among which are the government contracts (Al-Mubarak, 2004). It influences the decision-making process to favour certain firms or individuals when issuing bids for supply of public goods and services. In most cases these firms or individuals are not the appropriate or qualified ones. However, controlling corruption is feasible. The Kuwait Government has to adopt proper strategies to address corruption. These strategies need to pay more attention to its root causes and thus to the role of incentives, prevention, and specific economic and institutional reforms.

Hors (2000) suggests procedures to fight corruption which include lowering tariffs, eliminating enterprise subsidies, minimising regulations, demonopolizing and privatising government assets, strengthened legal and judicial systems and the establishment of anticorruption watchdog bodies, such as the Independent

Commission Against Corruption in Hong Kong and smaller corruption-fighting institutions in Botswana, Chile, Malaysia, and Singapore, which were often credited with much of the progress.

Misconception of technology transfer process

The research revealed that the majority of the authorities of the three ministries possess a partial understanding of the technology transfer concept. They perceive it as the acquisition of the appropriate technology that assists the organisation to achieve its objectives. By scrutinising these objectives, it was found that the main concern of these authorities was the “hard issue” part of the technology transfer. The “soft issue” part, i.e. the absorption, organisation and managerial practices, tacit knowledge and the like, was often neglected. This view coincides with the findings of Bell (1980) in his work on the acquisition of imported technology for industrial development in the Arab Region.

“When policy measures concerned with imports of technology were developed, they were concerned almost solely with what we describe earlier as Flow A¹ with ensuring that the imported designs and equipment for new production capacity were the most ‘modern’ available” (Bell, 1980: 33).

In their study, Behbehani et al. (1982) concur with the above statement by indicating that the direct and indirect costs of acquisition of technology are not as critical in Kuwait as obtaining a technology that will assist in socio-economic development. If a potential market exists for a particular technology, it will be acquired without concern for cost, strategy or selectivity.

It must be thoroughly acknowledged that technology transfer involves the transfer of physical items (equipment, machines, tools, etc.) as well as the transfer of

1. See section 2.3 in Chapter 2 for details.

knowledge (manuals, skills, documents, etc.). As Bennett (2002: 5) indicates “a fundamental point when understanding how technology is acquired is that it is not just a physical thing but also comprises knowledge embedded in hardware and software”.

It is clear that the Kuwait Government has to rectify this misunderstanding among its authorities through various measures, such as training programmes, seminars, workshops and so forth.

Shortage of skilled workforce

The research has also showed that the shortage of skilled workforce is still representing a chronic problem for Kuwait. Although one of the policies of the Higher Planning Council is human resource development, as shown in Chapter 5, there were no indications that the Council has actually pursued this objective (Al-Mazidi et al., 2001).

All of the research participants indicated that the scarcity of skilled personnel, particularly technical staff, is a common problem. It is widely recognised that skilled personnel (managerial and technical) represent a crucial factor for the effective acquisition and absorption of transferred technology.

As indicated in Chapter 4, the total population of Kuwait is 2.33 million. The labour force constitutes about 40% of the total population, of which 73.3% are expatriates. Table 5.3 (Chapter 5) illustrates the scientific and technical researchers and workers in Kuwait. It shows that researchers and technicians in R&D per million people is 212 and 53, respectively. These figures clearly indicate that Kuwait suffers from an acute shortage of skilled and semi-skilled Kuwaiti personnel in almost all sectors of the economy. Consequently, the country relies extensively on expatriates, specifically technicians, in its socio-economic development. The imbalance in the labour force can be attributed to various

reasons, for instance, government policies (part of Kuwait foreign policy is to dedicate a certain share to expatriates from certain nationalities, specifically from the Arab World), the weak link between the educational system and industry, the nature of Kuwait society which favours administrative and management areas over professional and technical fields and the low contribution of female graduates in scientific and technical careers (Al-Ali, 1997; Qaram, 1997). More information regarding this issue is presented in section 10.4.3.

The ultimate dependency on turnkey projects

In the MEW case it was evident that MEW not only depends crucially on the foreign transferor for planning and implementing the transfer, but also for the operation and maintenance of the technology. The degree of dependency increases as the complexity of the project increases. Although these types of projects, i.e. turnkey, have had significant advantages in terms of speed of completion of projects and minimal risk, two major disadvantages were associated with it. First, the cost of a turnkey project in most cases was significantly high. Second, the participation of local staff, and hence the opportunity to learn, was restricted. The consequence was that the technology-dependency of MEW on foreign contractors has been perpetuated.

10.4.3 Technological capability

As indicated earlier, one of the most important determinants of effective transfer of technology is the existence of a certain level of indigenous technological capability in the host firm. With the rapid increase in technology complexity, the capabilities needed have become more varied and skill-intensive.

To further elaborate this issue it is important to recall the definition of technological capability in Chapter 3. Technological capability can be defined as the variety of knowledge and skills, managerial and technical, that organisations need to acquire, assimilate, use, adapt, improve and generate new technology.

Since it is evident that developing countries lack the appropriate skills to acquire and absorb the foreign technologies (not to mention innovation capability), the focus of this research was on the fundamental capabilities: acquisition and absorption.

The rationale of omitting innovation capability in this study is that this issue has been adequately investigated in the literature. Also, the current capabilities of developing countries are lagging too far behind to support this capability. Finally, as Zwizwai (1996) and Dahlman and Westphal (1984) point out, acquisition and absorption capabilities are a prerequisite for innovation capability. The accumulation of acquisition and absorption experience can provide the understanding necessary to carry out some of the tasks involved in modification or generation of new technology¹.

The following subsections describe the situation of technological capability in Kuwait and suggest a framework for the possible enhancement of this capability.

Technological capability in Kuwait

The transfer of technology (in particular know-how) has been regarded as a major source of developing indigenous capabilities (managerial and technical). Yet, the real success of any transfer depends heavily on the contribution of imported technology in building a sound indigenous scientific and technical infrastructure.

The benefits of technology transfer are twofold. In the short term, the immediate recipients benefit by boosting productivity, quality improvement, new products/processes or lower costs. Over the long term, their benefits depend on how much they learned from the technology and are able to strengthen their technological capabilities.

1. Note that even a minor incremental modification is considered as part of innovation capability.

Several developing countries have significantly enhanced their technological capabilities through the technology transfer process, though the transfer method varies.¹ However, this was not the case in Kuwait. For example, the research revealed that despite the fact that the MEW has established numerous relationships with various prominent, specialised and highly experienced international firms² over decades to provide the required technologies, no serious efforts were made to benefit from the transferred technologies in developing indigenous capability. Two factors support this finding: the continuous reliance of MEW on expatriates to acquire, operate and maintain the acquired technologies and the low score of its technological capability (46%).

Another example is when Kuwait was liberated after the Iraqi invasion, the country was almost put in jeopardy soon after the liberation due to the lack of indigenous capabilities to repair and rebuild the damaged oil sector (Al-Sultan et al., 1999).

There are various factors that may have contributed to this situation. First, the lack of a national technology policy. Second, Kuwait is a wealthy country capable of purchasing the required technology. Hence, it has not seen the need to develop indigenous capability. Third, the socio-economic structure of the country, which seeks vast prosperity,³ dictates continued heavy reliance on foreign contractors for the acquisition and absorption of technologies. Fourth, which is dependent on the preceding factor, the ultimate dependency on turnkey projects. The non-participation of local staff in technical tasks in these projects has prevented any opportunity to develop indigenous capability. Without active intervention and interaction in these projects, the growth of capability which occurs among local staff is likely to be marginal and of little value. Fifth, the lack of trust and the fear of having to risk relying on local manpower to provide

1. For example, Malaysia mostly relied on foreign direct investment (FDI), while China used original equipment manufacturer (OEM) and other types of subcontracting.

2. Siemens, Hyundai and Mitsubishi are a few examples.

3. Especially in the 1960s and 1970s.

technical services. Last, but not least, the lack of awareness among the government authorities of the importance of indigenous technological capability.

It is worth mentioning that although the findings indicated the presence of noticeable levels of indigenous technological capabilities, there was no evidence to indicate that these capabilities were developed according to a preset plan or policy. It seems that they were developed as a result of the accumulated technology transfer process.

The above argument raises a potential question: how could the public sector in Kuwait in particular, and developing countries in general, enhance their local capability and hence minimise their dependency on foreign contractors and suppliers? The following sections propose an answer to this question.

Technological capability development

Before developing indigenous capability the Kuwait Government should appreciate that the establishment of awareness of the value of technological capability and its assessment are perceived as a vehicle for the enhancement of this capability. In the MEW case there was no practical evidence that its authorities have recognised the significance of technological capability. Subsequently, MEW has never conducted an assessment of its capability.

As was stressed earlier, in Chapter 3, the starting point for the technological capability building process is the generation of a national awareness of the pivotal role of this capability in sustaining the technology transfer process. This awareness itself often generates the need to assess indigenous technological capability. In addition to other advantages, the assessment process provides a comprehensive view of the ability to operate, assimilate and adapt a transferred technology.

Having created this awareness the next step is to embark on enhancement procedures for technological capabilities. As was stated earlier, the first step lies in the formulation of a proper technological policy. This policy should explicitly emphasise the role of technology transfer in strengthening local capabilities. Then, the Kuwait Government should pay special attention to the factors that influence capability development. According to Al-Oaitaibi and Al-Sultan (2004) and Badran (2002) these factors are the learning process, a local science and technology infrastructure, the educational system and employee motivation. These factors need to be evaluated in order to take the necessary corrective actions. These factors are described below.

The learning process

The learning process can be achieved in different ways, among which are training and learning by doing. Training can improve human skills while learning by doing improves technological knowledge. The authorities in Kuwait focus only on training. As was revealed by the findings of phase one of this research, the authorities have stressed their awareness of the importance of training programmes in improving personnel capabilities.¹ However, Al-Ali (1997; 1991) observed that despite the sophisticated nature of the technology involved, public sector authorities in Kuwait have ignored the importance of training programmes in enhancing personnel skills and knowledge. He illustrated this notion by an example of a training clause in one of the public sector contracts.² The clause did not provide details about the duration of the training programme, number of trainees, the method of selecting candidates, qualifications required and so forth. Also, there was no clause specifying the incremental replacement of expatriates, nor that technical skills should be transferred to local staff. Al-Ali (1997: 89) concluded that “in the view of the decision makers, these training programmes

1. It is worth noting that the evaluation of the efficiency of training programmes and their impact on capability building is outside the scope of this research. It is, however, a subject for further investigation in the future.

2. More detail of the clause is given in Appendix B.

seem to have become a habit that occurred in their organisation regardless of the outcomes”.

This leads to an important fact: that the transfer of skills and knowledge should be considered more profound than just including a training kit in the shipment of the new technology, or a brief clause in the contract. It must thoroughly understand that skills and knowledge have to be acquired through fairly complex learning processes.

Local science and technology infrastructure

The learning process necessitates the establishment of R&D capability. Few developing countries have set up a national research institution for this purpose, but Kuwait is one of these. The Kuwait constitution¹ describes the role of the state in encouraging scientific research. Several scientific and technological institutions and centres have been established and funded by the government. Among these are the Kuwait Institute for Scientific Research (KISR), the Public Authority of Industry, the Water Resource Development Centres and the Kuwait Foundation for Advanced Science (KFAS). The aim of these institutions was the support and the development of research and studies in various sectors. However, the contribution of these institutions and centres to technological and industrial development was limited (Tahir, 2003; Al-Halwaji, 2002).

Education system

Although the Kuwait Government has devoted a notable effort to developing its educational system, the outcome of this system is rather disappointing, particularly in the technology fields. Most of the graduates do not support the minimum requirements of the local industry sector (Al-Ali, 1997). Industrialists were forced to re-train them to suit their requirements and, simultaneously, employ expatriates to fill the gaps. This was evident in the MEW case when

1. Articles 14 and 36.

some authorities¹ complained about the weakness of the technological level of the graduates.

According to Al-Ali (1997), this is mainly due to the weak link between the institutions and local industry, the lack of incentives to encourage students to enrol in scientific and technological fields, such as engineering, physics and maths and the low cost of expatriates compared to the Public Authority for Applied Education and Training (PAAET) graduates.²

It is necessary, therefore, for the Kuwait Government to reform its higher education policy to meet local industry requirements. Kuwait might learn much from the South Korean experience. South Korea has introduced appropriate technology from industrialised countries for assimilation and improvement, while simultaneously promoting the development of a domestic technological capability. The Korean Government planned an intensive programme emphasising expansion of the education and training of human labour in order to promote their capability of absorption and assimilation of foreign technology.

Employee motivation

There is a notion that the public sector in developing countries experiences various difficulties and deficiencies which have an adverse impact on its performance. As stated in Chapter 4, the public sector is normally characterised by low productivity, low morale, poor quality of products or services, poor efficiency, bureaucracy and most of all the scarcity of skilled human resources. Added to this, many negative managerial symptoms (e.g. daily routine, excessive number of employees in a certain department, the influence of personal relations and bureaucratic procedures) have unfortunately characterised the management system in the public sector. This situation is equally congruent to the public sector in Kuwait. As for Kuwait, about 92% of the Kuwaiti labour force is

1. They were the Assistant General Director, Chief Engineer and the Manager of Technical Services and Training of Sabiya power station.

2. More than 75% of graduates in Kuwait are non-science or technology based.

employed in the public sector. This labour force has been absorbed by the public sector whatever their skills, without demanding a high level of productivity, and offering higher employment benefits¹ than the private sector (Al-Oaitaibi and Al-Sultan, 2003). In contrast, the Kuwaitis take up few employment opportunities in the private sector.² This environment has left little incentive for the Kuwaiti labour force to acquire skills and improve productivity levels, as is required for absorption into the private sector.

Some of the participants in phase one of this research have recognised the low productivity and performance status of their employees. They mainly attribute it to the current incentives which are insufficient to stimulate employees to improve their productivity and performance, particularly technical staff, i.e. the engineers and technicians. They have proposed two solutions for this problem: the privatisation of the ministries or the introduction of proper incentives systems. Since the issue of public sector privatisation has been investigated by some researchers (see for example Al-Homoud, 1990), the focus of this section will be on motivation and incentives.

It is essential for authorities in the public sector in Kuwait to recognise the importance of the motivation factor and act accordingly towards improving it. Also, it must be clearly realised that employee motivation is a dynamic process, not a task. This implies constant monitoring and maintenance of the motivation level. Authorities in the Kuwait public sector need to set up a proper motivation process, taking into account different aspects of human needs. The most effective action to improve motivation is incentives. Normally, incentives boost performance levels because of the direct relationship between performance and reward.

1. Most of these benefits are financial, such as basic salary, child allowance and social allowance.

2. The government established a Manpower and Government Restructuring Programme (MGRP) in 2001 to implement the labour law, provide unemployment benefits to unemployed Kuwaiti nationals, and provide training and facilitate employment of Kuwaiti nationals in the private sector. The consequences of this programme have not been assessed yet.

To improve motivation and, hence, human skills and capabilities, the Kuwait Government should focus on the best methods to implement a scheme comprising all or some of the following incentives:

- promotion
- flow-down of goals
- formal feedback system
- conducting effective performance evaluation
- positive and empathetic leadership
- reduce interpersonal conflicts
- empowerment
- training, development and career advancement

This has to be combined with national strategy and proper management. Pay has been exempted from the above incentives because it has been proven not to be a motivating factor.

The outcomes of this research are depicted in a simple diagram in Figure 10.1. As it shows, the figure represents a “jigsaw” picture of the technology transfer process. The complete set of the picture requires the consolidation and incorporation of several other pieces. In this diagram the completion of all the pieces of the picture symbolises the success of the technology transfer process. The pieces symbolise factors affecting the success of the transfer process. Each piece has its own sub-piece to be incorporated to be effective.

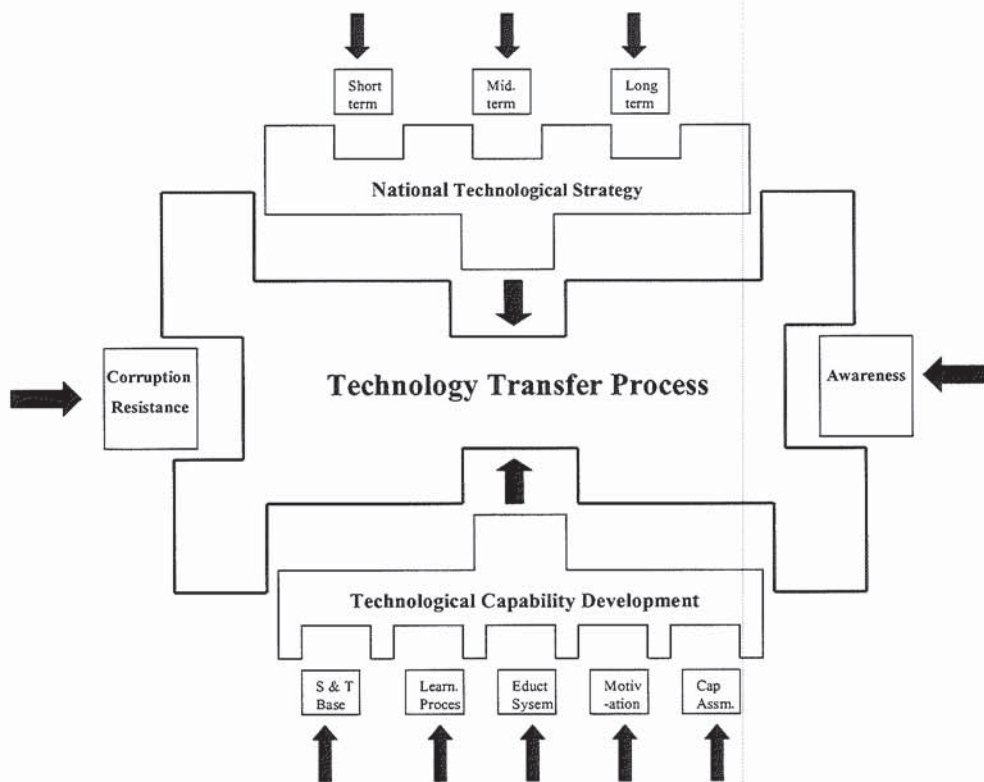


Figure 10.1 A 'jigsaw' diagram for technology transfer to developing countries

To sum up this section, the researcher would recommend the following points to be considered by the Kuwait Government in order to obtain the most benefit from the transferred technologies in the public sector. These points have been classified according to their relevance to the macro (political and economical) and micro (organisational) levels.

Macro level considerations

- there is an urgent need for a comprehensive and coherent technological strategy which would “harmonise” the technological efforts in the country. The

strategy should be able to determine the technological priorities for each sector and reflect short-term, medium-term and long-term objectives. Also, the strategy should view the transfer of technology as a process of upgrading and widening the base of techno-managerial skills in the country. This can be mainly achieved through the establishment of appropriate industrial and technological policies which promote the importation of foreign technologies to strengthen the local technological capability

- building up technological capabilities requires the establishment of awareness of their value and importance in sustaining the technology transfer process, particularly at the executive level of the public sector. Management style and attitude has to change to reflect this issue. A proper way to achieve this is by the introduction of educational instruments, such as seminars (local and international), training programmes and visits to prominent industrial sectors abroad (e.g. South Korea)
- the technology transfer process should be viewed not only as the purchase of physical items but also as a learning process. High priority should be devoted to maximise the learning effect of the technology transfer process. This would necessitate the linking of the transfer process to the process of education, training and R&D
- the incorporation of proper incentive systems within the public sector regulations would improve employees motivation and enhance their productivity. This would be part of the implementation strategy
- a proper strategy to minimise the adverse impact of corruption has to be addressed. Several measures could be applied to activate such a strategy, e.g. demonopolizing and privatising government assets, minimising regulations and strengthen legal and judicial systems
- an incentive scheme needs to be introduced in the educational system which offers rewards to students who enrol in the science and technology fields. The scheme could include privileges such as financial reward, instant appointment upon graduation, opportunities for higher-education study, early retirement, etc.

- reforming the educational system and linking local curricula to industry requirements is an essential task to cope with the new era of international development, especially in the technology field

Micro level considerations

- the assessment of acquisition and absorption capabilities is an essential task in developing technological capability. Decision makers have to recognise that prior knowledge of the relative technological capability possessed by the organisation enables it to identify its needs, to know where to seek technology candidates to be imported, to assess each technology, to compare those candidates and to select the most appropriate one. It also assists in selecting the appropriate mechanism of technology transfer. Furthermore, it supports a firm's operation by lowering the cost of productivity and improving reliability, maintenance procedures and service quality
- building up technological capabilities requires large pools of scientifically and technically trained personnel. This entails the organisation reforming its recruitment policies and processes and improving its incentives to attract the most qualified and expert resources¹
- a stronger link between educational institutions, research institutions and industry would promote and sustain the scientific and technological base. This could be achieved through the establishment of science parks, incubators and industrial liaison offices. However, this process normally requires substantial time and effort to be achieved, so the government has to take this in the account in the planning process
- local and international contractors must be required to allow the participation of local staff in the planning and execution of projects. This policy would allow the gradual attainment of technology self-reliance and minimise technological

1. Practically speaking, the lack of autonomy in the public sector in Kuwait, particularly in employment policy, and the interference of the government, parliament members, etc., may hinder the organisation from achieving this recommendation.

dependency. However, in the case of absence of a local contractor a qualified third party could undertake the role of project monitoring

- the development of a wide, informative and rich up-to-date technology provider database is necessary to support research and development activities
- the structure and application of training programmes need to be reviewed in order to ensure that trainees are given every opportunity to apply the knowledge and skills acquired through the training programme to the workplace. It must be thoroughly understood here that these training programmes should not become a habit but a contribution to the continuous improvement of the business

10.5 Generalisation of the research

One of the aims of this research was to draw a conclusion which can be generalised to the public sector in Kuwait and in the other developing countries. As for Kuwait, it may be argued that the outcomes can be generalised to include the whole public sector, based on the various similarities between the subject ministries and the other ministries and public authorities in the public sector, as described below:

- all of them constitute the public sector¹
- none of them has an explicit technological strategy
- all of their leaders (ministers, under-secretaries and general directors) are appointed by the government through the Amiri Decree
- the government controls their annual budget
- their organisational structure is identical
- their employment policy is dictated by the government.

1. Refer to sections 5.1.1 and 5.2.1 in Chapter 5 for details.

Regarding developing countries, it would be impractical to assume that the findings of this research can be generalised to all developing countries. Clearly, developing countries exhibit tremendous variation: culturally, politically, socially and economically. This study has focused on issues that arise most frequently and drawn conclusions that can be applied in many different countries.

What this research targets here is a country that relies almost completely on technological imports for its socio-economic development, mainly through turnkey projects, in their embodied forms as machinery, equipment or products and systems providing various types of services. Such a country usually relies heavily on foreign expertise across the whole spectrum of activities leading to acquisition and/or operation of the technological imports. Also, the socio-economic activities in this country must be dominated by the public sector. Furthermore, the indigenous technological capability of this country has to be limited. Needless to say, that even within this definition there is a variety of situations, particularly in the size, diversity, education, financial status or experience of the national manpower involved in importing, installing and operating imported technology.

Based on the examination of developing countries classification, it was decided to focus on the GCC for the generalisation purpose. As stated earlier in Chapter 4, these countries have witnessed an unprecedented economic and social transformation. Oil proceeds have been used to modernise infrastructure, create employment, and improve social indicators. These countries share many socio-economic characteristics, as follows:

- oil contributes about one-third to total GDP and three-quarters to annual government revenues and exports
- an extensive welfare system is in place in all GCC countries
- the industrial sectors in the GCC states lack an overall industrialisation strategy and technological and scientific policies (with the exception of Saudi Arabia)

- these countries rely extensively on foreign technologies for their economic and industrial development. The dominant type of transferred technology is turnkey contracts
- the public sector in the GCC plays a major role in socio-economic activities
- government services in many GCC countries are provided free or at highly subsidised prices
- GCC countries are highly dependent on a large expatriate labour force, particularly technical specialists, reflecting the small size of the domestic workforce and the limited domestic supply of adequate skills. Expatriate workers now account in most GCC countries for about three-quarters of the total workforce
- most of the national labour force has been employed in the government sector with high wage expectations.

Having said this, it must be acknowledged that there are, however, some differences among GCC countries. For example, per capita income ranges from less than US \$ 8,000 in Oman to US \$ 28,400 in Qatar. Also, based on current production, the proven oil reserves (in years) ranges from 15 in Bahrain to 134 in Kuwait. Moreover, the population number varies from 0.6 million in Qatar to 17.7 million in Saudi Arabia. Finally, the manufacturing sector has been growing very rapidly in Saudi Arabia, while the banking and insurance sector is by far the single most important sector in Bahrain.

By examining the similarities and the differences between the GCC countries it can be observed that the similarities are directly associated with the technology transfer process (such as the lack of technological policy, the crucial dependency on expatriates, etc.), whereas the differences are far less related. Consequently, in the light of the above argument, the findings of this research could be generalised to embrace the GCC countries.

The generalisation steps of this research is illustrated in Figure 10.2. The research has selected three ministries to represent the public sector in Kuwait. The focus then was on the public sector in Kuwait. Kuwait was chosen to represent the GCC countries. Finally, the focus was on GCC countries among the developing countries for generalisation purposes.

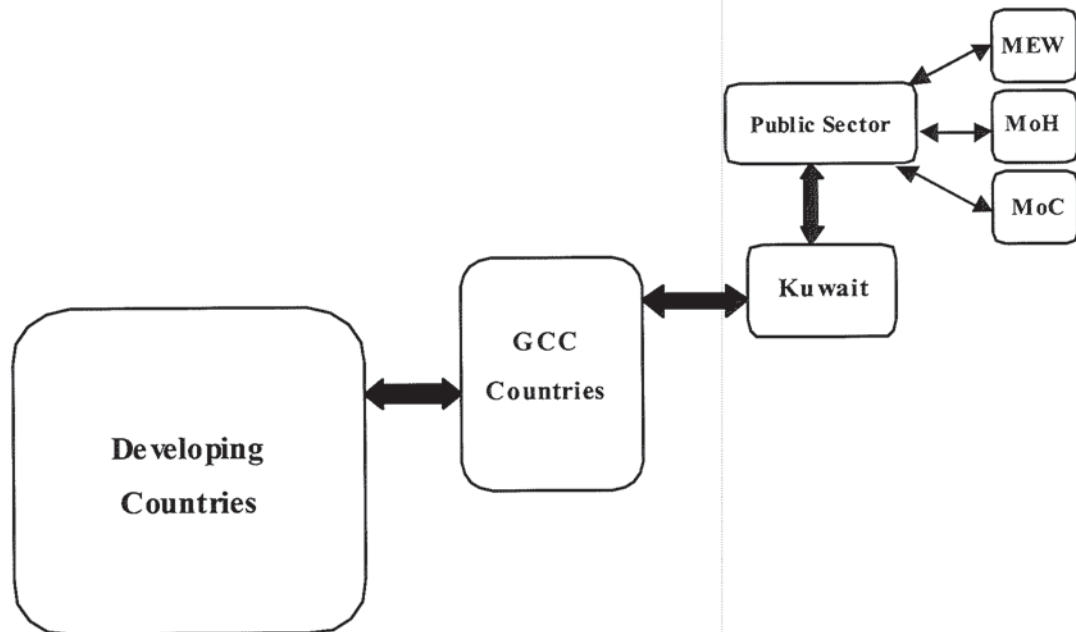


Figure 10.2 Steps of the research and its generalisation

10.6 Critique of the Panda and Ramanathan model

The outcomes of the research indicated that the Panda and Ramanathan model is applicable to the public sector. However there are some remarks about the model which need to be addressed. First, certain areas of the model required

some modifications to suit public sector organisations.¹ Second, the model did not propose a practical framework which could be used as a guideline to conduct the assessment. For example, there are some indicators² which could be assessed either at the level of the organisation's headquarters or at the power plant or at both. A practical framework would direct the researcher to the appropriate department/section for each assessment indicator. Third, the model calibrates each capability element on a three-point scale; low, medium and high. It seems that the applying of a numerical scale would be more appropriate to represent the value of indicators, especially for values which fall in between two points. For example, if an indicator value falls between the low and middle points, it would be clearer to assign a value of "1.7" or "1.6" instead of assigning "low-medium" value. Also the use of a numerical scale allows the calculation of the overall capabilities in the form of a percentage, as shown in Table 9.14 in Chapter 9. Finally, the way the model was structured is not user-friendly.

10.7 Limitations of the research

As with all research, this investigation has both strengths and limitations. It is necessary to acknowledge these limitations to ensure that the research results can be placed in an appropriate context as well as to enable future research to improve upon the present design.

The following limitations of the research should be noted. First, being a qualitative-based study means that impressions and interpretations cannot be statistically tested. Second, this research depended extensively on interviews. Two major risks are normally associated with this approach; the veracity of the people interviewed and errors of memory. Third, the sample size was small. The restriction of three organisations for the preliminary phase and one organisation as a unit analysis for the main case study made the generalisation for a larger

1. Refer to section 9.4 in Chapter 9 and Appendix F for more details.

2. For example, ACC, SEC3, SUC (see Appendix F for details).

population of organisations difficult. Fourth, there is a possibility of some missing data pertaining to Powergen, since the collected data was achieved through the post and telephone conversation only. Finally, the issue of the reliability of the research. It is generally believed that qualitative research does not provide such high reliability as does quantitative research (Sarantakos, 1997).

10.8 Research contribution

In general, this research has achieved its objectives according to its design and has obtained some meaningful outcomes which contribute to knowledge and provide empirical evidence for developing countries. As noted earlier, the majority of the previous studies that discussed indigenous technological capability in developing countries have mainly focused on the development of the innovation capability only. It is evident that technological capability in the public sector in developing countries is insufficient to acquire and absorb modern technology from foreign suppliers. Furthermore, the emphasis of these studies was on the private sector. The main contribution to knowledge was to fill this gap in the literature. This was achieved by the assessment of the acquisition and absorption technological capability of the public sector. Another “minor” contribution was the modification of the Panda and Ramanathan model. The objective of the modification was to make the model suitable to public sector organisations and to be more user-friendly.¹

10.9 Recommendations for further work

The assessment process of the indigenous technological capability should not be considered as an end by itself. Rather, it should be viewed as a basis for further action.

The findings of this research indicated that the technological capability of the public sector in Kuwait is weak. Also, the findings have proposed a framework for

1. See section 9.3.1.2 in Chapter 9 for more information.

technological capability enhancement. The researcher recommends that the public sector authorities should be acquainted with these findings in order for them, possibly, to take the necessary actions. Then, the whole assessment process can be repeated again to record any improvement in the capability. This implies that this research could represent phase one of a longitudinal study. However, if it is not feasible to conduct an assessment of the organisational levels due to the fact of that the senior management is not convinced, it would be advisable to implement the assessment model on specific workshop or department as a demonstrative tool to prove its effectiveness. As a hypothetical example, assume that the senior management at MEW is cooperative and has agreed to use the Electrical Workshop at Sabiya power station as a demonstration project for technological capability improvement. The first step towards the improvement process is to differentiate between the managerial and technical staff. This step is necessary because each of them has a different role to play, and hence the required capabilities vary. Having said this, however, there are some common capabilities that both of them, i.e. the managerial and the technical staff, share such as communicating with the others and the ability to work as a team. The next step is to implement the following activities:

- training programmes: it must be assured that these programmes were specifically designed to assist the staff in performing their tasks effectively and efficiently
- missions abroad: sending engineers and technicians from the workshop to the contractor's location to participate and gain some experience in advanced systems¹
- incentives²: a scheme of incentives shall be introduced to motivate staff. This could include annual bonus, allowances³ and promotion

1. Note this is highly dependent on contractor's cooperation.

2. Note that pay rises are not included because such decisions pertain to the Civilian Service Council (an independent governmental agency).

3. Such as transportation, accommodation, health, etc.

- work environment improvement: this includes modern office furniture and facilities (rest rooms, lounge, cafeteria, etc.)
- flow-down of organisation goals: this begins with the strategic plan, the annual organisational goals and director's individual performance goals. Each member of the workshop should be able to tie their individual performance goals to the MEW goals
- formal feedback system: the function of this system is twofold. First, it permits individual performance results to flow back to senior management who should reward consistent performance, support employee initiative, maintain the self confidence of others and reinforce desired results. Second, it allows individuals to be acknowledged as to their personal performance and pinpointing of strengths and weak areas
- empowerment¹: empowering employees with the autonomy to assume more responsibilities as this has proved to be a powerful motivator

It must be acknowledged that once the above activities have been accomplished a time frame has to be specified (6-9 months) to monitor and evaluate the result. One way of evaluating the degree of improvement at the end of the project is to apply the assessment model at the Electrical Workshop. This necessitates the refining of the model by omitting irrelevant capabilities, indicators and elements. Then the results can be compared with previous one to observe any difference.

Also, based on the current differences among the GCC countries, the author would recommend further work on the public sector of these countries to strengthen the generalisation argument and to identify any exceptions.

Finally, the assessment process could be applied to other industrial sectors to test the applicability of the Panda and Ramanathan model.²

1. Increased autonomy at lower levels of the organisation requires more discretionary decisions and increased cooperation throughout the organisation.

2. Panda and Ramanathan (1997) have suggested that their model with appropriate modifications is applicable to other industrial sectors.

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Appendix A

Reliability in Qualitative Research¹

Reliability in social science can be divided into two types: internal reliability and external reliability. The former means consistency of results within sites, and that data are plausible within that site. The latter refers to consistency and replicability of data across the sites.

The following sets of steps should be followed if reliability in qualitative research is to be achieved.

For internal reliability:

1. Use low inference descriptors.
2. Use multiple researchers whenever possible.
3. Establish a careful audit trail (record of data that can be followed by another scholar back from conclusions to the raw data).
4. Use mechanical recording devices where possible (and with permission).
5. Use participants as researchers or informants to check the accuracy or congruence of perceptions.

For external reliability:

1. Clearly specify the researchers' status or position so that readers know exactly what point of view drove the data collection.
2. Clearly state who informants are (or what role they play in the natural context) and how and why they were selected or chosen (while maintaining confidentiality).
3. Carefully delineate the context or setting of boundaries and characteristics so that the reader can make judgments about similar circumstances or settings.

1. Adopted from the work of Drew et al. (1996).

4. Define the analytic constructs that guide the study (describe specific conceptual frameworks used in design and deductive analysis).
5. Specify the data collection and analysis procedures meticulously.

Appendix B

The Pilot Survey

On December 2001 the researcher conducted a preliminary investigation in the form of an unstructured interview with the former under-secretary of MEW, Engineer Abdullah Al-Munayes (retired in 1996). He worked at MEW for more than 27 years. The last five years of his career was as under-secretary. The following inquiries were addressed through the interviews:

- 1. What is the dominant type of transferred technology to MEW and why?*
- 2. How does the process of selection and transfer of the required technologies occur?*
- 3. How often were local staff involved in the process of technology transfer?*
- 4. Is there general awareness of the significance of indigenous technological capability among decision makers? If not, why?*
- 5. What are the current technological capabilities of MEW?*
- 6. What are the factors that have an adverse impact on the development of indigenous technological capability?*
- 7. Has MEW conducted an assessment of its technological capability?*
- 8. Does MEW draw up plans for the acquiring of the required capabilities?*

According to Mr Al-Munayes, all of the MEW projects were executed by turnkey process. The prime reason for this is that this method of technology transfer is mainly characterised by speed of completion of projects and minimal risk. The selection process of the required technology – in this case a power plant project – is roughly commenced as follows. A foreign consultancy agency conducts the feasibility study and draws up the specifications. Then, MEW issues a bidding request form. Once the applications have been received and studied, MEW signs a contract with the winning firm. In most cases the selection process is based on the cost of the project and on the reputation of the firm. The involvement of MEW local staff in this process is limited to administration and legislation issues.

The technological capabilities of MEW are limited. Mr Al-Munayes believes that very little attention was given to the importance of indigenous technological capability by policy makers in MEW. In his opinion, the main reason is that Kuwait is a wealthy country and is capable of obtaining any available technology through the market. Another reason is that electricity and water are vital elements and the chief priority of MEW is to maintain their provision to a high quality, promptly and at any cost to cope with the vast development of the socio-economic structure of the country. Thus, no concern was given to the enhancement of local capabilities. As a result, MEW has never evaluated its technological capability, apart from evaluating the operational and administration skills of the staff.

Appendix C

Technology Transfer Agreement¹

The following clause² covers the training programme for the Doha Water Distribution Project.

“After preliminary acceptance of the contractor’s work, and at a time mutually agreeable with the engineer, the contractor shall employ a factory-trained start-up and systems engineer to instruct and assist Ministry of Electricity and Water operating personnel in the start-up and check-out of the entire metering and instrumentation system.

The contractor shall provide the services of a trained person who can provide the Ministry of Kuwait³ with on-site courses for maintenance and operation of the entire system”.

1. Adopted from Al-Ali (1991).

2. Part of Ministry of Electricity and Water (MEW) agreement.

3. There is no such ministry as the “Ministry of Kuwait”. What is really meant is MEW.

Appendix D

Interview Questions (Phase 1)

1. What is the technology strategy of the Ministry? Is there any relevant documentation?
2. Is this an internal strategy or part of a national strategy?
3. How would you conceptualise the term “technology transfer”?
4. What are the objectives for the adoption of the technology?
5. How frequently is technology acquired? What is the duration of the acquisition? (to determine the required learning skills)
6. What is the dominant type of transferred technology and why?
7. How dependent is the ministry on foreign firms in the technology transfer process?
8. How does the selection and transfer process of the required technologies occur?
9. How often and at what levels are local staff involved in the process of technology selection and transfer?
10. What constitutes a successful transferred technology?
11. In your opinion, what are the factors that contribute to the success of the transferred technology?
12. How would you evaluate the technology transfer process to your ministry?
13. What are the major problems normally encountered when technology is transferred?
14. How would you define the term “technological capability”?
15. Is there general awareness of the significance of indigenous technological capability among decision makers? How? If not, why?

Appendix E

MEW Interview Questions (Phase 2)

1. How would you define the term “technological capability”?
2. How would you define “acquisition “ and “absorption” capabilities?
3. Are you aware of the significance of indigenous technological capability? How?
4. What is the relationship between technological capability and the successful transfer of technology?
5. Has the organisation benefited from the accumulated technology transfer process to enhance its technological capability?
6. What are the overall levels of technological capabilities of the organisation?
 - a. acquisition and absorption capabilities
 - b. the ability to operate the imported technology
 - c. the ability to repair and maintain the acquired technology locally
 - d. the ability to manufacture the required spare parts through local workshops
7. Has the organisation conducted an assessment of its technological capability? If yes, how and when? If not, why?
8. Does the organisation draw up plans for the acquisition or development of the required capabilities?
9. What are the factors that have an adverse impact on the acquisition or development of indigenous technological capability?
10. Describe the technology transfer process of the organisation.
11. Does the organisation ensure the effective transfer of technology or does it coordinate this with policy-making bodies?
12. How would you describe the degree of dependency on foreign firms for the following activities:
 - a. technology acquisition
 - b. technology absorption

c. technology minor modification

13. What are the major obstacles to the technology transfer process?

Appendix F

Technological Capabilities Needed by Different Electric Utility Companies (Adapted from Panda and Ramanathan model, 1996)

Company type	Electric utility company	Capability required
Type 1	Electricity service company	Service, acquiring, supportive and steering,
Type 2	Electricity distribution company	Marketing & selling, service, acquiring, supportive and steering
Type 3	Power plant construction company	Construction, acquiring, supportive and steering
Type 4	Power plant consultancy company	Design & engineering, acquiring, supportive and steering
Type 5	Electricity generating and transmitting company	Production, marketing & selling, acquiring, supportive and steering
Type 6	Electricity distribution and service company	Marketing & selling, service, acquiring, supportive and steering
Type 7	Electricity generating and consulting company	Production, design, acquiring, supportive and steering
Type 8	Electricity generating, transmitting, distribution and service company	Production, marketing & selling, acquiring, service, supportive and steering
Type 9	Electricity generating, transmitting, construction and power plant	Design & engineering, construction, marketing & selling, acquiring, supportive and steering
Type 10	A – Z company	Creation, design & engineering, construction, production, marketing & selling, service, acquiring, supportive and steering

Appendix G

Capabilities and their Elements

(Adapted from Panda and Ramanathan model, 1996)

- **Strategic technological capabilities**

Creation capability (CRC)

CRC1. Capability to carry out improvement of existing product(s) or process(es) and/or development of new ones.

CRC2. Capability to create new organisational structure.

CRC3. Capability to plan, monitor and control research and development projects.

Design and engineering capabilities (DEC)

DEC1. Capability to evaluate the project in terms of technical, economic, financial, environmental and social factors.

DEC2. Capability to do routine design and detail engineering of product or process.

DEC3. Capability to adapt purchased or generated technology.

DEC4. Capability for duplicating purchased equipment.

DEC5. Capability to plan, monitor and control design engineering, and contract activities.

Construction capability (COC)

COC1. Capability to support project feasibility studies & do site engineering.

COC2. Capability to perform civil construction.

COC3. Capability to perform erection & commissioning activities for mechanical, electrical, control & instrumentation items.

COC4. Capability to plan, monitor and control construction, erection and commissioning activities.

- **Tactical technological capabilities**

Production capability (PRC)

PRC1. Capability to effectively utilise and control the conversion technologies of the main and auxiliary process.

PRC2. Capability for carrying out quality assurance, inspection and inventory control.

PRC3. Capability for troubleshooting, and for carrying out preventative, routine and breakdown maintenance.

PRC4. Capability to perform production planning, and equipment and maintenance scheduling.

Marketing and selling capability (MSC)

MSC1. Capability to identify customers, bid and negotiate the terms of product/service selling.

MSC2. Capability to develop and maintain the distribution channel for the product/service

MSC3. Capability to supply product/service to customers, as per contract, either alone or through consortium.

MSC3. Capability to plan, monitor and coordinate marketing and selling activities.

Servicing Capabilities (SEC)

SEC1. Capability for diagnosing problems & undertaking corrective actions (including repairs, maintenance & replacement)

SEC2. Capability to provide technical advice to customers.

SEC3. Capability to conduct research to determine and monitor customers' needs, wants and satisfaction levels and to set service-level standards.

SEC4. Capability to plan, monitor and coordinate service capacity, service activities, and to schedule service personnel and equipment.

• **Supplementary Technological Capabilities**

Acquiring Capability (ACC)

ACC1. Capability to identify, assess, negotiate and finalise the terms of the technology to be acquired.

ACC2. Capability to identify, assess, negotiate and finalise the terms of acquiring raw materials, supporting facilities, spare parts and consumables.

ACC3. Capability to identify, assess, negotiate and finalise the terms of the finance to be acquired without any external support.

ACC4. Capability to identify, assess, negotiate and finalise the terms of human resource to be acquired.

ACC5. Capability for planning, monitoring and coordinating resource acquisition process and vendor development.

Supportive Capability (SUC)

SUC1. Capability to provide training.

SUC2. Capability to undertake strategic planning.

SUC3. Capability for providing information support & networking.

SUC4. Capability to sell technology.

SUC5. Capability to adhere to high standards of safety and Security.

- **Steering Capability (STC)**

STC1. Capability for path finding.

STC2. Capability for decision making and implementing.

STC3. Capability to integrate the organisation's activities.

Appendix H

MEW Technological Capability Assessment (The Managerial Part)

(Adapted from Panda and Ramanathan model, 1996)

- DEC11 Total number of feasibility studies of large projects completed during the last 10 years. A new power project worth more than \$ 200 m or a capacity of 100 MW is considered large.
- DEC12 Number of large projects for which feasibility studies were completed during the last 10 years without external assistance.
- DEC13 Degree of dependence on external agencies for carrying out feasibility studies. (Tick the appropriate box)
- Dependent on outside agencies for complete study.
 - Dependent only for technology evaluation, environmental impact assessment and mitigation planning.
 - The company can perform the study but retain external consultant for review.
- DEC31 Cost of adaptation activities as a percentage of the cost of technology purchased. It means modifying the process or system of production to suit the current environment. It could cover modification of technoware, enhancement of human skills, development of operation and maintenance manuals.
- DEC32 Complexity of the adaptation process. (Tick the appropriate box)
- Adaptation in power plant & transmission & distribution system equipment
 - Adaptation in thermal cycle processes, transmission & distribution systems
 - Adaptation in operation, maintenance & training procedures.
- COC11 Degree of dependence on external agencies in site selection, construction specification preparation & construction cost estimation during the last 10 years. (Tick the appropriate box)
- Full dependence
 - Partial dependence
 - Self dependence

COC12 Level of site engineering activities. (Tick the appropriate box)

- 1st level: simple design changes such as minor layout changes
- 2nd level: load calculation on structures, piping & equipment for modification on site.
- 3rd level: failure diagnosis & recommendation of solution.

COC31 Number of plants for which mechanical, electrical & control and instrumentation erection & commissioning was done, during the last 10 years without external assistance.

COC32 Degree of dependence for erection & commissioning activities for mechanical, electrical & control and instrumentation items. (Tick the appropriate box)

- The organisation can perform a task of low level complexity
- The organisation can perform a task of medium level complexity
- The organisation can perform a task of high level complexity

ACC11 Percentage of major contracts for which technology acquisition activities were performed without any external assistance for the last 10 years. This can be computed by taking the ratio of the number of major contracts for which acquisition activities were completely handled in-house to the total number of contracts handled by the firm

ACC12 Extensiveness of database for major utility-related technologies. It can be a function of its contents, frequency of updating & extent of networking with other databases. It need to be determined for each technology such as electricity generation, transmission & distribution. (Tick the appropriate box)

- Contents of database: source address, key technology parameters, cost, reference address of users & reference feedback. Frequency of updating: annual. Extent of networking: linked to databases of industry association & academic institutions & major manufacturers.
- Contents of database: source address, key technology parameters & reference address of users. Frequency of updating: every 2-3 years. Extent of networking: linked to databases of major manufacturers.
- Contents of database: source address & key technology parameters
Frequency of updating: once in more than 3 years.
Extent of networking: no outside linkage.

ACC13 Degree of dependence in performing contractual activities. (Tick the appropriate box)

- If assistance is required for floating tender, bid evaluation, contract negotiation & letter of award placement.
- If assistance is required for bid evaluation.
- If normally no assistance is required but external consultant may be retained for occasional review of bid evaluation.

ACC21 Percentage of major contracts for which technology acquisition activities for raw materials, supporting facilities, spare parts & consumable were performed without any external assistance during the last 10 years. This can be computed by taking the ratio of the number of major contracts for which acquisition activities were completely handled in-house to the total number of contracts handled by the firm.

ACC22 Extensiveness of technological database. (Tick the appropriate box)

- Contents of database: source address, key technology parameters, cost, reference address of users & reference feedback. Frequency of updating: annual. Extent of networking: linked to databases of industry association & academic institutions & major manufacturers.
- Contents of database: source address, key technology parameters & reference address of users. Frequency of updating: every 2-3 years. Extent of networking: linked to databases of major manufacturers.
- Contents of database: source address & key technology parameters. Frequency of updating: once in more than 3 years. Extent of networking: no outside linkage.

ACC23 Degree of dependence for the procurement of raw materials, supporting facilities, spare parts & consumables. (Tick the appropriate box)

- Assistance is required for floating tender, bid evaluation, contract negotiation & letter of award placement.
- Assistance is required for bid evaluation.
- Normally no assistance is required but external consultant may be retained for occasional review of bid evaluation.

ACC31 The percentage of financial packages identified, assessed & negotiated during the last 10 years.

ACC32 Degree of dependence for the procurement of finance. (Tick the appropriate box)

- External assistance is necessary for identification of financing source, assessing, negotiating & finalising the terms of conditions.

External assistance is necessary only for review of the finalised terms & conditions.

All financial procurement activities are executed by self, excepting a few occasional reviews by external consultant.

ACC41 Extensiveness of human resource database. (Tick the appropriate box)

Contents of database: for each expert the address, relevant experience & achievements. Frequency of updating: annual. Geographical scope: global.

Contents of database: for each expert the address, relevant experience & achievements. Frequency of updating: every 2-3 years. Geographical scope: national & regional

Contents of database: for each expert the address, relevant experience & achievements. Frequency of updating: once in more than 3 years. Geographical scope: national.

ACC42 Percentage of personnel hired with more than 10 years of experience, as a percentage of the total personnel hired.

ACC51 Average time over-run during the resource acquisition process as a percentage of the schedule time. It is calculated on the basis of the extent to which the scheduled time between tender announcement to letter of award placement is exceeded.

ACC52 The percentage of new vendors developed in the various fields during the last 10 years. It can be calculated by accounting how many new contracts were awarded to new vendors.

SUC11 Average hours of training per person per annum. It is calculated by taking the ratio of total person-hours of training received to the total number of employees in the company.

SUC12 Degree of optimality in internal & external training index. (Tick the appropriate box).

Person-hour training obtained from outside falls in the range of 10-20% of total training person-hour.

Person-hour training obtained from outside falls in the range of either 5-10% or 20-30 % of total training person-hour.

Person-hour training obtained from outside falls in the range of either less than 5 % or more than 30 % of total training person-hour.

SUC13 Degree of dependence in various training activities. (Tick the appropriate box)

- More than 50% of the training material preparation & training are performed with outside assistance.
- Between 10-50% of training material preparation & training are done by outside agencies.
- Less than 10% of training material preparation & training are done by outside agencies.

SUC21 Degree of deviation from the optimal system reserve margin. It is calculated by the ratio of the difference between installed capacity & the capacity demanded to the maximum capacity demand.

SUC31 Degree of computerisation. (Tick the appropriate box).

- More than 90% of the information needs are met by accessing computerised database.
- Between 50-90% of the information needs are met by accessing computerised database.
- Less than 50% of the information needs are met by accessing computerised database.

SUC32 Degree of reliability of the information system. (Tick the appropriate box).

- The desired information is available when needed, accurate & up-to-date.
- The desired information is not available less than 25% of requested times, accurate & up-to-date.
- The desired information is not available more than 25% of requested times, not always accurate & not up-to-date.

SUC33 Level of networking within the company & with outside agencies. (Tick the appropriate box).

- All the computers & systems within the organisation are linked & have linkage with outside agencies.
- All the computers & systems within the organisation are linked but have no linkage with outside agencies.
- All the computers & systems within the organisation are not linked

SUC51 The number of fatalities per 1000 employees per annum.

- SUC52 The number of injuries per 100 employees per annum.
- SUC53 The number of lost working days per 100 employees per annum.
- SUC54 Level of safety training programme. (Tick the appropriate box).
- All the important safety training areas are included.
- Safety training only includes first aid procedure, accident investigation, fire protection & prevention & new worker orientation.
- Safety training only includes first aid procedure, fire protection & prevention
- STC11 Percentage of employees in the company sharing the vision of the top management of the company.
- More than 75% of employees have the shared vision.
- 50-75% of employees have the shared vision.
- Less than 50% of employees have the shared vision.
- STC12 Level of commitment from the top management towards technological leadership
- More than 50% of total investment in a year is in technologies new to the organisation.
- Between 20-50% of total investment in a year is in technologies new to the organisation.
- less than 20% of total investment in a year is in technologies new to the organisation.
- STC21 Degree of autonomy in decision making. It can be judged by the clear responsibilities of managers.
- STC22 Degree of participation in task planning. It can be assessed by the number of meetings organised by the managers with the employees in a year.
- STC31 Information communication effectiveness. (Tick the appropriate box)
- More than 90% of employees are aware of the contents of various memoranda issued by the management.

Between 90% -80% of employees are aware of the contents of various memoranda issued by the management.

Less than 80% of employees are aware of the contents of various memoranda issued by the management.

STC32 Liaising effectiveness of top management. (Tick the appropriate box)

Projects get clearance from government within scheduled time and company do not face public reaction (level 1).

Projects get clearance from government within 110% of the scheduled time and company faces major public reaction but not resulting in projects abandonment (level 2).

Projects get clearance from government beyond 110% of the scheduled time and company faces major public reaction resulting in projects abandonment (level 3).

Appendix I

Technological Capability Assessment (Technical Part)

(Adapted from Panda and Ramanathan model, 1996)

PRC11	Actual heat rate as a percentage of the design heat rate under the same conditions of operation. Heat rate is defined as the units (kj) of primary energy to produce one unit (kWh) of electricity.	<input type="checkbox"/>
PRC12	Unit availability factor. It is the ratio of available energy over a given time period to the max amount of energy that can be produced over the same period.	<input type="checkbox"/>
PRC13	Successful start-up rate. It is the percentage of occasions the unit is available in the grid in comparison to the total number of times requested in a given period.	<input type="checkbox"/>
PRC14	Accidental shutdowns to zero load per 7000 operating hours.	<input type="checkbox"/>
PRC21	Pollution emission index. It is calculated by taking the ratio of actual emission to allowable standard value.	<input type="checkbox"/>
PRC22	Degree of extensiveness of pollution control monitoring means. It can be done at various levels. Level 1 if it is monitored by independent agencies. Level 2 if it monitored internally and externally by plant authorities. Level 3 if it monitored internally by plant authorities.	<input type="checkbox"/>
PRC23	Inventory turnover of major spare parts. It is measured by taking the ratio of value of spare parts consumed per unit time to the average level of inventory maintained.	<input type="checkbox"/>
PRC31	Unplanned capability loss factor. It is calculated as the ratio of unplanned unavailable energy over a given period of time to the maximum amount of energy which would be produced over the same period.	<input type="checkbox"/>
PRC32	Unplanned automatic grid separations per 7000 hours of operation	<input type="checkbox"/>
PRC33	The rate of successful in operation on house load. It is calculated by the ratio of the number of times the unit could come to house load to the number of unplanned automatic grid separations per 7000 hours of operation.	<input type="checkbox"/>

PRC34 Maintenance complexity index. It can be expressed in a five-point scale corresponding to the level to which it belongs: (select the appropriate level)

- 1st level: Very minor preventative maintenance. It is carried out while the plant is running. It includes actions that are carried out using elements which are accessible with no dismantling or opening of the equipment, such as oil treatment by centrifuging or replacement of fouled filters & recorder forms.
- 2nd level: Minor preventive & minor breakdown maintenance. The identification & diagnosis of minor failures; provisional repair by standard replacement of elements provided for that purpose and performance of qualification tests of systems. Examples are preventive maintenance of switchboards or batteries and calibration of measurement sensors or instruments.
- 3rd level: Moderate preventive & minor breakdown maintenance. The identification & diagnosis of complex failures; repair by replacement of functional elements or components. Examples include the replacement of large elements such as electric motors, diesel engines & pumps.
- 4th level: Major preventive & minor breakdown maintenance. Thorough knowledge of the design, manufacture & operation of the equipment is essential. Examples are the identification & diagnosis of failures which are not corrected during second & third line operations, general or partial overhauls of equipment.
- 5th level: Reconditioning & rebuilding. The rebabbiting of turbogenerator bearings; and reconditioning of rotor shafts for pumps, compressors & turbines.

PRC35 Degree of dependence. It can be determined by examining two criteria: expenses on outside experts, tools and tackles as a percentage of total maintenance expense and the reasons for dependence.

The expenses percentage:

The reason:
.....

PRC41 Actual unit availability as a proportion of planned unit availability.

PRC42 Total maintenance man-hours used as a proportion of gross available man-hours.

SEC11 System average restoration index. It is defined as the ratio of total interruption duration to the number of interruptions.

SUC22 Average availability of the electricity generation as a percentage of the targeted objective.

Appendix J

Criteria for Evaluation

(Adapted from Panda and Ramanathan model, 1996)

Indicators	High	Medium	Low
DEC11	More than 2 projects annually	1-4 projects every 2 yrs.	Less than 1 project every 2yrs.
DEC12	At least 1 project annually (avg)	At least 1 project every 2yrs(avg)	Less than 1 project every 2yrs.(avg)
DEC13	Completely dependent	Dependent for technology evaluation & mitigation planning	External consultants is retained only for review
DEC31	If higher than 20%	If between 10% - 20%	If less than 10%
COC31	More than 2 projects annually	Between 0.5 – 2 annually	Less than 0.5 projects annually
COC32	Perform a task of only low level complexity	Perform a task of medium level complexity	Perform a task of high level complexity
ACC11	If more than 90%	If between 75% and 90%	If less than 75%
ACC21	If more than 90%	If between 75% and 90%	If less than 75%
ACC31	If more than 90%	If between 75% and 90%	If less than 75%
ACC42	If more than 20%	If between 10% - 20%	If less 10%
ACC51	If more than 30%	If between 10% - 30%	If less than 10%
ACC52	More than 20% for new vendors	10% - 20% for new vendors	Less than 10% for new vendors
SUC11	If more than 40%	If between 20% - 40%	If less than 40%
SUC12	If between 10% - 20%	If between 5%-10% or 20% -30%	If less than 5% or more than 30%
SUC21	Less than 0.1 or more than 0.4	Within 0.3 - 0.4 or 0.2 – 0.3	More than 0.2 & less than 0.3
SUC22	More than 95%	Between 85% - 95%	Below 85%
SUC31	More than 90%	Between 50% - 90%	Less than 50%
SUC32	Level 1	Level 2	Level 3
SUC33	Level 1	Level 2	Level 3
SUC51	If more than 0.1%	If between 0.05 – 0.1%	If less than 0.05%
SUC52	If more than 2%	If between 1 – 2%	If less than 1%
SUC53	If more than 10%	If between 6 – 10%	If less than 6%
SUC54	Level 1	Level 2	Level 3
STC11	More than 75%	Between 50% - 70%	Less than 50%
STC12	More than 50%	Between 20% - 50%	Less than 20%
STC21	Performance contracts exist at all functional level interface	Performance contracts exist at all business unit level interface	Performance contracts do not exist
STC22	More than 25	Between 15 – 25	Less than 15
STC31	More than 90%	Between 80% - 90%	Less than 80%
STC32	Level 1	Level 2	Level 3
PRC11	More than 20% of the design rate	More by 10% - 20%	More by less than 10%

Indicators	High	Medium	Low
PRC12	More than 85%	Between 70% - 85%	Less than 70%
PRC13	More than 90%	Between 75% - 90%	Less than 75%
PRC14	More than 30	Between 20 – 30	Less than 20
PRC21	More than 1.1	Between 0.9 – 1.1	Less than 0.9
PRC22	Pollution level monitoring is open for independent verification	Monitoring is done both inside & outside by plant authority	Monitoring is done only inside plant by plant authority
PRC23	More than 1	Between 0.5 – 1	Less than 0.5
PRC31	More than 10%	Between 4% - 10%	Less than 4%
PRC35	Expenses equal or more than 50% of maintenance expenses	Expenses equal or more than 10% & less than 50%	Expenses is less than 10% of total maintenance expense
PRC41	More than 0.9	Between 0.7 & 0.9	Less than 0.7
PRC42	More than 0.9	Between 0.7 & 0.9	Less than 0.7
SEC11	More than 10 hours	Between 3 – 10 hours	Less than 3 hours

Appendix K
Numerical values of the indicators

Design and engineering capability

Indicator	Ordinal value	Assigned value
DEC11	High	3
	Medium	2
	Low	1
DEC12	High	3
	Medium	2
	Low	1
DEC13	High	1
	Medium	2
	Low	3
DEC31	High	3
	Medium	2
	Low	1
DEC32	High	3
	Medium	2
	Low	1

Construction capability

Indicator	Ordinal value	Assigned value
COC11	High	1
	Medium	2
	Low	3
COC12	High	3
	Medium	2
	Low	1
COC31	High	3
	Medium	2
	Low	1
COC32	High	3
	Medium	2
	Low	1

Acquiring capability

Indicator	Ordinal value	Assigned value
ACC11	High	3
	Medium	2
	Low	1
ACC12	High	3
	Medium	2
	Low	1
ACC13	High	1
	Medium	2
	Low	3
ACC21	High	3
	Medium	2
	Low	1
ACC22	High	3
	Medium	2
	Low	1
ACC23	High	1
	Medium	2
	Low	3
ACC31	High	3
	Medium	2
	Low	1
ACC32	High	1
	Medium	2
	Low	3
ACC41	High	3
	Medium	2
	Low	1
ACC42	High	3
	Medium	2
	Low	1
ACC51	High	1
	Medium	2
	Low	3
ACC52	High	3
	Medium	2
	Low	1

Supportive capability

Indicator	Ordinal value	Assigned value
SUC11	High	3
	Medium	2
	Low	1
SUC12	High	1
	Medium	2
	Low	3
SUC13	High	1
	Medium	2
	Low	3
SUC21	High	3
	Medium	2
	Low	1
SUC22	High	3
	Medium	2
	Low	1
SUC31	High	3
	Medium	2
	Low	1
SUC51	High	1
	Medium	2
	Low	3
SUC32	High	3
	Medium	2
	Low	1
SUC33	High	3
	Medium	2
	Low	1
SUC52	High	1
	Medium	2
	Low	3
SUC53	High	1
	Medium	2
	Low	3
SUC54	High	3
	Medium	2
	Low	1

Production capability

Indicator	Ordinal value	Assigned value
PRC11	High	1
	Medium	2
	Low	3
PRC12	High	3
	Medium	2
	Low	1
PRC13	High	3
	Medium	2
	Low	1
PRC14	High	1
	Medium	2
	Low	3
PRC21	High	1
	Medium	2
	Low	3
PRC22	High	3
	Medium	2
	Low	1
PRC23	High	1
	Medium	2
	Low	3
PRC31	High	1
	Medium	2
	Low	3
PRC32	High	1
	Medium	2
	Low	3
PRC33	High	3
	Medium	2
	Low	1
PRC34	High	3
	Medium	2
	Low	1
PRC35	High	1
	Medium	2
	Low	3
PRC41	High	3
	Medium	2
	Low	1
PRC42	High	3
	Medium	2
	Low	1

Steering capability

Indicator	Ordinal value	Assigned value
STC11	High	3
	Medium	2
	Low	1
STC12	High	3
	Medium	2
	Low	1
STC21	High	3
	Medium	2
	Low	1
STC22	High	3
	Medium	2
	Low	1
STC31	High	3
	Medium	2
	Low	1
STC321	High	3
	Medium	2
	Low	1

Servicing capability

Indicator	Ordinal value	Assigned value
SEC11	High	1
	Medium	2
	Low	3

Chapter 6

Profile of the Case Studies

Introduction

The discovery of oil in the 1940s ushered in a comprehensive and radical change involving different aspects of Kuwait's society: educational, cultural, economic and structural. Health, communication and utility ministries have played a crucial role in laying down the foundation for this change and in satisfying the needs and requirements of cultural evolution. These three ministries have provided vital services for the community. Moreover, based on the nature of the provided services, these ministries are involved with the acquisition of foreign technologies more often. Therefore, these ministries are considered to be suitable candidates to investigate the technology transfer process and to assess their technological capability, as illustrated in Chapters 8 and 9. All of these ministries are owned, operated and maintained by the government.

This chapter provides a summary of the profile of the Ministry of Health and Ministry of Communication. Because it represents the core of the empirical work of the research, an in-depth profile of the Ministry of Electricity and Water follows. It should be noted that the researcher's objective was to focus on technology transfer issues within each ministry. However, the lack of adequate supporting references in the literature and within the ministry publications represented a major obstacle in achieving this objective.

6.1 Ministry of Health (MoH)

The Government of Kuwait is focusing its attention for health services and medical care through the Ministry of Health (MoH). Kuwait has highly developed and comprehensive public health services that are provided to both citizens and residents (Health Statistical Report, 2003). The MoH in Kuwait offers an essentially free health service to all Kuwaiti citizens and at a subsidised fee for residents. This service is disseminated through five health regions covering the whole country. Each region maintains a number of primary health care centres and one general hospital (secondary care level). All the specialised hospitals and centres are concentrated in the separate Sabah health region (tertiary care level). The government has been allocating generous funds to construct hospitals, polyclinics and school clinics across the country. In 2002, the Government's annual expenditure on health was \$ 979 million. The health care cost per capita was \$ 477. In addition to providing health care services to the public, MoH regulates the work of the private hospitals and clinics and continuous monitoring of their performance. As of 2002, the total number of the employees in MoH is 27,877, about 27 % of whom are technicians (most of them are expatriates).

In 2002, there were 298 general and specialized hospitals, health care centres and clinics in Kuwait. In addition, there are 47 hospitals and clinics which are totally owned and operated by the private sectors (Health Statistical Report, 2003). Although widely dispersed with its employees, the ministry maintains an essentially manual system for its records whether administrative or clinical. The MoH has attempted to introduce information technology and integrated health information systems since 1980. However, these attempts resulted in isolated small solutions in several hospitals. On the whole, the MoH continues to suffer from the lack of an integrated health information infrastructure resulting in:

- incomplete and fragmented patient records

- lack of control over drug dispensing and other health services leading to high wasteful expenditure
- unavailability of fast reliable information for proper decision making
- no wide on-line communication facility within the MoH or to international institutions

In terms of technology initiatives, in 1995 the MoH declared and adopted a new strategy to establish a National Health Information System: "Afya" the Arabic word for good health, was chosen as a name for this technological project for the execution of the strategy. A budget of nearly 8.5 million Kuwaiti Dinars (around US\$28 million) was granted for the whole Afya project (ibid.).

AfyaNet will provide the basic communication infrastructure for the health care arena within Kuwait. No integrated health systems are expected without it. It would facilitate internal communication within the MoH and this will positively effect information dissemination and flow. The network will also allow the MoH professionals easy access to the Internet and therefore the international wealth of information. It will also allow them to communicate with each other and engage in on-line live consultations and case studies locally and remotely (telemedicine as an example). Most of all, and with the implementation of the health care information system, the duplication and waste in some services will be controlled leading to cost savings, better decision making, calculated planning, and eventually an overall better health care service (ibid.).

There are certain challenges in this technical project. AfyaNet's scope is very large and the implementation period is long. This is significant when considering:

- a. availability of highly qualified technical staff to support the network
- b. fast technology changes

To lessen the effect of these challenges, the MoH is keen to rely on the network vendor for its support for almost three years from the start of implementation.

During this period extensive staff recruitment and training will take place at the MoH. The technical specifications will be continually upgraded as part of the vendor contract subject to the latest compatible technology at time of delivery. Considering the fact that some facilities are old, inconveniences will be expected at the clinical facilities on both sides (vendor as well as MoH). A major consideration will be given to vendors who previously handled similar installations successfully.

In addition to the Afya project, the majority of the acquired technologies at MoH are associated with radiology (Computed Tomography (CT scan), Magnetic Resonance Imaging (MRI), X-Ray, etc.), intensive care units, anaesthesiology departments and biomedical services.

6.2 Ministry of Communications (MoC)

The communication services were introduced to Kuwait in 1956 by a UK company called British Cable and Wireless. Since then the Kuwait Government has devoted its efforts to developing the communication sector.

Because of the distinctive geographical location of Kuwait in the Arabian Peninsula, the government has given the transport and communications sector top priority to be able to cope with the vast technological development.

The Ministry of Communications has the responsibility for regulating and providing transportation (land and sea), the postal system and telephone network services. Some of the international services provided by the MoC are electronic mail (also called K-Mail), video conferencing, Internet, magnetic card for public phones, telex, AT&T prepaid calling cards, etc. The ministry also provides wireless services such as Smart Card, Motorola Wireless Call, Citizen Band Radio (CB) and Maritime Wireless.

Registration of navigation lines or regular ships, investigation of maritime collisions, issuance of transport certificates, inspection and survey of small ships,

investigation of accidents resulting in oil pollution of the sea are only some of the responsibilities of the ministry.

The newest facility of the Ministry of Communication is the Telecommunication Centre located in the heart of Kuwait City. The Liberation Tower is the most important component of this centre. Constructed by the Ministry of Public Works, this is the fifth tallest tower in the world (Ministry of Communication, 2003).

The ministry consists of eight sectors: communications, planning and administration, finance, customer services, international services, transportation and backing services and the post. The total number of employees was 7,559 at the end of 2002 (ibid.).

6.3 Ministry of Electricity and Water (MEW)

In Kuwait, the electricity and water sector is developing rapidly and is making significant improvements to the country's infrastructure. The increase in population, the development of new residential areas and the expansion of local industries appear to be responsible for the rapid rise in the utilities demand (Eltony, 1995). Kuwait has invested substantially in modern technologies to sustain its needs. Currently, these utilities are entirely owned by the government. The Ministry of Electricity and Water (MEW) is responsible for the generation, operation, maintenance and distribution of both services. The two utilities are fully integrated within dual-purpose power and water cogeneration units, where conventional steam boiler turbine generator systems (SBTG) are utilised to generate power and to supply the required steam for the water desalination process. The dual-purpose plants employ thermal steam turbines and multistage flash desalination units and use different types of fuel available in the country, such as natural gas, heavy fuel oil, crude oil and gas oil.

It should be mentioned that most of the desalination plants were either completely destroyed or dismantled and transferred to Iraq during the occupation

of Kuwait. Enormous efforts were subsequently devoted by the government to repair and reconstruct the entire water and electricity network in the country, a task which has proved to be very costly. During the past few years, MEW has witnessed a shift in its employment policy. This shift is represented in the increased number of Kuwaiti employees and the introduction of new technology to support these employees in performing their duties (MEW statistical year book: water, 2002). However, most of these employees were assigned administrative tasks. MEW acknowledged that the expansion in applying modern technology would only be successful if it was combined with a trained workforce. Therefore, MEW provided its employees at all organisational levels with different training programmes¹. Currently, there are a total of 7,228 (as of 2002) employees working at the MEW. The distribution of personnel and the organisational structure of the ministry are illustrated in Table 6.1 and Figure 6.1 respectively.



Table 6.1 MEW personnel distribution
Source: MEW yearly statistics book, 2002.

1. It will be evident in Chapters 8 and 9 that these programmes were insufficient to absorb the imported technologies.



Illustration removed for copyright restrictions

Figure 6.1 MEW organisational structure
Source: MEW Yearly Statistics Book: Water, 2002.

In the subsequent sections, the water and electricity utilities will be explored in more detail.

6.3.1 The water sector

Kuwait is an arid country. Since its foundation, the State of Kuwait has faced extremely challenging circumstances represented by the scarcity of natural fresh water resources. These resources are limited to a very few brackish water and ground water wells, which are scattered in some areas around the country.

The nature of Kuwait's climate had worsened the situation. The geographical position of Kuwait in a desert region has deprived it of almost all fresh water, which obstructed its development for many years in the past. Being located on the Arabian Peninsula, the characteristics of the climate of Kuwait are those of a typical desert having extreme high temperatures, a high percentage of sunshine and frequently occurring dust storms. Maximum temperatures range from 40° C to 50° C during the hottest season in July and August, while mild and cool days characterise the weather from November to April. During the cooler months of December and January, night temperatures can be as low as 0° C. Occasional rain falls between November and May. It is generally light and amounts to an average of fifteen centimetres (six inches) annually, although thunderstorms can bring as much as five centimetres at a time. Only a small amount of rainwater percolates into the ground because of the high evaporation and the presence of an impervious layer in some regions.

Because of this dilemma, Kuwait is obliged to secure its needs for potable water through various means. During the pre-oil discovery era Kuwait turned to Shaat-Al-Arab, a large natural water reservoir south of Iraq, for fresh water supplies brought by Dhows (large wooden ships). Primitive storage and distribution networks were established to control the utilisation of fresh water locally. Transport of water by Dhows continued for some time before specially designed wooden ships replaced them. This situation has changed radically after the

discovery of oil in the late 1940s. The revenue from oil sales was invested in modern water production facilities that could cater for fresh water demand.

Since the 1950s, Kuwait has relied heavily on desalination to meet its critical need of fresh water for drinking and domestic purposes, particularly with the continuous growth in population and the expansion of local industries and the agricultural sector. It uses advanced technology in desalinating seawater. As a result, Kuwait is considered one of the most experienced countries in the realm of water desalination (Abdel-Jawad et al., 2001).

Management of its scarce water resources is one of the greatest challenges facing Kuwait. The main institutions involved in water resources management are:

- The Ministry of Electricity and Water: MEW is responsible for generation, operation, maintenance and distribution of both services. In addition, research studies, development, exploration, monitoring and granting licences for drilling and using groundwater are other major tasks that MEW is responsible for.
- The Water Resources Development Centre: a highly specialised centre responsible for conducting research in the domain of water resources. It is attached to MEW.
- The Ministry of Public Works: responsible for sewage water networks and collection reservoirs, wastewater treatment and utilisation.
- The Public Authority for Agricultural Affairs and Fish Resources: responsible for irrigation systems and monitoring ground water quality and quantity.
- The Kuwait Institute for Scientific Research: in charge of research related to water resources.
- The Environmental Protection Council: in charge of monitoring water quality.

Multi-Stage Flash (MSF) technique

In the early part of 1952, a plan was endorsed to establish a desalination plant that utilises the submerged tube technique. The basic idea of this technique is to employ a submerged tube to evaporate seawater and pass the evaporation to a condensation chamber. The resulting water is collected in large storage tanks. The inefficiency and the high cost of the submerged tube conventional technique led MEW to seek more appropriate desalination technology. The solution was brought from Westinghouse Company in 1957 when it first introduced the Multi Stage Flash (MSF) technology. The design was based on an old multi-effect system design known as a once-through system. The basic concept of this technique is that the intake water is heated then discharged into a chamber maintained slightly below the saturation vapour pressure of the incoming water, so that a fraction of the water content flashes into steam. The steam condenses on the exterior surface of the heat transfer tubing and becomes water. The unflashed brine enters another chamber at a lower pressure, where a portion flashes to steam. Each evaporation and condensation chamber is called a stage.

Kuwait was the first to adopt this technology and awarded Westinghouse Company the construction of the first commercial MSF desalination plant. Kuwait also took the lead in modifying and upgrading most of the original specification of the MSF technique by MEW engineers to suit its requirement. Initially, the company established a four-stage flash type each with two units of 0.5 MIGD (million imperial gallons per day) production capacities. Subsequently, MEW discovered that from an engineering and economic perspective the size of 6 MIGD proved ideal in terms of steam consumption and chemicals and yielded optimal production. Hence, it became the backbone of the fresh water industry in Kuwait (MEW Statistical Year Book: Water, 2002).

The location of Kuwait along the north west of the Arabian Gulf has a significant effect in supplying abundant seawater, and also made the elements of the

seawater desalination technologies readily accessible. The number of MSF units has grown as the demand for fresh water has increased. In 1979, Kuwait was leading the world with an installed MSF capacity of 102 MIGD. By 2000, the total number of operating MSF in MEW was 44 units, with a total capacity of 315.6 MIGD. The total capacity of the distillation plants will be 345.6 by the year 2006 when the new station (Sabiya) is fully operational. The following figure illustrates the growth rate in the MSF installed capacity in Kuwait over the last 40 years.



Figure 6.2 Growth rate in MSF units installed capacity
Source: MEW Yearly Statistics Book: Water, 2002.

Following its success in Kuwait, the MSF process became the most widely used technology for seawater desalination in the world. Wangnick indicates that the total capacity of all seawater desalination plants worldwide grew from nearly 32

MIGD in 1966 to 3 billion IGD in 1997. The MSF process alone grew worldwide from a total capacity of 30 MIGD in 1966 to 453 MIGD in 1976, and about 2 BIGD in 1996. In other words, the MSF process dominated the world's seawater desalination by almost 95% in 1966, by about 91% in 1976 and about 75% in 1997 (Wangnick, 1998). In 1997, the total installed capacities of MSF plants in the Gulf Cooperation Council (GCC) countries reached almost 81% of the world's total installed capacity. Kuwait alone accounts for about 15% of the world's total installed capacity and 19% of the GCC countries' total installed capacity.

Kuwait has adopted the MSF technology as part of dual-purpose systems providing power and water by cogeneration. These dual-purpose systems have successfully supported the country's fastest growth rate and have backed up the social, economic and industrial developments witnessed in Kuwait during the last four decades. In particular, the MSF process has proved to be the most reliable and safest source of the highest purity and best quality fresh water from the sea, regardless of the feed water quality. In addition this method requires less space and incurs substantial saving in operation and maintenance costs (Al-Wazzan & Al-Modaf, 2001).

Currently, there are six MSF distillation plants distributed over different locations along the Gulf coastline of Kuwait. Each distillation unit consists of a number of stages ranging between 24-26 stages and the capacity of each unit is between 5-6 MIGD. Table 6.2 demonstrates the commissioning date and the total capacity of these plants.

As stated previously, these plants are fully integrated within dual-purpose power and water cogeneration complexes where conventional Steam Boiler Turbine Generator (SBTG) systems are used for power generation and for supplying the required steam for operating the MSF distillers.

Station	Date of Commissioning	Total Capacity MIGD
Al-Shuwaikh	1960	28
Al-Shuaibah North	1965	9
Al-Shuaibah South	1971	30
Al-Doha East	1978	42
Al-Doha West	1983	110.4
Azzour South	1988	115.2

Table 6.2 MSF plants in Kuwait

MSF features

As mentioned above, the MSF process has proved to be the most suitable method for Kuwait's environment. This is particularly significant in Kuwait where the feed water quality is characterised by its high silt density, which could be a major problem for other desalination technologies. MSF remains practically independent of feed water quality.

The following are some of the positive impacts that have resulted in the present extensive use of MSF plants in Kuwait (Abdel-Jawad et al., 2001):

- It would be extremely difficult to maintain the sudden and vast increase in the industrial, social and economic growth in Kuwait that commenced earlier in the 1960s and 1970s without sufficient power and fresh water resources. The MSF and SBTG combinations were the only suitable candidates for the large power and water cogeneration plants needed then.

- The MSF process is thermally driven, which requires relatively high thermal energy inputs. The abundance of gas as the primary source of thermal energy made such extensive application of the MSF process affordable and held in check any concern over its high-energy consumption. MSF units with very large capacities, e.g., the 6-MIGD (operated at normal temperature), which became the standard capacity in Kuwait, favoured the MSF process over other commercially available processes. Such a capacity proved to be very suitable for maximum plant utilisation under the prevailing conditions in Kuwait.
- The history of the MSF technology in Kuwait as well as the other GCC countries reveals no cultural or social concern on the part of the public regarding the extent to which MSF product water is used. The fact that the process involves heating to high temperatures and results in distilled product water made this water fully acceptable without reservation.

Based on its implementation in Kuwait, Al-Wazzan and Al-Modaf (2001) summarised the major advantages of the MSF technology as follow:

- very high resulting water quality
- high independence of feed water quality
- very high reliability and safety record
- less space required
- operation and maintenance efficiency
- minimal or insignificant impact on the environment

Although the MSF process plays a crucial role in sustaining the continuous growth in fresh water demand in Kuwait, there are major drawbacks associated with this technology (ibid.):

- very low water recovery ratio, typically only about 10% of the total feed water to the MSF is recovered as distilled water
- high thermal energy input, which places the MSF process in the highest energy consumption category in comparison to other commercially available desalination processes
- inflexibility in power and water cogeneration systems due to the dependence of MSF on the steam imported from the SBTG as the main source of energy
- relatively high capital cost

Operation and maintenance of MSF plants

Over the last four decades, Kuwait has accumulated a great wealth of knowledge and experience in the operation, maintenance and, as required, development of technical and engineering specifications of MSF plants. Today, MEW independently operates and maintains all MSF plants locally utilising all available local resources including highly experienced staff covering all technical and administrative activities. Operation and maintenance scheduling is designed to maximise the availability of MSF units during the summer months when the demand for freshwater reaches its peak value. Regular annual maintenance is usually scheduled during the moderate and cold weather months, i.e., when the demand for freshwater is less.

Based on the previous facts, “ Kuwait, undoubtedly, has successfully transferred, managed and indigenised promptly all the technological know-how aspects of MSF”¹ (Abdel-Jawad et al., 2001).

1. This statement is somehow misleading because MEW is still heavily dependent on foreign contractors and expatriates to build and maintain its MSF units, as discussed in Chapters 8 and 9.

Reverse Osmosis technique (RO)

Although MSF is still the dominant technology in the desalination field, its high thermal energy consumption prompted the future of this process to be questioned. The energy crisis during the 1970s highlighted the importance of searching for alternative methods to MSF. After decades of continued attempts, the Reverse Osmosis method has proved to be an important and practical one for water desalination and purification. This technology is based on membrane-type desalination, where pressure is applied continuously to the feed water, forcing water molecules through a semipermeable membrane. Water that passes through the membrane leaves the unit as product water; most of the dissolved impurities remain behind and are discharged in a waste stream.

When RO was first introduced in the 1960s, it was considered to desalinate only the brackish water which is much less saline than the seawater, but still far too saline for human consumption. Today, however, the process has been improved and seawater RO units are available on a commercial scale.

The major contributing factor to the increased popularity of RO is that it is inherently more efficient and much simpler than MSF. Unlike the MSF process which requires a large quantity of thermal energy, the RO process operates at ambient temperature, hence requires less energy. In addition, RO units are easier to operate and maintain, and require much less space. Also, due to the design simplicity and low energy consumption, the cost of an RO unit is lower than MSF.

MEW has installed 33 brackish water desalination units employing RO technology, with a total capacity of 9 MIGD. This type of water is used for blending with distilled water, irrigation and landscaping, domestic purposes, livestock watering and construction works. Moreover, MEW has decided to rely on this resource to turn some of it into potable water, which is stored for

emergency usage.

Having recognised the significance of the RO seawater process, in 1984 MEW conducted an RO research programme with the cooperation of the Kuwait Institute for Scientific Research (KISR) and GKSS, representing the Ministry of Research and Technology of the Federal Republic of Germany at that time. The main objective of this programme was to test and optimise the RO process under local conditions. As a result of the continuous development and implementation of RO technology, the encouraging result obtained from applying the RO method to brackish water and the improvement of the membrane materials, MEW is now on the threshold of constructing its first large seawater RO plant at Az-Zour North with a production capacity of 24 MIGD.

Water storage and networks

The water distribution system in Kuwait comprises two networks. One for fresh water and the other for brackish water. Each system has its own underground reservoirs, pumping stations and elevated towers and necessitated facilities.

The MEW plan is to increase the potable and brackish water storage capacity as a stand by for emergencies and for meeting peak consumption. Such a plan involves the construction of reservoirs with different capacities in various locations. Table 6.3 shows the present storage capacity.

The fresh water reservoirs are equipped with infection equipment to disinfect the water from harmful particles. This equipment operates automatically from a control centre connected to pumping stations.

The water produced from distillation plants or ground wells is pumped to the underground reservoirs then to distribution networks and elevated towers located in several areas around the country. The distribution networks consist of main pumping and distribution lines and subsidiary networks. At the current stage,

Table 6.3 Fresh and brackish water capacity
Source: MEW Statistical Year Book: Water , 2002.

these networks do not cover the entire country. In areas where water lines are not yet installed people can easily obtain water from water filling stations located in different areas of Kuwait by means of water trucks.

Chemical works

In order to be drinkable, the produced distilled water needs to be mixed with underground water which is supplied from brackish water wells. Then, the distilled water is disinfected by injecting a chlorine solution to eliminate bacteria and harmful organisms. Finally, caustic soda solution is added to maintain the OH value within the required limits as specified by the World Health Organisation (WHO). This operation takes place in the blending plants in the Chemical Works Administration (CWA). CWA has many different functions. One of the major responsibilities of CWA is to maintain the high standard of the quality of distilled fresh water. It achieves this by continuous examination of samples which are collected randomly from different locations. These samples are chemically analysed in the CWA's administrations lab. These labs have been recently equipped with advanced instruments to carry out tests for all heavy metals which pollute the distilled water, and are supported by highly skilled national staff.

In addition, the CWA supervises the flushing and disinfection process for the new water networks in the new districts, and arranges the training courses for the students from Public Authority for Applied Education and Training colleges.

Consumption rate

The annual consumption of fresh water has been steadily increasing over the past decades. In 1959, the average per capita was about 13 imperial gallons per day (IGD), which is equivalent to 60 litres. This increased dramatically during the following years at a very high rate until it reached more than 109 IGD in 2000, which is equal to 503 litres. Such a massive growth in the per capita consumption could not be sustained without a much faster growth in the MSF production capacity and the construction of new desalination plants, which are required to maintain the fast growth in population and industries (Mukhopadhyay et al., 2000).

Although fresh water resources in Kuwait are limited as was already discussed, citizens and residents are behaving as if it is bountiful. The latest monthly report issued by MEW in July 2002 showed that the daily average consumption rate has reached a critical level necessitating use of the strategic water reservoir of the state. A recent study carried out by KISR has attributed this negative phenomenon to the pricing policy. The estimated cost of desalinated water is around US \$6.5/1000 IG. The consumer is, however, charged at US \$2.7/1000 IG, and the industrial sector is charged even less (US \$0.8/1000 IG). As it is part of government policy to maintain the welfare of the citizens by providing financial support to the utilities, these prices have been in force since 1966 (Al-Rashed et al., 1998).

The continuity of this phenomenon will undoubtedly lead to a perilous water crisis. Therefore, it is crucial to change the current behaviour of consumers (individuals, industries and institutes) through the introduction of awareness programmes for consumers or minimising government subsidies for this service. It is hoped that these actions could lead to an appreciation of the limitation of fresh water resources.

Table 6.4 shows the statistics of production and consumption of fresh water over the period 1975-2000, while Figure 6.3 shows the per capita consumption rate for the same period.



Aston University

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Table 6.4 Consumption of fresh water for the period 1975-2000

Source: MEW Yearly Statistics Book: Water, 2002.

Per Capita Consumption Rate



Aston University

Illustration removed for copyright restrictions

Figure 6.3 Per capita consumption rate

Source: MEW Yearly Statistics Book: Water 2002.

Water Resources Development Centre

Due to the demand for water the Water Resources Development Centre was established in 1968 in collaboration with the United Nations Development Programme (UNDP) and under the sponsorship of MEW as a specialised centre for research, development and conservation of water resources. The centre is responsible for the following tasks:

- studying present and anticipated demands for water
- carrying out technical, environmental and economic research on water resources
- issuing assurance certificates for various materials to be safely used in the water field in Kuwait
- participating in technical specification committees and different water projects
- conducting training programmes for local college students

The centre includes the following departments:

- Research and Development
- Chemical Lab
- Bacteriological Lab
- Technical Library

Future plans

In addition to the 44 MSF units currently in operation, four additional units are under construction at the Az-Zour South location as part of stage two of the project. All four units are of similar capacities to the existing ones, i.e., 6 MIGD at normal temperature (90°C) and 7.2 MIGD at high temperature (110°C). Construction, operation and take over of all distillation units have been completed and the remaining outstanding work and the handing over of contractual spare

parts are expected to be completed by the beginning of 2004. In stage three, the plan is to supply and erect four distillation units to produce 24-28.8 MIGD. It is estimated to be completed by mid-2004.

MEW is planning to install two additional MSF units at the new Sabiya Power Station, north of Kuwait, each with 12.5 MIGD capacity with provision for increases in the capacity up to 15 MIGD per unit at higher temperatures. These two units are expected to be operational in year 2004. In addition, an RO desalination plant project with a capacity of 24 MIGD at Azzour North is expected to be in service by 2006.

To counteract its water shortage, the government of Kuwait unveiled a US \$2 billion Kuwait-Iran water project. Under this plan, up to 200 million gallons per day of fresh water is to be pumped from Karkheh Dam in south-western Iranian territory through a 540 km pipeline to the coast of southern Kuwait. Of this 330 km will be constructed on Iranian territory, while the rest will be laid under the sea. Kuwait is expected to promulgate its stance after an all-out survey of the plan. It is anticipated that this project will be completed within year 2005 and it will be carried out by a consortium of investors from Iran, Kuwait and the United Kingdom.

6.3.2 The electricity sector

Electricity is a vital element in the development of the economic and social aspects of developing nations. Kuwait is no exception in this respect. The amount of consumed electricity in Kuwait has grown consistently since the 1970s. If past trends are examined to the year 2000, the electricity consumption rate is at least ten-fold the level of the 1970s.

The year 1934 witnessed the birth of the first electricity supply service in Kuwait, which was established by a commercial company. The small station was capable of producing "direct current" (DC) only. The production process started with two

30 KW generators and the power was distributed through 200 volt capacity lines. At the beginning, the number of consumers was rather small. As a result of the rapid progress and growth of all aspects of society, demand rose considerably, rendering the existing plants unable to cope with it. This chaotic situation led the government in 1951 to procure the commercial company and establish the Directorate of Electricity, which later became MEW, to provide and distribute an adequate electric supply. Upon taking over, the Directorate constructed the first power plant near the sea shore to use the seawater for cooling purposes.

Power plants

The growth in the power consumption rate and the establishment of the Shuaiba Industrial Area led in 1965 to the construction of the Shuaiba North power plant, operated by steam turbines with a capacity of 70 MW. In the light of the continuing increase in the electrical power consumption as a result of urban development and industrial expansion, MEW constructed more plants operated by steam or gas turbine units. Steam turbine units have a larger capacity than gas turbine units. Table 6.5 indicates the major specification of these plants.



Table 6.5 Power plants in Kuwait

Source: MEW Yearly Statistics Book: Electricity, 2002.

Although all plants were damaged to a certain extent by the Iraqi troops and were repaired, Al-Shuwaikh and Al-Shuaibah North power stations were so severely damaged that they were beyond repair and their operations were ceased.

To sustain the excessive growth of electrical power demand, MEW has continuously updated this utility. Figure 6.4 illustrates the development of power station installed capacity over the past 25 years.

Electrical networks

In the early stages, the electrical networks employed overhead lines with copper conductors on wooden poles. The operating voltage was 200 DC. Later, the network voltage was changed to 380/220 50 Hertz alternative current (AC). In 1951, the networks' voltage was raised to 11 Kilo Volt (KV) to extend the range of the network to satisfy the continuous growth of electrical load as a result of the increase in the number of consumers. Underground cables were also constructed for power distribution, in addition to overhead lines.



Year

Figure 6.4 Growth of power station installed capacity
Source: MEW yearly Statistics Book: Electricity, 2002.

Consequently, MEW repeatedly constructed lines carrying higher power to feed the newly developed remote suburban areas. Following the continuous increase in demand for electricity it was decided to introduce a new 300 KV network to reinforce the expansion of electrical networks. Such high voltage adequately permits the transmission of large amounts of power to the centres of consumption, i.e. houses, factories, hospitals, etc.

The current structure of the electrical network consists of extra high voltage (300 KV), high voltage (132/33 KV), medium voltage (11 KV), low voltage (415 V) and street lighting.

Supervisory Control Centres (SCCs)

A high capacity and widespread power system including four generating stations, hundreds of substations and thousands of kilometres of overhead lines and cables cannot operate normally and efficiently unless it has control centres to manage the huge tasks assigned. In the light of this, MEW has established Supervisory Control Centres (SCCs). These centres are the heart of the power system organisation which deals with power system operation. The purpose of the SCC is to bring together all the requisite information of each power plant element from different power stations and substations. Then, necessary commands are sent back to these stations and substations for efficient operation of the power system. Briefly, SCCs are responsible for the following:

- to coordinate the activities of power generation, its transmission and distribution
- to secure the continuity of the service to the public
- to ensure the efficiency of the systems
- to ensure the safety of the workers and the equipment

The SCCs are distributed in different locations to cover the entire network. These centres require very sensitive, reliable and accurate advanced systems. These include information collection systems, telephony systems and peripherals, communication systems and peripherals, computer systems and peripherals and auxiliary power systems.

Foreign firms involvement

Since its establishment in 1953 and due to socio-economic and political issues, MEW had devoted efforts to acquiring the latest technologies which could secure the local demand for electricity and water, through highly experienced foreign firms (MEW Statistical Year Book: Electricity, 2002). As a result, it contracted various firms to design and construct the power plants and the SCCs. These firms are:

- Westinghouse
- Siemens
- Mitsubishi Heavy Industry
- Hyundai Engineering and Construction

The following paragraphs briefly discuss the type of involvement of each of these firms with MEW:

- *Westinghouse*

As described previously, Westinghouse was the first foreign firm that MEW contracted in 1957 to design and construct the first MSF desalination plant. Westinghouse cooperation with MEW finished in 1968 when it built two units of 2 MIGD MSF plant.

- *Siemens*

Business ties between Kuwait and Siemens are based on more than 40 years of successful cooperation, with Siemens having established its first office in Kuwait in 1959. Siemens main representative in Kuwait is National and German Electrical and Electronic Service Company (NGEECO), a joint venture with Kuwaiti partners in which Siemens holds a 49% stake. NGEECO offers expert consulting, comprehensive technical support, reliable customer service and end-to-end solutions from nearly all Siemens Group – power generation, power transmission and distribution, automation and drives and industrial solutions and services – as well as from the information and communication and the lighting segments.

Since 1993, NGEECO has been responsible for maintaining Siemens and Hitachi transformer substations in Kuwait. In 1999, the maintenance contract was extended by MEW for a further three years. A turnkey contract worth US\$20 million was signed to supply and commission a transformer substation, extending the Kuwaiti 132 KV network. Siemens also received an order for two additional 132/11 KV substations.

- *Mitsubishi Heavy Industry*

MEW contracted Mitsubishi Heavy Industry to embark on the 2400 MW Sabiya Power Plant project in the north of Kuwait in 1989. The conventional thermal station was planned to provide support for existing power stations under emergency situations and to ensure comfortable coverage of potential power demand into the next millennium. The contract was disrupted by the Iraqi invasion of Kuwait in 1990. Under the reopened contract, Mitsubishi Heavy Industry resumed work to expand the Sabiya oil-fired power plant in 1994. Mitsubishi was engaged in the construction work on a full turnkey basis, including assembly and installation of eight 300 MW boilers and steam turbines. The 2400 MW project was completed in 2001 at a cost of US\$2.3 billion.

- *Hyundai Engineering and Construction*

Hyundai Engineering and Construction and local partner United Gulf Construction Company were awarded a US\$450 million civil work assignment contract for the Sabiya power plant. The Korean group held off competition from local, UK and French construction groups.

The consumption rate

The demand for electricity in Kuwait is characterised by high load in the summer, especially in July and August due to the heavy usage of air-conditioning systems, and low load in the winter. Also, the electrical load fluctuates during the summer holidays because a large number of people leave the country for their vacations.

Although the population size and the scale of industries in Kuwait are small, the consumption rate of electricity in Kuwait is one of the highest in the world (Burney, 1998). Once again, the main reason for this unusual consumption is the extremely cheap price of electricity. The estimated cost of producing 1 KW of electrical power is US\$0.45, while the consumer pays only US\$0.06 (Nadeem and Al-Matrouk, 1996).

Another substantial reason is the lack of structured educational programmes, rather than the current short advertisements through the media, which could direct the general public attention to the dimensions of this problem (Al-Mazidi, 1995). The per capita consumption rate is illustrated in the Table 6.6 and Figure 6.5.

Fuel networks

All of the dual-purpose power plants, i.e. electrical power generation and water desalination, consume the country's natural resources of fuel, namely oil (crude



Table 6.6 Per capita consumption of electrical power in Kuwait
Source: MEW Yearly Statistics Book: Electricity, 2002.



Figure 6.5 The increase of per capita consumption in electrical power
Source: MEW Yearly Statistics Book: Electricity, 2002.

oil, gas oil and heavy fuel oil) and natural gas.

Fuel networks consist of several lines with different diameters and lengths extending to several areas around the country. These lines are as follows:

- major lines (gas and liquid fuel) to feed power stations and water desalination plants
- gas scrubbers for reducing pressure and purifying gas
- the main network lines for natural gas

The following table demonstrates the consumption of energy (oil and natural gas) and the associated cost for the last three years (1998- 2001).



Table 6.7 Energy consumption for the period 1998-2001
Source: MEW Yearly Statistics Book: Electricity, 2002.

Expenditures

The estimated cost of constructing a dual-purpose plant with capacity of 2400 MW and 96 MIGD is approximately US\$2.3 billion 06 (Nadeem and Al-Matrouk 1996). This value excludes the operation cost, maintenance, wages, fuel and the spare parts. A 2400 MW power station consumes an average of 640 tons of

liquid fuel per hour. The average annual cost of total consumed fuel for each station is estimated to be US\$190 million.

Future plans

MEW is intending to build gas turbine units with a total capacity of about 1000 MW at Shuaiba power station.

Also, the annual rise in electrical power demand, which is around 8% and is expected to follow this pattern in the coming years, has led MEW to build a new steam power station in order to meet future demand. The Az-Zour North Steam Power Station project is proposed to have a total capacity of 2500 MW. This project is still in the feasibility study phase.

During the annual GCC meeting in 1997, the ministers of MEW in the GCC countries made an initial agreement to establish a Power Grid Network to link all of the electricity utilities in the GCC. The project will reduce the consumption of electricity and decrease its cost. It is divided into three phases. In phase one the electrical networks in Kuwait, Saudi Arabia, Bahrain and Qatar will be linked. In phase two, Oman and UAE will be linked. The final phase will link the west and the east of the Arab world. Gulf finance ministers asked the Gulf organisation for industrial consultation to conduct a marketing study of the power grid network. The GCC states will request companies implementing the project to pay a certain amount of money annually in return for their use of the network. The estimated cost of this project is US\$3 billion.

6.4 Conclusion

The discovery of oil in Kuwait was the major contributor to the country's massive socio-economic development. Among other sectors, health, communication and utility sectors have played an essential role in this development. MoH, MoC and MEW are owned, operated and maintained by the

government. The government also controls and regulates their provided services. Their infrastructures are mostly based on advanced technology systems and equipment.

These ministries were chosen as case studies for the purpose of investigating the technology transfer process to Kuwait, as well as to assess their technological capability. Since they represent minor case studies (as discussed in Chapter 8) a brief profile for MoH and MoC was presented in this chapter. On the other hand, an in-depth profile of MEW was provided because MEW constituted the major case study of this research.

In the next chapter the adopted research methodology is identified. Also, it discusses the technological capability assessment model that was implemented in this research.